

TABLE OF CONTENTS

MODULE I	1
SCIENCE—THE BASICS	
What is Science	2
Science and Technology	3
What is Physical Science	3
The Scientific Process	4
Making Observations	4
Experiment 1.1: Making Observations	7
Forming Hypotheses	8
Testing Hypotheses	9
Experiments	10
Analyzing Data	12
Drawing Conclusions	12
Scientific Theories and Laws	13
Science Does Not Prove	14
When the Scientific Method Isn't Possible	15
Inferences	15
Models	16
Measuring and Manipulating Data	17
The Metric System	18
Mass	20
Length	21
Volume	21
Time	21
Temperature	21
Converting Units	24

Organizing and Presenting Scientific Data	27
Data Tables	27
Analyzing Data with Graphs	29
Bar Graphs	29
Circle Graphs	30
You Do Science	31
Experiment 1.2: Practice Data Collecting and Analyzing with Pendulums	32
Summing Up	35
Answers to the “On Your Own” Questions	36
Study Guide for Module 1	38

MODULE 2 41

CHEMISTRY PROPERTIES AND STATES OF MATTER

Classifying Matter	42
Pure Substances and Mixtures	43
Pure Elements and Compounds	35
Mixtures	45
Solids, Liquids, and Gases	48
Other States of Matter	49
Kinetic Theory of Matter	50
Solids	51
Liquids	51
Gases	52
Experiment 2.1: Diffusion at Different Temperatures	53
Metals and Nonmetals	55
Properties of Matter	55
Physical Properties	55
Appearance and Odor	55
Conductivity	56
Density	56
Experiment 2.2: Exploring Different Densities	57
Hardness	59
Malleability	59
Viscosity	59
Melting and Boiling Points	60
Chemical Properties	61
Flammability	62
Reactivity	62
Changes in Matter	63
Physical Changes	63
Volume and Density Changes	63
You Do Science: Volume and Density Change Activity	65
Phase Changes	65
Solubility Changes	67

Chemical Changes.	68
A Change in Color	69
Production of a Gas	70
Experiment 2.3: Changes in Matter	71
Summing Up	73
Answers to the “On Your Own” Questions.	74
Study Guide for Module 2	75

MODULE 3 79

CHEMISTRY—ATOMIC STRUCTURE AND THE PERIODIC TABLE

A History of the Atom	80
Ancient Atomic Models.	81
Dalton’s Atomic Theory	82
Thomson’s Atomic Model	84
Plum Pudding Model	85
Rutherford’s Atomic Model	86
The Structure of Atoms.	88
Subatomic Particles.	88
Atomic Number and Mass Number	90
Isotopes.	92
Modern Atomic Theory.	94
Bohr’s Atomic Model	94
The Electron Cloud or the Quantum-Mechanical Model	95
Electron Orbitals.	96
Experiment 3.1: Constructing 3-D Atomic Models	98
Organizing Elements: The Periodic Table	100
Mendeleev’s Periodic Table	101
Experiment 3.2: Creating a Periodic Table	102
Groups and Periods.	103
Modern Periodic Table	103
Representative Groups	104
The Alkali Metals	105
The Alkaline Earth Metals	105
The Boron Group	106
The Carbon Group	107
The Nitrogen Group	107
The Oxygen Group.	108
The Halogens	108
The Noble Gases.	109
Summing Up	109
Answers to the “On Your Own” Questions.	111
Study Guide for Module 3	112

MODULE 4 115

CHEMISTRY—CHEMICAL BONDS

A Model for Chemical Changes	116
Chemical Formulas	116
Chemical Equations	117
Balancing Equations	118
Types of Chemical Bonding	121
Ionic Bonds	122
Ions	122
Formation of Ions and Ionic Bonds	123
You Do Science: Grow a Salt Crystal	125
Electron Dot Diagrams	125
Covalent Bonds	127
Multiple Covalent Bonds	129
Unequal Sharing of Electrons	130
Experiment 4.1: Polarity of Water	132
The Wonder of Water	134
Solubility	135
Hydrogen Bonding and the Phases of Water	136
Experiment 4.2: Comparing Solids	137
Cohesion, Adhesion, and Surface Tension	140
Experiment 4.3: Forces Between Molecules	141
Summing Up	145
Answers to the “On Your Own” Questions	146
Study Guide for Module 4	149

MODULE 5 151

CHEMISTRY—REACTIONS AND ENERGY

Naming Compounds and Writing Formulas	152
Describing Ionic Compounds	152
Polyatomic Ions	154
Writing Formulas for Ionic Compounds	156
Describing Molecular Compounds	158
Describing Molecular Compounds	158
Writing Molecular Formulas	161
Types of Reactions	161
Synthesis	161
Decomposition	162
Experiment 5.1: Decomposition of Water	163
Single Replacement	166
Double Replacement	167
Combustion	168
Energy Changes in Reactions	170
Energy in Chemical Bonds	171
Counting with Moles	172
Bond Energy	173

Exothermic Reactions	174
Endothermic Reactions	175
Experiment 5.2: Reaction Energy	173
You Do Science	179
Summing Up	180
Answers to the “On Your Own” Questions.	181
Study Guide for Module 5	184
MODULE 6	187
PHYSICS—MOTION	
Distance and Displacement	188
A Frame of Reference	188
Measuring Distance	190
Adding Displacement	190
Displacement Not Along a Straight Line	192
Speed and Velocity	192
Speed	193
Graphing Speed.	196
You Do Science: Measuring Average Speed Activity	199
Velocity	200
Experiment 6.1: The Importance of Direction in Velocity	200
Acceleration	206
Graphing Acceleration	214
Summing Up	215
Answers to the “On Your Own” Questions.	216
Study Guide for Module 6	221
MODULE 7	225
PHYSICS—FORCES	
Forces	226
Combining Forces.	227
Friction	228
Types of Friction	230
Gravity	232
Acceleration Due to Gravity	232
Experiment 7.1: Acceleration Due to Gravity	232
You Do Science: Measuring Height with a Stopwatch.	236
Newton’s Laws of Motion.	236
A Brief History	237
Newton’s First Law of Motion	240
Experiment 7.2: Newton’s First Law.	241
Newton’s Second Law of Motion	245
Weight and Mass.	251
Newton’s Third Law	252
Experiment 7.3: Newton’s Third Law	253

You Do Science: Balloon Rockets	255
Fundamental Forces	256
Electromagnetic Forces	256
Nuclear Forces	257
The Strong Force.	258
The Weak Force	258
Gravitational Forces	259
What Causes Gravitational Forces	260
Summing Up	262
Answers to the “On Your Own” Questions.	263
Study Guide for Module 7	267
MODULE 8	271
PHYSICS—ENERGY	
Energy.	272
Types of Energy.	272
Kinetic Energy.	272
Potential Energy	275
Gravitational Potential Energy	276
Elastic Potential Energy.	278
Experiment 8.1: Energy of a Rubber Band	279
Forms of Energy	281
Mechanical Energy	281
You Do Science: Ball Bounce.	282
Thermal Energy	282
Chemical Energy.	283
Electrical Energy.	283
Electromagnetic Energy.	284
Sound Energy	284
Nuclear Energy	285
Conservation of Energy.	285
Everyday Examples of Energy Conversions.	286
Energy and Work	289
Calculating Work	290
Power	291
Experiment 8.2: How Fast Can You Do Work?.	294
Work and Machines	296
Mechanical Advantage	298
Efficiency	301
Simple Machines.	301
Summing Up	304
Answers to the “On Your Own” Questions.	305
Study Guide for Module 8	308

MODULE 9	311
PHYSICS—WAVES AND SOUND	
Mechanical Waves	312
Types of Mechanical Waves	312
Transverse Waves	313
Longitudinal Waves	314
Surface Waves	315
Properties of Waves	316
Amplitude	316
Frequency and Period	317
Wavelength	318
Wave Speed	319
Sound	320
Experiment 9.1: Sound Waves	320
Hearing	323
You Do Science: Feeling Sound Waves	324
Experiment 9.2: The Speed of Sound	324
The Speed of Sound in Other Substances	329
Traveling Faster than the Speed of Sound	329
Intensity and Loudness	331
Experiment 9.3: Amplitude and Loudness	331
Wavelength, Frequency, and Pitch	334
Experiment 9.4: Wavelength and Sound	335
Pitch and Music	336
The Doppler Effect	338
You Do Science: The Doppler Effect	339
Use of Sound Waves	340
Medical Ultrasound	341
Sonar	341
Summing Up	342
Answers to the “On Your Own” Questions	343
Study Guide for Module 9	347
MODULE 10	349
PHYSICS—LIGHT	
Electromagnetic Waves	350
The Speed of Electromagnetic Waves—Light	352
Wavelength and Frequency	353
The Dual Nature of Light	353
Evidence for the Wave Model	354
Evidence for Wave-Particle Duality	356
The Electromagnetic Spectrum	358
Radio Waves	359
Microwaves	359
Infrared Light	360
Visible Light	360

Experiment 10.1: Visible Light	361
You Do Science: The Temperature of a Rainbow	364
Ultraviolet Light	364
X-Rays	366
Gamma Rays	366
The Behavior of Light	367
Interactions of Light	367
Reflection	368
Experiment 10.2: The Law of Reflection	368
Refraction	370
Experiment 10.3: Refraction of Light	371
You Do Science: The Magical Quarter	374
Polarization	377
Scattering	377
Your Eyes and Color	380
Lenses	380
The Human Eye	382
How We Perceive Color	384
Experiment 10.4: How the Eye Detects Color	384
Adding and Subtracting Colors	386
Primary Colors of Light	386
Primary Colors of Pigment	386
Summing Up	388
Answers to the “On Your Own” Questions	389
Study Guide for Module 10	391

MODULE 11 393

PHYSICS—ELECTRICITY AND MAGNETISM

A Detailed Look at the Electromagnetic Force	394
James Clerk Maxwell	394
The Electromagnetic Force	395
Experiment 11.1: Electrical Attraction and Repulsion	395
Science and Math	398
Photons and the Electromagnetic Force	400
Electric Charge	402
Electric Field	402
Static Electricity and Charging Objects	402
Charging by Friction	403
Charging by Conduction	403
Charging by Induction	404
Experiment 11.2: Making and Using an Electroscope	404
Electrical Circuits	408
Voltage	408
Electrical Current	409
How Current Flows	411

Conductors and Insulators	413
Resistance	413
Experiment 11.3: Current and Resistance	414
Switches and Circuits	416
Series and Parallel Circuits	417
Magnetism	419
Experiment 11.4: Making an Electromagnet	419
Magnetic Materials	420
Magnets and Magnetic Forces	422
More About Magnetic Fields	423
Earth’s Magnetic Field	423
Summing Up	427
Answers to the “On Your Own” Questions	428
Study Guide for Module 11	430

MODULE 12 433

EARTH SCIENCE—OUR EARTH

Earth’s Structure	434
The Crust	435
The Mantle	435
Experiment 12.1: A Simulation of Plastic Rock	437
The Core	438
Earth’s Core and Magnetic Field	439
Rocks and Minerals	439
Rocks	440
Minerals	441
Processes of the Lithosphere	443
The Rock Cycle	443
The Hydrosphere and the Hydrologic (Water) Cycle	446
Experiment 12.2: Evaporation, Condensation, and Precipitation	448
Weathering	451
Mechanical Weathering	452
You Do Science: Mechanical Weathering Model	453
Chemical Weathering	454
You Do Science: Chemical Weathering Model	455
Erosion Shapes the Land	455
Land Features Formed by Moving Water	456
Features Formed by Sediment Deposition	458
Features Formed by Groundwater Erosion	458
Features Formed by Glaciers	459
Features Formed by Wind	461
Summing Up	462
Answers to the “On Your Own” Questions	463
Study Guide for Module 12	465

MODULE 13	467
EARTH SCIENCE—OUR ATMOSPHERE AND BEYOND	
Our Atmosphere	468
Carbon Dioxide in the Air	469
Experiment 13.1: Carbon Dioxide and the Greenhouse Effect	470
Atmospheric Pressure	472
Experiment 13.2: Atmospheric Pressure	473
Units of Pressure	476
Altitude and Air Pressure	477
You Do Science: Air Pressure	479
Energy and Atmosphere	479
What is Temperature?	481
Experiment 13.3: Seeing the Effect of Changing Temperature	481
Layers of the Atmosphere	484
The Temperature Gradient in the Atmosphere	485
The Ionosphere	487
Beyond Our Atmosphere	488
Summing Up	490
Answers to the “On Your Own” Questions	491
Study Guide for Module 13	493
 MODULE 14	 495
CHEMISTRY AND PHYSICS IN THE LIFE SCIENCES	
Chemistry and Biology	496
Carbon Chemistry	496
Hydrocarbons	497
Saturated Hydrocarbons	498
You Do Science: Modeling Isomers	500
Unsaturated Hydrocarbons	500
Fossil Fuels	502
Biochemistry	504
Biochemical Compounds	504
Chemical Reactions in Cells	505
Photosynthesis and Cellular Respiration	506
Reaction Helpers	507
Experiment 14.1: Comparing Vitamin C in Fruit Juices	508
Physics and Life	509
Physics at the Park	509
Transportation and Physics	511
You Do Science	512
Physics and Forensics	513
Physics and Health	513
Summing Up	514
Answers to the “On Your Own” Questions	515
Study Guide for Module 13	516

MODULE 15	517
PHYSICAL SCIENCE RESEARCH	
Conducting Research	518
Getting Started	518
Brainstorming and Narrowing	519
Finding Credible Sources	519
Research	520
Sharing Your Research	521
Alternate Research Presentations	521
Your Turn	522
Summing Up	522
GLOSSARY	525
APPENDIX	533
LAB SUPPLY LIST	535
INDEX	541
IMAGE SOURCES	565