



CONCEPTUAL
Integrated Science
SECOND EDITION

Paul G. Hewitt
City College of San Francisco

Suzanne Lyons
California State University, Sacramento

John Suchocki
Saint Michael's College

Jennifer Yeh
University of California, San Francisco

PEARSON

Boston Columbus Indianapolis New York San Francisco Upper Saddle River
Amsterdam Cape Town Dubai London Madrid Milan Munich Paris Montréal Toronto
Delhi Mexico City São Paulo Sydney Hong Kong Seoul Singapore Taipei Tokyo

Publisher: Jim Smith
Project Manager: Chandrika Madhavan
Editorial Manager: Laura Kenney
Editorial Assistant: Kyle Doctor
Marketing Manager: Will Moore
Senior Program Manager: Corinne Benson
Media Producer: Kate Brayton
Production Service and Composition: Cenveo Publisher Services
Project Manager, Production Service: Cindy Johnson, Cenveo Publisher Services
Copyeditor: Carol Reitz
Design Manager: Derek Bacchus
Text Designer: Naomi Schiff, Seventeenth Street Studios
Cover Designer: Naomi Schiff, Seventeenth Street Studios
Illustrations: Rolin Graphics, Inc.
Photo Researcher: Sarah Bonner, Bill Smith Group
Image Lead: Maya Melenchuk
Manufacturing Buyer: Jeffrey Sargent
Printer and Binder: R.R. Donnelley
Cover Printer: Lehigh Phoenix
Cover Photo Credit: age fotostock / SuperStock

Credits and acknowledgments borrowed from other sources and reproduced, with permission, in this textbook appear on page C-1.

Copyright © 2013, 2007 Pearson Education, Inc. All rights reserved. Manufactured in the United States of America. This publication is protected by Copyright, and permission should be obtained from the publisher prior to any prohibited reproduction, storage in a retrieval system, or transmission in any form or by any means, electronic, mechanical, photocopying, recording, or likewise. To obtain permission(s) to use material from this work, please submit a written request to Pearson Education, Inc., Permissions Department, 1900 E. Lake Ave., Glenview, IL 60025. For information regarding permissions, call (847) 486-2635.

Many of the designations used by manufacturers and sellers to distinguish their products are claimed as trademarks. Where those designations appear in this book, and the publisher was aware of a trademark claim, the designations have been printed in initial caps or all caps.

MasteringPhysics® is a trademark, in the U.S. and/or other countries, of Pearson Education, Inc. or its affiliates.

[Library of Congress CIP data to be inserted here.]

ISBN 10: **0-321-81850-4**; ISBN 13: **978-0-321-81850-8** (Student Edition)
ISBN 10: **0-321-82745-7**; ISBN 13: **978-0-321-82745-6** (Exam Copy)
ISBN 10: **0-133-10526-1**; ISBN 13: **978-0-133-10526-1** (School binding)
ISBN 10: **0-321-82287-0**; ISBN 13: **978-0-321-82287-1** (Books a la Carte Edition)

PEARSON

www.pearsonhighered.com

1 2 3 4 5 6 7 8 9 10—RRD—15 14 13 12 11

*This book is dedicated to the inquiring minds devoted
to protecting the beautiful planet we call home.*

Brief Contents

- 1 About Science 1

PART ONE

Physics 17

- 2 Describing Motion 18
3 Newton's Laws of Motion 44
4 Momentum and Energy 69
5 Gravity 95
6 Heat 121
7 Electricity and Magnetism 147
8 Waves—Sound and Light 178

PART TWO

Chemistry 213

- 9 Atoms and the Periodic Table 214
10 The Atomic Nucleus and Radioactivity 243
11 Investigating Matter 272
12 Chemical Bonds and Mixtures 297
13 Chemical Reactions 336
14 Organic Compounds 376

PART THREE

Biology 409

- 15 The Basic Unit of Life—The Cell 410
16 Genetics 445
17 The Evolution of Life 482
18 Diversity of Life on Earth 516
19 Human Biology I—Control and Development 548
20 Human Biology II—Care and Maintenance 580
21 Ecology 608

PART FOUR

Earth Science 643

- 22 Plate Tectonics 644
23 Rocks and Minerals 672
24 Earth's Surface—Land and Water 702
25 Surface Processes 729
26 Weather 755
27 Environmental Geology 787

PART FIVE

Astronomy 819

- 28 The Solar System 820
29 The Universe 854

APPENDIX A:

- On Measurement and Unit Conversion A-1

APPENDIX B:

- Linear and Rotational Motion A-5

APPENDIX C:

- More on Vectors A-11

APPENDIX D:

- Exponential Growth and Doubling Time A-12

APPENDIX E:

- Physics of Fluids A-17

APPENDIX F:

- Chemical Equilibrium A-23

ODD-NUMBERED SOLUTIONS

S-1

GLOSSARY

G-1

CREDITS

C-1

INDEX

I-1

Detailed Contents

1	About Science	1			
1.1	A Brief History of Advances in Science	2			
1.2	Mathematics and Conceptual Integrated Science	3			
1.3	The Scientific Method—A Classic Tool	3			
1.4	The Scientific Hypothesis	5			
1.5	The Scientific Experiment	6			
1.6	Facts, Theories, and Laws	7			
1.7	Science Has Limitations	8			
1.8	Science, Art, and Religion	9			
1.9	Technology—The Practical Use of Science	10			
1.10	The Natural Sciences: Physics, Chemistry, Biology, Earth Science, and Astronomy	11			
1.11	Integrated Science	11			
	INTEGRATED SCIENCE 1A CHEMISTRY AND BIOLOGY				
	<i>An Investigation of Sea Butterflies</i>	12			
PART ONE					
	Physics	17			
2	Describing Motion	18			
2.1	Aristotle on Motion	19			
2.2	Galileo's Concept of Inertia	19			
2.3	Mass—A Measure of Inertia	22			
2.4	Net Force	24			
2.5	The Equilibrium Rule	25			
2.6	The Support Force	26			
2.7	Equilibrium of Moving Things	29			
2.8	The Force of Friction	30			
	INTEGRATED SCIENCE 2A BIOLOGY, ASTRONOMY, CHEMISTRY, AND EARTH SCIENCE				
	<i>Friction Is Universal</i>	31			
2.9	Speed and Velocity	32			
2.10	Acceleration	35			
	INTEGRATED SCIENCE 2B BIOLOGY				
	<i>Hang Time</i>	37			
3	Newton's Laws of Motion	44			
3.1	Newton's First Law of Motion	45			
3.2	Newton's Second Law of Motion	45			
	INTEGRATED SCIENCE 3A BIOLOGY				
	<i>Gliding</i>	51			
3.3	Forces and Interactions	53			
3.4	Newton's Third Law of Motion	54			
	INTEGRATED SCIENCE 3B BIOLOGY				
	<i>Animal Locomotion</i>	58			
3.5	Vectors	60			
3.6	Summary of Newton's Three Laws	61			
4	Momentum and Energy	69			
4.1	Momentum	70			
4.2	Impulse	70			
4.3	Impulse–Momentum Relationship	71			
	INTEGRATED SCIENCE 4A BIOLOGY				
	<i>The Impulse–Momentum Relationship in Sports</i>	72			
4.4	Conservation of Momentum	74			
4.5	Energy	76			
4.6	Power	78			
4.7	Potential Energy	78			
4.8	Kinetic Energy	80			
4.9	The Work–Energy Theorem	81			
4.10	Conservation of Energy	84			
	INTEGRATED SCIENCE 4B BIOLOGY AND CHEMISTRY				
	<i>Glucose: Energy for Life</i>	85			
4.11	Machines	86			
5	Gravity	95			
5.1	The Legend of the Falling Apple	96			
5.2	The Fact of the Falling Moon	96			

vi DETAILED CONTENTS

5.3	Newton's Law of Universal Gravitation	96	7.4	Electric Potential	152
5.4	Gravity and Distance: The Inverse-Square Law	97	7.5	Conductors and Insulators	153
5.5	The Universal Gravitational Constant, G	99	7.6	Voltage Sources	154
	INTEGRATED SCIENCE 5A BIOLOGY <i>Your Biological Gravity Detector</i>	99	7.7	Electric Current	155
5.6	Weight and Weightlessness	102	7.8	Electrical Resistance	156
	INTEGRATED SCIENCE 5B BIOLOGY <i>Center of Gravity of People</i>	103	7.9	Ohm's Law	157
5.7	Centripetal Force Can Simulate Gravity	104		INTEGRATED SCIENCE 7A BIOLOGY <i>Electric Shock</i>	158
5.8	Projectile Motion	105	7.10	Electric Circuits	160
5.9	Projectile Altitude and Range	108	7.11	Electric Power	161
5.10	The Effect of Air Drag on Projectiles	109	7.12	The Magnetic Force	162
5.11	Fast-Moving Projectiles—Satellites	110	7.13	Magnetic Fields	163
5.12	Elliptical Orbits	111		INTEGRATED SCIENCE 7B BIOLOGY AND EARTH SCIENCE <i>Earth's Magnetic Field and the Ability of Organisms to Sense It</i>	166
	INTEGRATED SCIENCE 5C ASTRONOMY <i>Escape Speed</i>	113	7.14	Magnetic Forces on Moving Charges	167
			7.15	Electromagnetic Induction	169
6	Heat	121	8	Waves—Sound and Light	178
6.1	The Kinetic Theory of Matter	122	8.1	Vibrations and Waves	179
6.2	Temperature	122	8.2	Wave Motion	180
6.3	Absolute Zero	123	8.3	Transverse and Longitudinal Waves	182
6.4	What Is Heat?	124	8.4	The Nature of Sound	182
6.5	The Laws of Thermodynamics	126		INTEGRATED SCIENCE 8A BIOLOGY <i>Sensing Pitch</i>	183
	INTEGRATED SCIENCE 6A CHEMISTRY AND BIOLOGY <i>Entropy</i>	127	8.5	Resonance	185
6.6	Specific Heat Capacity	129	8.6	The Nature of Light	186
	INTEGRATED SCIENCE 6B EARTH SCIENCE <i>Specific Heat Capacity and Earth's Climate</i>	131	8.7	Reflection	188
6.7	Thermal Expansion	133	8.8	Transparent and Opaque Materials	190
6.8	Heat Transfer: Conduction	136	8.9	Color	192
6.9	Heat Transfer: Convection	137		INTEGRATED SCIENCE 8B BIOLOGY <i>Mixing Colored Lights</i>	194
6.10	Heat Transfer: Radiation	139	8.10	Refraction	196
7	Electricity and Magnetism	147	8.11	Diffraction	200
7.1	Electrical Force and Charge	148	8.12	Interference	201
7.2	Coulomb's Law	149	8.13	The Doppler Effect	203
7.3	Electric Field	151		INTEGRATED SCIENCE 8C ASTRONOMY <i>The Doppler Effect and the Expanding Universe</i>	204
			8.14	The Wave–Particle Duality	205

PART TWO

Chemistry 213

9 Atoms and the Periodic Table 214

INTEGRATED SCIENCE 9A PHYSICS <i>Atoms Are Ancient and Empty</i>	215
9.1 The Elements	216
9.2 Protons and Neutrons	218
9.3 The Periodic Table	221
INTEGRATED SCIENCE 9B BIOLOGY AND EARTH SCIENCE <i>Physical and Conceptual Models</i>	226
9.4 Identifying Atoms Using the Spectroscope	229
9.5 The Quantum Hypothesis	231
9.6 Electron Waves	234
9.7 The Noble Gas Shell Model	236

10 The Atomic Nucleus and Radioactivity 243

10.1 Radioactivity	244
INTEGRATED SCIENCE 10A BIOLOGY <i>Radiation Dosage</i>	246
10.2 The Strong Nuclear Force	249
10.3 Half-Life and Transmutation	251
INTEGRATED SCIENCE 10B BIOLOGY AND EARTH SCIENCE <i>Radiometric Dating</i>	255
10.4 Nuclear Fission	257
10.5 Mass–Energy Equivalence	262
INTEGRATED SCIENCE 10C ASTRONOMY <i>Nuclear Fusion</i>	264

11 Investigating Matter 272

11.1 Chemistry: The Central Science	273
11.2 The Submicroscopic View of Matter	274
11.3 Phase Changes	277
11.4 Physical and Chemical Properties	279
11.5 Determining Physical and Chemical Changes	282

11.6 Elements to Compounds	284
11.7 Naming Compounds	287
INTEGRATED SCIENCE 11A PHYSICS AND BIOLOGY <i>The Advent of Nanotechnology</i>	288

12 Chemical Bonds and Mixtures 297

12.1 Electron-Dot Structures	298
12.2 The Ionic Bond	299
INTEGRATED SCIENCE 12A EARTH SCIENCE <i>Metals from Earth</i>	304
12.3 The Covalent Bond	307
12.4 Polar Covalent Bonds	310
12.5 Molecular Polarity	312
12.6 Molecular Attractions	315
INTEGRATED SCIENCE 12B BIOLOGY AND EARTH SCIENCE <i>Most Materials Are Mixtures</i>	320
12.7 Describing Solutions	323
12.8 Solubility	327

13 Chemical Reactions 336

13.1 Chemical Equations	337
13.2 Energy and Chemical Reactions	339
13.3 Reaction Rates	343
INTEGRATED SCIENCE 13A EARTH SCIENCE AND BIOLOGY <i>Catalysts</i>	348
13.4 Acids Donate Protons; Bases Accept Them	350
13.5 Acidic, Basic, and Neutral Solutions	355
INTEGRATED SCIENCE 13B EARTH SCIENCE <i>Acid Rain and Ocean Acidification</i>	358
13.6 Losing and Gaining Electrons	361
INTEGRATED SCIENCE 13C PHYSICS <i>Batteries and Fuel Cells</i>	363
13.7 Corrosion and Combustion	366

14 Organic Compounds 376

14.1 Hydrocarbons	377
14.2 Unsaturated Hydrocarbons	381
14.3 Functional Groups	383

14.4	Alcohols, Phenols, and Ethers	384
14.5	Amines and Alkaloids	388
14.6	Carbonyl Compounds	390
	INTEGRATED SCIENCE 14A BIOLOGY	
	<i>Drug Action</i>	394
14.7	Polymers	396

PART THREE

Biology 409

15 The Basic Unit of Life—The Cell 410

15.1	Characteristics of Life	411
	INTEGRATED SCIENCE 15A CHEMISTRY	
	<i>Macromolecules Needed for Life</i>	412
15.2	Cell Types: Prokaryotic and Eukaryotic	415
	INTEGRATED SCIENCE 15B PHYSICS	
	<i>The Microscope</i>	417
15.3	Tour of a Eukaryotic Cell	419
15.4	The Cell Membrane	421
15.5	Transport Into and Out of Cells	422
15.6	Cell Communication	426
15.7	How Cells Reproduce	427
15.8	How Cells Use Energy	430
	INTEGRATED SCIENCE 15C CHEMISTRY	
	<i>ATP and Chemical Reactions in Cells</i>	431
15.9	Photosynthesis	434
15.10	Cellular Respiration and Fermentation	437

16 Genetics 445

16.1	What Is a Gene?	446
16.2	Chromosomes: Packages of Genetic Information	446
	INTEGRATED SCIENCE 16A CHEMISTRY	
	<i>The Structure of DNA</i>	448
16.3	DNA Replication	450
16.4	How Proteins Are Built	450
16.5	Genetic Mutations	455
	INTEGRATED SCIENCE 16B PHYSICS	
	<i>How Radioactivity Causes Genetic Mutations</i>	457
16.6	Meiosis and Genetic Diversity	459
16.7	Mendelian Genetics	461

16.8	More Wrinkles: Beyond Mendelian Genetics	466
16.9	The Human Genome	469
16.10	Cancer: Genes Gone Awry	471
	INTEGRATED SCIENCE 16C EARTH SCIENCE	
	<i>Environmental Causes of Cancer</i>	472
16.11	Transgenic Organisms and Cloning	472
16.12	DNA Technology—What Could Possibly Go Wrong?	475

17 The Evolution of Life 482

17.1	The Origin of Life	483
	INTEGRATED SCIENCE 17A ASTRONOMY	
	<i>Did Life on Earth Originate on Mars?</i>	485
17.2	Early Life on Earth	485
17.3	Charles Darwin and <i>The Origin of Species</i>	487
17.4	How Natural Selection Works	489
17.5	Adaptation	492
	INTEGRATED SCIENCE 17B PHYSICS	
	<i>Staying Warm and Keeping Cool</i>	495
17.6	Evolution and Genetics	496
17.7	How Species Form	499
17.8	Evidence of Evolution	503
	INTEGRATED SCIENCE 17C EARTH SCIENCE	
	<i>Fossils: Earth's Tangible Evidence of Evolution</i>	506
17.9	The Evolution of Humans	508

18 Diversity of Life on Earth 516

18.1	Classifying Life	517
18.2	The Three Domains of Life	520
18.3	Bacteria	521
18.4	Archaea	523
18.5	Protists	523
18.6	Plants	525
	INTEGRATED SCIENCE 18A PHYSICS AND CHEMISTRY	
	<i>Moving Water up a Tree</i>	531
18.7	Fungi	532
18.8	Animals	533
	INTEGRATED SCIENCE 18B EARTH SCIENCE AND CHEMISTRY	
	<i>Coral Bleaching and Ocean Acidification</i>	534
	INTEGRATED SCIENCE 18C PHYSICS	
	<i>How Birds Fly</i>	541
18.9	Viruses and Prions	542

19 Human Biology I—Control and Development 548

19.1	Organization of the Human Body	549
19.2	Homeostasis	550
19.3	The Brain	551
19.4	The Nervous System	553
19.5	How Neurons Work	556
	INTEGRATED SCIENCE 19A PHYSICS <i>How Fast Can Action Potentials Travel?</i>	558
	INTEGRATED SCIENCE 19B CHEMISTRY <i>Endorphins</i>	560
19.6	The Senses	562
19.7	Hormones	566
19.8	Reproduction and Development	570
19.9	The Skeleton and Muscles	573

20 Human Biology II—Care and Maintenance 580

20.1	Integration of Body Systems	581
20.2	The Circulatory System	581
	INTEGRATED SCIENCE 20A CHEMISTRY <i>Hemoglobin</i>	584
20.3	Respiration	585
20.4	Digestion	587
20.5	Nutrition, Exercise, and Health	590
	INTEGRATED SCIENCE 20B PHYSICS AND CHEMISTRY <i>Low-Carb Versus Low-Cal Diets</i>	591
20.6	Excretion and Water Balance	593
20.7	Keeping the Body Safe: Defense Systems	595

21 Ecology 608

21.1	Organisms and Their Environments	609
21.2	Population Ecology	610
21.3	Human Population Growth	614
21.4	Species Interactions	616
21.5	Kinds of Ecosystems	622
	INTEGRATED SCIENCE 21A EARTH SCIENCE <i>Materials Cycling in Ecosystems</i>	627
21.6	Energy Flow in Ecosystems	630
	INTEGRATED SCIENCE 21B PHYSICS AND CHEMISTRY <i>Energy Leaks When Organisms Eat</i>	632
21.7	Change in an Ecosystem	633

PART FOUR Earth Science 643

22 Plate Tectonics 644

22.1	Earth Science Is an Integrated Science	645
22.2	Earth's Compositional Layers	646
	INTEGRATED SCIENCE 22A PHYSICS AND CHEMISTRY <i>Earth Developed Layers When It Was Young, Hot, and Molten</i>	648
22.3	Earth's Structural Layers	649
	INTEGRATED SCIENCE 22B PHYSICS <i>Using Seismology to Explore Earth's Interior</i>	651
22.4	Continental Drift—An Idea Before Its Time	653
22.5	Seafloor Spreading—A Mechanism for Continental Drift	655
	INTEGRATED SCIENCE 22C PHYSICS, CHEMISTRY, AND ASTRONOMY <i>Magnetic Stripes Are Evidence of Seafloor Spreading</i>	657
22.6	The Theory of Plate Tectonics	659
	INTEGRATED SCIENCE 22D PHYSICS <i>What Forces Drive the Plates?</i>	660
22.7	Plate Boundaries	662
	INTEGRATED SCIENCE 22E BIOLOGY <i>Life in the Trenches</i>	666

23 Rocks and Minerals 672

23.1	What Is a Mineral?	673
23.2	Mineral Properties	674
23.3	Types of Minerals	677
	INTEGRATED SCIENCE 23A CHEMISTRY <i>The Silicate Tetrahedron</i>	680
23.4	How Do Minerals Form?	681
23.5	What Is Rock?	684
23.6	Igneous Rock	686
23.7	Sedimentary Rock	689
	INTEGRATED SCIENCE 23B BIOLOGY, CHEMISTRY, AND PHYSICS <i>Coal</i>	691
23.8	Metamorphic Rock	692
23.9	The Rock Cycle	694
	INTEGRATED SCIENCE 23C BIOLOGY AND ASTRONOMY <i>Earth's History Is Written in Its Rocks</i>	696

24 Earth's Surface—Land and Water 702

24.1	A Survey of Earth	703
24.2	Crustal Deformation—Folds and Faults	705
24.3	Mountains	708
24.4	Plains and Plateaus	712
24.5	Earth's Waters	713
24.6	The Ocean	714
	INTEGRATED SCIENCE 24A CHEMISTRY AND BIOLOGY	
	<i>The Composition of Ocean Water</i>	716
24.7	Fresh Water	718
24.8	Glaciers	723
	INTEGRATED SCIENCE 24B PHYSICS, CHEMISTRY, AND BIOLOGY	
	<i>Water Pollution</i>	723

25 Surface Processes 729

25.1	Processes That Sculpt Earth: Weathering, Erosion, and Deposition	730
	INTEGRATED SCIENCE 25A PHYSICS, CHEMISTRY, AND BIOLOGY	
	<i>Weathering</i>	732
	INTEGRATED SCIENCE 25B BIOLOGY	
	<i>Soil</i>	735
25.2	The Impact of Running Water	737
25.3	Glaciers—Earth's Bulldozers	742
25.4	Effects of Gravity Alone—Mass Movement	744
25.5	Groundwater Erodes Rock to Make Caves and Caverns	746
25.6	Wave Effects	748
25.7	Wind—Agent of Change	750

26 Weather 755

26.1	The Atmosphere	756
	INTEGRATED SCIENCE 26A PHYSICS	
	<i>Atmospheric Pressure</i>	757
26.2	The Structure of the Atmosphere	759
	INTEGRATED SCIENCE 26B PHYSICS	
	<i>Solar Radiation and the Greenhouse Effect Drive Global Temperature</i>	761
26.3	Temperature Depends on Latitude	765

26.4	Earth's Tilted Axis—The Seasons	766
26.5	Flow of the Atmosphere—Wind	768
	INTEGRATED SCIENCE 26C BIOLOGY	
	<i>Wind Chill</i>	768
26.6	Local and Global Wind Patterns	769
	INTEGRATED SCIENCE 26D PHYSICS	
	<i>The Coriolis Effect</i>	771
26.7	Ocean Currents Distribute Heat	772
26.8	Water in the Atmosphere	774
26.9	Changing Weather—Air Masses, Fronts, and Cyclones	779

27 Environmental Geology 787

27.1	Earthquakes	788
27.2	Tsunami	793
27.3	Volcanoes	794
27.4	Hurricanes	798
	INTEGRATED SCIENCE 27A PHYSICS, CHEMISTRY, BIOLOGY, AND ASTRONOMY	
	<i>Climate Change</i>	801

PART FIVE

Astronomy 819

28 The Solar System 820

28.1	The Solar System and Its Formation	821
28.2	The Sun	825
28.3	The Inner Planets	827
28.4	The Outer Planets	831
	INTEGRATED SCIENCE 28A BIOLOGY	
	<i>What Makes a Planet Suitable for Life?</i>	835
28.5	Earth's Moon	837
28.6	Failed Planet Formation	844

29 The Universe 854

29.1	Observing the Night Sky	855
29.2	The Brightness and Color of Stars	857
29.3	The Hertzsprung–Russell Diagram	859
29.4	The Life Cycles of Stars	862
29.5	Black Holes	867

29.6	Galaxies	871	APPENDIX E:	
	INTEGRATED SCIENCE 29A BIOLOGY		Physics of Fluids	A-17
	<i>The Drake Equation</i>	882		
29.7	Looking Back in Time	883	APPENDIX F:	
29.8	Dark Matter and Dark Energy	887	Chemical Equilibrium	A-23
			ODD-NUMBERED SOLUTIONS	S-1
APPENDIX A:			GLOSSARY	G-1
On Measurement and Unit Conversion	A-1		CREDITS	C-1
APPENDIX B:			INDEX	I-1
Linear and Rotational Motion	A-5			
APPENDIX C:				
More on Vectors	A-11			
APPENDIX D:				
Exponential Growth and Doubling Time	A-12			

Special Features

MATH CONNECTION

Equations as Guides to Thinking	4
Applying the Equilibrium Rule	28
Equations as Guides to Thinking: $a = F/m$	49
When Air Resistance Slows Acceleration	52
Vector Components	61
Quantifying Collisions	77
Work Practice Problems	78
Power Practice Problems	79
Calculating Potential Energy	80
Applying the Work–Energy Theorem	83
Efficiency Calculations	89
Comparing Gravitational Attractions	100
The Heat-Transfer Equation	131
Ohm’s Law	158
Solving Power Problems	162
Frequency and Wave Speed	181
Calculating Atomic Mass	221
Calculating for Solutions	326
Logarithms and pH	357
Why Does Diffusion Limit the Size of Cells?	426
Exponential and Logistic Population Growth	612
Calculate the Age of the Atlantic Ocean	663
How Long Can a Mountain Exist?	732
The Scale of the Solar System	823
The Scale of the Galaxy	881

SCIENCE AND SOCIETY

Pseudoscience	8
Paul Hewitt and the Origin of <i>Conceptual Integrated Science</i>	27
Stem Cells	430
Genetic Counseling	469
DNA Forensics	470
Antibiotic-Resistant Bacteria	494
Ethnobotany	530
Swine Flu	543
Fathers and Testosterone	569
What Are the Odds? Current Major Health Risks	592
The Placebo Effect	598
AIDS	602
Biodiversity, Nature’s Insurance Policy	619
Invasive Species	621
Wangari Maathai and Ecologically Sustainable Development	636
Mining	684
Whose Water Is It?	721
The Dust Bowl	750
Disaster Warnings—When Do You Tell the People?	797
Astrology	861
Falling into a Black Hole	870
Big Bang Helium	886

HISTORY OF SCIENCE

Aristotle	20
Galileo Galilei	21
The Moving Earth	47
Isaac Newton	62
110 Volts	157
Generators and Power Production	171
Cell Theory	417
Discovery of the Double Helix	449
The Peppered Moth	492
Classifying the Platypus	541

TECHNOLOGY

Junk Science	88
Communications Satellites	112
Engineering for Thermal Expansion	136
Electromagnetic Induction in Everyday Technologies	171
Broadcasting Radio Waves	180
Antinoise Technology	204
Gene Therapy	458
Bacterial Clean-Up Crews	522
Mapping the Brain in Action: Functional MRIs	553
Visual Prostheses for the Blind	564
Transplanting Bone Marrow in the Fight Against Cancer	585
Direct Measurement of Continental Drift	658
Synthetic Diamonds	683
Remote Sensing	704

The *Conceptual* *Integrated Science* Photo Album

THIS BOOK IS VERY PERSONAL to the authors, family undertakings shown in the many photographs throughout. Author Paul is seen with wife Lillian on page 58, and Lil again on pages 176, and 210. Lil's dad, Wai Tsan Lee, is on page 176. Paul's grown children begin with son Paul with his mother Millie on page 138, and daughter Leslie in her student days on page 240. Paul's sister (and John's mom) Marjorie Hewitt Suchocki (pronounced Su-hock-ee, with a silent *c*), a leading process theologian, is shown reflectively on page 188. Paul's brother Steve shows Newton's third law with his daughter Gretchen on page 67. Paul's grandchild Emily Abrams opens Part One on page 17. Paul's friends include Tenny Lim pages 1 and 79, Will Maynez on page 77, Burl Grey on page 25, Dan Johnson on page 146 and Bay Johnson (Dan's grandson) on page 185, John Hubisz on page 128, Mike and Jane Jukes on pages 34 and 68, Cassy Cosme on page 73. Little kids that Paul loves include Carlos Vasquez on page 195, Miriam Dijamco and Michelle Anna Wong on page 178, Francesco Ming Giovannuzzi on page 125, and Andrea Wu on pages 94 and 191.

Chemistry author John, who in his "other life" is John Andrew, singer and songwriter walks barefoot on red-hot coals on page 137. John's wife, Tracy, is seen again with oldest son Ian on page 216 and with their second son Evan on page 283. Their third child, Maitreya Rose, is featured in the Chapter 14 opening photograph on page 376. Exploring the microscopic realm with the uncanny resolution of electron waves is cousin George Webster, who is seen on page 234. Friend Rinchen Trashy looks through the spectroscope on page 230. John's former students and co-stars of the Kai and Maile Show from *Conceptual Chemistry Alive!* appear on page 370. Coauthor Leslie Hewitt is seen as a 16 year old inspecting a molecular model on page 240. Nephews and niece Liam, Bo, and Neve Hopwood are seen together in the chemistry part opener of page 213.

Paul's granddaughter Grace Hewitt is featured in the astronomy part opener on page 819. The left two photographs on page 842 show our lab manual author Dean Baird surrounded by crescent shaped images of the Sun during the 2012 solar eclipse. Colleague Paul Doherty, on the far right on page 842, reveals the rarely seen sun circles that formed during same eclipse at the time and place of annular totality.

Biology author Jennifer's daughter Daphne and her prized sunflower open up Biology on page 409. A special thank you to Daphne's aunt Anita Sherman for bringing Daphne the sunflower all the way from her Baltimore garden! Jennifer's kids Io and Pico show off their sunscreen and sun hats on page 472. Io also appears on page 552, where she engages in her favorite pastime. Jennifer's husband Nils shoots a basket on page 591. And Jennifer's sister Pam, who is also a biologist, shows a specimen she caught (and later released) during an ecological study in Nepal on page 609.

Earth-Science author Suzanne Lyons with her children Simone and Tristan are shown on page 211. Tristan is on page 32 demonstrating friction and Simone is on page 192 pondering the color of a rose. Suzanne's husband Pete demonstrates thermodynamics in everyday life on page 126.

These photographs are of people very dear to the authors, which makes *Conceptual Integrated Science* all the more our labor of love.



Paul G. Hewitt

Former silver-medal boxing champion, sign painter, uranium prospector, and soldier, Paul began college at the age of 27, with the help of the GI Bill. He pioneered the conceptual approach to teaching physics at the City College of San Francisco. He has taught as a guest teacher at various middle schools and high schools, the University of California at both the Berkeley and Santa Cruz campuses, and the University of Hawaii at both the Manoa and Hilo campuses. He also taught for 20 years at the Exploratorium in San Francisco, which honored him with its Outstanding Educator Award in 2000. He is the author of *Conceptual Physics* and a co-author of *Conceptual Physical Science* and *Conceptual Physical Science Explorations* (with John Suchocki and Leslie Hewitt Abrams).



Suzanne Lyons

Suzanne received her B.A. in physics from the University of California, Berkeley. She earned her M.A. in education and her California teaching credential both from Stanford University. She earned another M.A. degree in Integrated Earth Sciences from California State University Sacramento. Suzanne was editor of *Conceptual Physics* and other books in the Conceptual series for 16 years and has authored 7 books on physics, hands-on science activities, and other topics in science and education. She has taught science and education courses to students of diverse ages and ability levels, from elementary school through college. She is always interested in developing new ways to teach and to that end, she founded the small business CooperativeGames.com.



John A. Suchocki

John is the author of *Conceptual Chemistry* and coauthor of *Conceptual Physical Science* and *Conceptual Physical Science Explorations*. John obtained his Ph.D. in organic chemistry from Virginia Commonwealth University. He worked as a pharmacology postdoctoral fellow at the Medical College of Virginia before becoming a tenured professor at Leeward Community College in Hawaii, where his interests turned to science education, the development of distance learning programs, and student-centered learning curricula. Currently an adjunct professor at Saint Michael's College in Vermont, John also produces science multimedia through his company Conceptual Productions. His popular tutorial video lessons, as well as those of his coauthors, are freely available at ConceptualAcademy.com.



Jennifer Yeh

Jennifer earned a Ph.D. in integrative biology from the University of Texas, Austin, for her work on frog skeleton evolution. She obtained her B.A. in physics and astronomy from Harvard University. Following her graduate work, Jennifer was a postdoctoral fellow at the University of California, San Francisco, where she studied the genetics of breast cancer. Jennifer has taught courses in physics, cell biology, human embryology, vertebrate anatomy, and ecology and evolution. She is the author of various scientific papers as well as the book *Endangered Species: Must They Disappear?* (Thomson/Gale, © 2002, 2004). Jennifer continues to work on a wide variety of introductory biology materials, including various ancillaries and online tutorials.

To the Student

WELCOME TO *Conceptual Integrated Science*. The science you'll learn here is INTEGRATED. That means we'll explore the individual science disciplines of physics, chemistry, biology, Earth science, and astronomy PLUS the areas where these disciplines overlap. Most of the scientific questions you're curious about, or need to know about, involve not just one discipline, but several of them in an overlapping way. How did the universe originate? That's astronomy + physics. How are our bodies altered by the foods we eat, the medicines we take, and the way we exercise? That's chemistry + biology. What's the greenhouse effect? Will it trigger irreversible global warming, threatening life on our planet? Physics, chemistry, biology, and Earth science are all needed to understand the answers.

We're convinced that the CONCEPTUAL orientation of this book is the way in which students best learn science. That means that we emphasize concepts *before* computation. Although much of science is mathematical, a firm qualitative grasp of concepts is also important. Too much emphasis on mathematical problem solving early in your science studies can actually distract you from the concepts and prevent you from fully comprehending them. If you continue in science, you may follow up with classes requiring advanced mathematical methods. Whether you do or don't, we think you'll be glad you learned the concepts first with just enough math to make them clearer.

This course provides plenty of resources beyond the text as well. For example, the interactive figures, interactive tutorials, and demonstration videos on www.mastering-physics.com will help you visualize science concepts, particularly processes that vary over time, such as the velocity of an object in free fall, the phases of the Moon, or the formation of chemical bonds. The activities in the *Laboratory Manual* will build your gut-level feeling for concepts and your analytical skills. Ponder the puzzlers in the *Conceptual Integrated Science Practice Book* and work through the simple review questions—all this will increase your confidence and mastery of science.

As with all things, what you get out of this class depends on what you put into it. So study hard, ask all the questions you need to, and most of all enjoy your scientific tour of the amazing natural world!

To the Instructor

THIS SECOND EDITION OF *Conceptual Integrated Science* with its important ancillaries provides your students an enjoyable and readable introductory coverage of the natural sciences. As with the previous edition, the 29 chapters are divided into five main parts—Physics, Chemistry, Biology, Earth Science, and Astronomy. We begin with physics, the basic science that provides a foundation for chemistry, which in turn underlies biology, which extends to Earth science and astronomy.

For the nonscience student, this book affords a means of viewing nature perceptively. One can see that a surprisingly few relationships make up its rules, most of which are the laws of physics presented in Part One. Physics laws are nature's secret codes. Here they are expressed both in words and in equation form. We view equations as *guides to thinking*. Even students who shy away from mathematics can learn to read equations to guide their thinking—to see how concepts connect. The symbols in equations are akin to musical notes that guide musicians.

For the science student, this same foundation affords a springboard to further study. For quantitatively oriented students, ample end-of-chapter material provides problem-solving activity through the *Think and Solve* problems.

Physics begins with static equilibrium so that students can start with forces before studying velocity and acceleration. After success with simple forces, the coverage touches lightly on kinematics, enough preparation for Newton's laws of motion. The pace picks up with the conventional order of mechanics topics followed by heat, thermodynamics, electricity and magnetism, sound, and light. Physics chapters lead to the realm of the atom—a bridge to chemistry.

The chemistry chapters begin with a look at the submicroscopic world of the atom, which is described in terms of subatomic particles and the periodic table. Students are then introduced to the atomic nucleus and its relevance to radioactivity, nuclear power, as well as astronomy. Subsequent chemistry chapters follow a traditional approach covering chemical changes, bonding, molecular interactions, and the formation of mixtures. With this foundation students are then set to learn the mechanics of chemical reactions and the behavior of organic compounds. As with previous editions, chemistry is related to the student's familiar world—the fluorine in their toothpaste, the Teflon on their frying pans, and the flavors produced by various organic molecules. The environmental aspects of chemistry are also highlighted—from how our drinking water is purified to how atmospheric carbon dioxide influences the pH of rainwater and our oceans.

The biology section begins by asking—what constitutes life? Each of the first three chapters focuses on a key feature of living things. We begin with a discussion of cells, move on to genes, and finally, tackle evolution and the origin of life. From here, we proceed to an overview of the different kinds of living things found on Earth. This overview is followed by two chapters on humans, our own species. In these chapters, we study the human body and how it works. Finally, we look at ecology, the study of how living organisms interact with their environments.

The Earth science chapters begin with plate tectonics, the theory that establishes the underlying framework of the geosciences. The next chapter is about rocks and

minerals, the principal materials that make up the solid Earth. Then comes a tour of Earth's landforms, surface features, and geography followed by a chapter on surficial processes—those processes of weathering, erosion, and deposition that originate at Earth's surface and shape the planet's contours. Plate tectonics is about Earth's interior, and the chapters on rock, landforms, and surficial processes describe Earth's surface. The next chapter in the sequence rises higher still—into the atmosphere—with weather. The subject of weather is broken down into elements from atmospheric pressure to wind to precipitation that can be learned separately but then applied to complex phenomena such as weather systems. The Earth science unit concludes with a chapter on environmental geology, which is new to the second edition. It provides an updated review of earthquakes, tsunami, hurricanes, volcanic eruptions, and other geologic hazards. Most importantly, it features expanded coverage of our changing climate including extensive discussion of natural and anthropogenic climate change.

The applications of physics, chemistry, biology, and the Earth sciences applied to other massive bodies in the universe culminate in Part Five—astronomy. This unit introduces the basic structure of the universe from our local solar system and the stars we see at night to galaxies and superclusters of galaxies. Focus is given to modern theories describing how this structure evolved and is continuing to evolve. Many recent discoveries are featured in this edition, illustrating that science is more than a growing body of knowledge; it is an arena in which humans actively and systematically reach out to learn more about our place in the universe.

What's New to This Edition

Conceptual Integrated Science now comes with a powerful media package including **MasteringPhysics**[®], the most widely used, educationally proven, and technologically advanced tutorial and homework system available.

MasteringPhysics[®]
www.masteringphysics.com

MasteringPhysics contains:

- A **library of assignable and automatically graded content**, including tutorials, visual activities, end-of-chapter problems, and test bank questions so instructors can create the most effective homework assignments with just a few clicks. A **color-coded gradebook** instantly identifies vulnerable students or topic areas that are challenging for students in the class.
- A **student study area** with practice quizzes, Interactive Figures, self-guided tutorials, flashcards, videos, access to the Pearson eText version of the book, and more.
- An **instructor resources section** with PowerPoint lectures, clicker questions, Instructor Manual files and more.

Another significant revision for this second edition lies with the development of the end-of-chapter review. New questions were added while older ones were either discarded or reworded for improved quality. All questions were then organized following Bloom's taxonomy of learning as follows:

Summary of Terms (Knowledge)

These key terms match the definitions given within the chapter and are now listed in alphabetical order so that they appear as a mini-glossary for the chapter.

Reading Check Questions (Comprehension)

These questions frame the important ideas of each section in the chapter. They are for review and a check of reading comprehension. They are simple questions and all answers can easily be discovered in the chapter.

Think Integrated Science

Questions pertaining to the Integrated Science sections of each chapter are contained in this section. Questions range from straightforward, reading-check type questions to critical-thinking exercises.

Think and Do (Hands-On Application)

The Think and Do items are easy-to-perform hands-on activities designed to help students experience physical science concepts for themselves.

Think and Solve (Mathematical Application)

The *Think and Solve* questions blend simple mathematics with concepts. They allow students to apply problem-solving techniques, many of which are featured in the Math Connection boxed features.

Think and Rank (Analysis)

The *Think and Rank* questions ask students to make comparisons of quantities. For example, when asked to rank quantities such as momentum or kinetic energy, appreciably more judgment is called for than in providing numerical answers. Some *Think and Rank* analyze trends, as in ranking atoms in order of increasing size based upon student understanding of the periodic table. This feature elicits critical thinking that goes beyond *Think and Solve*.

Think and Explain (Synthesis)

The *Think and Explain* questions, by a notch or two, are the more challenging questions at the end of each chapter. Many require critical thinking while others are designed to prompt the application of science to everyday situations. All students wanting to perform well on exams should be directed to the *Exercises* because these are the questions that directly assess student understanding. Accordingly, many of the *Exercises* have been adapted to a multiple-choice format and integrated into the *Conceptual Integrated Science, 2e* test bank. This will hopefully allow the instructor to reward those students who put time and effort into the *Exercises*.

Think and Discuss (Evaluation)

The *Think and Discuss* topics provide students the opportunity to apply science concepts to real-life situations, such as whether a cup of hot coffee served to you in a restaurant cools faster when cream is added promptly or a few minutes later. Other discussion questions allow students to present their educated opinions on a number of science-related hot topics, such as the appearance of pharmaceuticals in drinking water.

Readiness Assurance Test

Each chapter review concludes with a set of 10 multiple choice questions that students can take for self-assessment. They are advised to study further if they score less than 7 correct answers.

Also new to this edition, are the solutions to the odd-numbered end-of-chapter questions in the back of this book. As before, solutions to all end-of-chapter questions are available to instructors through the Instructor Manual for *Conceptual Integrated Science*, which is found in the Instructor Resource Center and in the Instructor Resource area of MasteringPhysics.

This second edition features a new and, we think, refreshing page layout design. Integrated into this design are **learning objectives** that appear alongside each chapter section head. Each learning objective begins with an active verb that specifies what the student should be able to do after studying that section, such as “Calculate the energy released by a chemical reaction.” These section-specific learning objectives are further integrated into the new MasteringPhysics online tutorial/assessment tool.

Also within the design, appearing beneath each section head is another new feature, which we call an “**Explain This**” question. An ET question would be fairly difficult for the student to answer without having read the chapter section. Some require that the student recall earlier material. Others reveal interesting applications of concepts. In all cases the ET question should serve well as a launching point for classroom discussions. The answers to these ET questions appear only within the Instructor Manual.

The text of all chapters has been edited for accuracy, better readability and also updated to reflect current events, such as the nuclear power plant disaster following the 2011 Japanese earthquake and tsunami, and the discovery of Fermi clouds arising from the center of our Milky Way galaxy.

The scope and sequence of chapters is revised for this second edition. The material on the atom has been folded into the chemistry unit so that the atomic theory is explained at the point of use. The Earth science material has been reorganized such that the geography material is now separated from the discussion of surficial processes, allowing for more discussion of the oceans. A chapter on Historical Geology was eliminated with the most important concepts (such as the geologic time scale, Cretaceous extinction, and the nature of the rock record) being integrated into other chapters. The elimination of Historical Geology allowed the new chapter on Environmental Geology to be added with in-depth coverage of climate change. In Part Four—Astronomy, aside from updates from recent discoveries, the first section of Chapter 28 has been heavily revised in its presentation of nebular theory and the second chapter of this unit is expanded greatly to include discussions of cosmology.

Ancillary Materials

Most significantly, *Conceptual Integrated Science* is now available with MasteringPhysics—a homework, tutorial, and assessment system based on years of research into how students work problems and precisely where they need help. Studies show that students who use MasteringPhysics significantly increase their scores compared to hand-written homework. MasteringPhysics achieves this improvement by providing students with instantaneous feedback specific to their wrong answers and simpler sub-problems upon request when they get stuck. Instructors can also assign End-of-Chapter (EOC) problems from every chapter including multiple-choice questions, section-specific exercises, and general problems. Quantitative problems can be assigned with numerical answers and randomized values or solutions.

The Pearson eText of *Conceptual Integrated Science* is available through MasteringPhysics. Allowing students access to the text wherever they have access to the Internet, the Pearson eText comprises the full text, including figures that can be enlarged for better viewing, popup definitions and terms, a note-taking feature, and more.

MasteringPhysics®
www.masteringphysics.com

Tutorial video lessons and screencasts featuring the authors are now freely available to students at ConceptualAcademy.org. This is a must-visit website for any student who needs a bit of extra help and it is also a great tool for the online component of any course. Many author-created resources for the instructor are also available on this website, which is a great place to communicate directly with the authors as well as other instructors using *Conceptual Integrated Science*.

The *Instructor Manual for Conceptual Integrated Science* (ISBN 0-321-82743-0), which you'll find to be different from most instructors' manuals, allows for a variety of course designs to fit your taste. It contains many lecture ideas and topics not treated in the textbook as well as teaching tips and suggested step-by-step lectures and demonstrations. It has full-page answers to all the end of chapter material in the text.

The *Conceptual Integrated Science Practice Book* (ISBN 0-321-82298-6), our most creative work, guides your students to a sometimes computational way of developing concepts. It spans a wide use of analogies and intriguing situations, all with a user-friendly tone.

The *Test Bank for Conceptual Integrated Science* (ISBN 0-321-82276-5) has more than 2400 multiple choice questions as well as short answer and essay questions. The questions are categorized according to level of difficulty. The Test Bank allows you to edit questions, add questions, and create multiple test versions.

The *Laboratory Manual for Conceptual Integrated Science* (ISBN 0-321-82297-8) is written by the authors and Dean Baird. In addition to interesting laboratory experiments, it includes a range of activities similar to the activities in the textbook. These guide students to experience phenomena before they quantify the same phenomena in a follow-up laboratory experiment. Answers to the lab manual questions are in the Instructor Manual.

Another valuable media resource available to you is the *Instructor Resource DVD for Conceptual Integrated Science* (ISBN 0-321-82744-9). This cross-platform DVD set provides instructors with the largest library available of purpose-built, in-class presentation materials, including all the images from the book in high-resolution JPEG format; interactive figures™ and videos; PowerPoint® lecture outlines and clicker questions in PRS-enabled format for each chapter, all of which are written by the authors; and Hewitt's acclaimed Next-Time Questions in PDF format. The *Instructor Resource DVD* provides you with everything you need to prepare for dynamic, engaging lectures in no time.

Go to it! Your conceptual integrated science course really can be the most interesting, informative, and worthwhile science course your students will ever take.

Acknowledgments

THE AUTHORS WISH TO express their sincere appreciation to the many talented and generous people who helped make *Conceptual Integrated Science*, now in its Second Edition, come to life. To the teachers and professors who reviewed the manuscript, giving generously of their time, we express heartfelt appreciation.

We thank all the contributors to the first and second editions of *Conceptual Integrated Science*, as well as the many people who contributed to the other books in the *Conceptual* series: *Conceptual Physics*, *Conceptual Chemistry*, *Conceptual Physical Science*, and *Conceptual Integrated Science—Explorations*. For helping to shape the physics content over the years, in the student editions as well as our many supplements, we thank: Dean Baird, Tsing Bardin, Howie Brand, Alexi Cogan, Paul Doherty, Marshall Ellenstein, Ken Ford, Lillian Lee Hewitt, Jim Hicks, David Housden, John Hubisz, Will Maynez, Fred Myers, Bruce Novak, Ron Perkins, Diane Reindeau, David Williamson, Larry Weinstein, Phil Wolf, and Dean Zollman.

For development of chemistry chapters, thanks go to Adedoyin Adeyiga, John Bonte, Emily Borda, Charles Carraher, Natashe Cleveland, Sara Devo, Andy Frazer, Kenneth French, Marcia Gillette, Chu-Ngi Ho, Frank Lambert, Jeremy Mason, Daniel Predecki, Britt Price, Jeremy Ramsey, Kathryn Rust, William Scott, Anne Marie Sokol, Jason Vohs, Bob Widing, and David Yates.

For advice and wide-ranging contributions to the biology section, we thank Pamela Yeh, Sarah Ying, Nina Shapley, Nils Gilman, Todd Schlenke, Howard Ying, Brain West, Robert Dudley, Vivianne Ding, Mike Fried, W. Bryan Jennigs, Rachel Zierow, Ernie Brown, and Lil Hewitt.

For Earth science inspiration, input and advice, we are grateful to Leslie Hewitt Abrams and Bob Abrams. They gave generously of their time to share insights gained from their work authoring and teaching Earth science. We are also grateful to Tsing Bardin, Judy Kusnick, Bruce Gervais, Lil Hewitt, Diane Carlson, and Lynne Cherry.

For space science we are grateful to Jeffrey Bennett, Megan Donahue, Nicholas Schneider, and Mark Volt for permission to use many of the graphics that appear in their textbook *The Cosmic Perspective*, 6th edition. Also, for reviews of the astronomy chapters we remain grateful to Richard Crowe, Bjorn Davidson, Stacy McGaugh, Michelle Mizuno-Wiedner, John O'Meara, Neil de Grass Tyson, Joe Wesney, Lynda Williams, and Erick Zackrisson.

Our colleagues at Pearson have been our partners in this project and given us much support and guidance. For the second edition, we thank Jim Smith, seasoned Publisher, for wise and sensible overall direction. We thank our project editor Chandrika Madhavan for being great to work with, patient, and wonderfully competent in her role at the crossroads of communication. We thank Cindy Johnson for graceful and intelligent handling of the production process.

The *Conceptual Integrated Science* authors are fortunate to have helpful and loving spouses who have supported us through the long hours and contributed to our efforts. Thanks go to Lillian Lee Hewitt, Pete Lang (Suzanne's husband), Tracy Suchocki, and Nils Gilman (Jennifer's husband). And to our kids, ranging now from preschool to high school, we send our love and gratitude: Tristan and Simone Lyons Lang; Ian, Evan, and Maitreya Suchocki; and Io, Pico, and Daphne Yeh Gilman.

Reviewers

Leila Amiri, University of South Florida
Leanne Avery, Indiana University of Pennsylvania
Bambi Bailey, Midwestern State University
Dirk Baron, California State University, Bakersfield
Daniel Berger, Bluffton University
Reginald Blake, City Tech University of New York
Derrick Boucher, King's College
Martin Brock, Eastern Kentucky University
Linda Brown, Gainesville College
Mary Brown, Lansing Community College
Steven Burns, St. Thomas Aquinas College
Erik Burtis, Northern Valley Community College,
Woodbridge
Gerry Clarkson, Howard Payne University
Anne Coleman, Cabrini College
Gary Courts, University of Dayton
Red Chasteen, Sam Houston State University
Randy Criss, St. Leo University
Jason Dahl, Bemidji State University
Terry Derting, Murray State University
David DiMattio, St. Bonaventure University
Gary Neil Douglas, Berea College
S. Keith Dunn, Centre College
George Econ, Jackson Community College
Michael S. Epstein, Mount St. Mary's University
Charles Figura, Wartburg College
Lori K. Garrett, Danville Area Community
College
David Goldsmith, Westminster College
Brian Goodman, Lakeland College
Nydia R. Hannah, Georgia State University
Carole Hillman, Elmhurst University
James Houpis, California State University, Chico
Thomas Hunt, Jackson Community College
David T. King, Jr., Auburn University
Jeremiah K. Jarrett, Central Connecticut State University
Peter Jeffers, State University of New York, Cortland
Charles Johnson, South Georgia College
Richard Jones, Texas Women's University
Carl Klook, California State University, Bakersfield
Kenneth Laser, Edison Community College
Jeffrey Laub, Rogers State University

Holly Lawson, State University of New York,
Fredonia
David Lee, Biola University
Steven Losh, State University of New York, Cortland
Ntungwa Maasha, Coastal Georgia Community College
Kingshuk Majumdar, Berea College
Lynette McGregor, Wartburg College
Preston Miles, Centre College
Frank L. Misiti, Bloomburg University
Matthew Nehring, Adams State College
Marlene Morales, Miami Dade College
Douglas Nelson, Coastal Carolina University
Jan Oliver, Troy State University
Treva Pamer, New Jersey City University
Todd Pedlar, Luther College
Denice Robertson, Northern Kentucky University
Judy Rosovsky, Johnson State College
Steven Salaris, All Saints Christian School
Terry Shank, Marshall University
Sedonia Sipes,
Southern Illinois University, Carbondale
Ran Sivron, Baker University
Priscilla Skalac, Olivet Nazarene University
Stanley Sobolewski, Indiana University of Pennsylvania
John Snyder, Lansing Community College
Stuart Snyder, Montana State University
Anne Marie Sokol, Buffalo State College
Pamela Stephens, Midwestern State University
Laura Stumpe, Holy Cross College, Notre Dame
Karen Swanson, William Patterson University
Timothy Swindle, University of Arizona
Rachel Teasdale, California State University, Chico
Diana Treahy, Anderson University
Christos Valiotis, Antelope Valley College
Robin van Tine, St. Leo University
Daniel Vaughn, Southern Illinois University
Stephen Webb, Brescia College
Karen Wehn, Buffalo State University
Adam Wenz, Montana State University, Great Falls
William Wickun, Montana State University, Billings
Bonnie S. Wood, University of Maine, Presque Isle
Robert Zdor, Andrews University