

# **Gaither's Dictionary of Scientific Quotations**

**Volume I**

# Gaither's Dictionary of Scientific Quotations

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

**Carl C. Gaither**

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

and

**Alma E. Cavazos-Gaither**

*BA (Spanish)*

**Volume I**

**Abortion – Medical Science**

 Springer

Carl C. Gaither  
502 Weiss Drive  
Killeen, Texas 76542

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

ISBN: 978-0-387-49575-0

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

Library of Congress Control Number: 2007938494

© 2008 Springer Science+Business Media, LLC

All rights reserved. This work may not be translated or copied in whole or in part without the written permission of the publisher (Springer Science+Business Media, LLC, 233 Spring Street, New York, NY 10013, USA), except for brief excerpts in connection with reviews or scholarly analysis. Use in connection with any form of information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed is forbidden.

The use in this publication of trade names, trademarks, service marks and similar terms, even if they are not identified as such, is not to be taken as an expression of opinion as to whether or not they are subject to proprietary rights.

Printed on acid-free paper.

9 8 7 6 5 4 3 2 1

springer.com

***This book is dedicated to***

*Timothy M. Donovan, Jr.*

*Aubree D. Moore-Woorley*

*Liliana Noemi Lopez*

*Annette Koth*

*James and Sharon Smith*

*Alice Pomeroy, USA (Retired)*

*Laura Rodriguez, USNR*

*Margaret Evans*

***And to the memory of***

*Rosa Cervantes (1952–1997)*

*Clifford C. Gaither, LTC USAF (Retired) (1917–2000)*

*Pearl Gaither, RN (1917–2002)*

*Maurice Moore II (1983–2004)*

*Magdalena Cavazos (1923–2004)*

*Pedro T. Villaneuva (1925–2006)*

# Preface

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

# Contents

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



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

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

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

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

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

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

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

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



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

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

# Contents (Volume II)

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

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

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

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

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

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



## A

### ABORTION

#### **Hachamovitch, Moshe**

American physician

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

In Louise Kapp Howe

*Moments on Maple Street*

Chapter Three (p. 21)

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

#### **Hippocrates** 460 BCE–377 BCE

Greek physician

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

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

*Hippocratic Writings*

The Oath (p. xiii)

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

#### **Kennedy, Florynce** 1916–2000

American black activist and lawyer

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

The Verbal Karate of Florynce Kennedy

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

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

No biographical data available

Physicians roasted on the spit;

Is learning the name of it?

For complications, spare no precaution;

To save a life think abortion.

On Renewed Maternal Mortality Reports

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

#### **Pope Pius XI** 1857–1939

Bishop of Rome and Italian scholar

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

*Casti connubii*

December 31, 1930

#### **Reagan, Ronald W.** 1911–2004

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

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

Presidential campaign debate, Baltimore, Maryland, 21 September 1980

#### **Tertullian** ca. 162–224

North African theologian

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

*Apologeticus*

IX, 197

Printed by Thomas Harper. London, England. 1655

### ABSORPTION LINE

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

German chemist

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

*The Life and Experiences of Sir Henry Enfield Roscoe*

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

London, England. 1906

### ABSTRACTNESS

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

Scottish-American mathematician and educator

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

*The Development of Mathematics* (p. 248)

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

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

*Mathematics* (p. 19)

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

#### **Einstein, Albert** 1879–1955

German-born physicist

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

In Lincoln Barnett

*The Universe and Dr. Einstein*

Forward (p. 1)

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

#### **Gell-Mann, Murray** 1929–

American physicist

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

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

Quarks

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

**Joubert, Joseph** 1754–1824

French moralist

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

Translated by H.P. Collins

*Pensées and Letters of Joseph Joubert*

Chapter XI (p. 88)

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

**Kemeny, John** 1926–92

Hungarian-born mathematician

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

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

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

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

Wadsworth, Inc. Belmont, California, USA. 1984

## ABSTRACTION

**Bacon, Sir Francis** 1561–1626

English lawyer, statesman, and essayist

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

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

*Novum Organum*

Second Book, Section 4 (p. 137)

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

**Bagehot, Walter** 1826–77

English journalist

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

*Physics and Politics*

Chapter 6 (p. 196)

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

**Bohm, David** 1917–92

American physicist

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

In C.H. Waddington (ed.)

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

Further Remarks on Order (p. 42)

Aldine Publishing Company. Chicago, Illinois, USA. 1968

**Boole, George** 1815–64

English mathematician

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

*A Treatise on Differential Equations*

Preface (p. vi)

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

**Devlin, Keith** 1947–

English mathematician and writer

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

*Mathematics: The Science of Patterns*

Chapter 2 (p. 55)

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

**Dingle, Herbert** 1890–1978

English astrophysicist

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

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

Williams & Norgate Ltd. London, England. 1931

**Einstein, Albert** 1879–1955

German-born physicist

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

regions of highest abstraction.

Translated by Alan Harris

*Essays in Science*

The Problem of Space (p. 69)

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

**Haber, Fritz** 1868–1934

German physical chemist

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

In Richard Willstätter

*From My Life: The Memoirs of Richard Willstätter*

Chapter 8 (p. 174)

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

**Huxley, Aldous** 1894–1963

English writer and critic

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

*Literature and Science*

Chapter 3 (p. 9)

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

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

English philosopher, logician, and social reformer

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

*The Scientific Outlook*

Chapter III (p. 87)

George Allen & Unwin Ltd. London, England. 1931

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

Irish mathematician

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

*Beethoven, His Spiritual Development*

Art and Reality (pp. 21–22)

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

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

English novelist, historian, and sociologist

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

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

*The Great Ideas Today, 1971*

The Time Machine, Chapter One (p. 449)

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

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

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

*Science and the Modern World*

Chapter I (p. 4)

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

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

*Science and the Modern World*

Chapter II (pp. 31–32)

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

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

*Science and the Modern World*

Chapter II (p. 32)

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

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

*Science and the Modern World*

Chapter II (p. 51)

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

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

*The Concept of Nature*

Chapter VIII (p. 171)

At the University Press. Cambridge, England. 1920

**Wilder, Raymond L.** 1896–1982

American mathematician

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

*Introduction to the Foundations of Mathematics*

Chapter XII (p. 275)

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

**Young, John Zachary** 1907–97

English zoologist

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

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

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

## ABYSS

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

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

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

## ACADEMIC MIND

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

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

Presidential address, First Indian Statistical Congress, 1938

## ACCELERATOR

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

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

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

## ACCIDENT

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

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

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

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

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

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

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

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

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

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

Nothing under the sun is coincidence.

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

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

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

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

## ACCOMPLISHMENT

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

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

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

In Camille Matignon

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

Marcellin Berthelot (p. 684)

Government Printing Office. Washington, D.C. 1908

**Einstein, Albert** 1879–1955

German-born physicist

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

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

## ACCURACY

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

English writer and mathematician

“How is bread made?”

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

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

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

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

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

*The Complete Works of Lewis Carroll*

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

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

**Darwin, Charles Robert** 1809–82

English naturalist

...good heavens, how difficult accuracy is!

In Francis Darwin (ed.)

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

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

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

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

In Francis Darwin (ed.)

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

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

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

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

In Francis Darwin (ed.)

*More Letters of Charles Darwin* (Volume 2)

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

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

**Fresenius, C. R.** 1818–97

German chemist

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

In Ferenc Szabadváry

*History of Analytical Chemistry*

Chapter VII (p. 176)

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

**Gombrich, Ernst Hans** 1909–2001

English art historian and scholar

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

*Art and Illusion*

Part II, Chapter VIII (p. 269)

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

**Hume, David** 1711–76

Scottish philosopher and historian

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

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

*An Enquiry Concerning Human Understanding*

Section I (p. 453)

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

**Huxley, Thomas Henry** 1825–95

English biologist

Accuracy is the foundation of everything else...

*Collected Essays* (Volume 3)

*Science and Education*

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

Macmillan & Company Ltd. London, England. 1904

**Jevons, William Stanley** 1835–82

English economist and logician

Numerical precision is the soul of science....

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

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

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

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

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

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

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

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

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

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

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

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

## ACID

**Huheey, James E.**  
American chemist

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

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

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

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

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

## ACTIVITY

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

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

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

## ACTUARY

**Karpansky, L.**

No biographical data available

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

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

## ADAPTABILITY

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

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

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

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