

Contents

Part 1	Electrical Energy and Circuits	
Lesson 1	Energy in Systems	2
	Inquiry 1.1 The Hand Generator	5
	Inquiry 1.2 The Solar Cell	6
	Inquiry 1.3 The Battery	7
	Inquiry 1.4 The Motor Generator	8
	Inquiry 1.5 The Van de Graaff Generator	9
	A Biological Energy System	10
Lesson 2	More Energy Investigations	12
	Inquiry 2.1 Examining the Design of Lightbulbs	14
	Inquiry 2.2 Investigating Energy With a Neon Lightbulb	15
	Inquiry 2.3 Exploring Other Ways To Light the Neon Lightbulb	17
	Lightning's Fearsome Power	19
	Protect Yourself From Lightning	21
	Can You Tell When Lightning Is About To Strike?	22
	How Close Was That?	22
	The Lightning Gods	23
Lesson 3	Electrical Forces	26
	Inquiry 3.1 Investigating Rubbed Plastic Strips	28
	Inquiry 3.2 Investigating the Strips With an Electric Plume	29
	Inquiry 3.3 Investigating the Strips With a Pith Ball	30
	The Shocking Link Between <i>Frankenstein</i> and Electricity	31
	Frogman Luigi Galvani	33
Lesson 4	Models	36
	Inquiry 4.1 Finding Out What's Inside	38
	Explaining the Unseen: Building Models	39
	Ben Franklin's Electrifying Experiments With Electricity	40
	Static Electricity at Work	43
	The Cling Thing	45

Lesson 5	Electrical Circuits	46
	Inquiry 5.1 Lighting a Lightbulb	48
	Drawing Electrical Diagrams	49
	Inquiry 5.2 Lighting More Lightbulbs	51
	Electricity at Home: Safety Means “Don’t Touch!”	52
	Get Wired	55
	A Word on Wires...	57
Lesson 6	Electrical Current	58
	Inquiry 6.1 Measuring Electrical Current in a Series Circuit	60
	Measuring Electrical Current in a Series Circuit	60
	Inquiry 6.2 Measuring Electrical Current in a Parallel Circuit	63
	Inquiry 6.3 Investigating the Direction of Current	64
	The Body Electric	65
	André-Marie Ampère: Father of Electromagnetism	68
	“Current” Affairs	69
Lesson 7	Batteries in Electrical Circuits	70
	Inquiry 7.1 Building Compound Batteries	72
	Inquiry 7.2 Investigating How Batteries Affect the Brightness of a Lightbulb	74
	Inquiry 7.3 Observing Differences in Series and Parallel Batteries	76
	A Sixth Sense	78
	There Once Was a Physicist Named Volta	82
Lesson 8	Batteries and Current	84
	Inquiry 8.1 Investigating How Batteries Affect Current	86
	Batteries, Voltage, and Current	88
	Electrical Line Mechanic: A Tough but Rewarding Job	90
Lesson 9	A Model for Voltage and Current	94
	Inquiry 9.1 Modeling Voltage	97
	Inquiry 9.2 Modeling Current	99
	The Electrical Network	101

Lesson 10	Electrical Power	104
	Electrical Power	106
	Inquiry 10.1 Investigating Electrical Power	108
	Inquiry 10.2 Calculating the Power Supplied to a Fan	109
	Inquiry 10.3 Calculating the Power of Lightbulbs	110
	James Watt: One Man's Invention Forges a New Era	111
	The Ultimate Power Struggle	114
Lesson 11	Circuits Assessment	118
	Inquiry 11.1 Using Schematic Diagrams	120
	Inquiry 11.2 Analyzing Electrical Circuits	120
	Inquiry 11.3 Building Electrical Circuits	121
Lesson 12	Accounting for Electrical Energy	122
	Calculating Electrical Energy Usage	125
	Inquiry 12.1 Comparing Energy	127
	Inquiry 12.2 Comparing Energy Used to Energy Supplied	127
	Keeping the Turbines Turning	129
	Your Meter's Running!	132
Lesson 13	The Anchor Activity	134
	Calculating the Cost of Electrical Energy	136
	Inquiry 13.1 Planning Our Investigation	138
	Inquiry 13.2 Sharing What We've Learned	139
	A Future Look at Home Sweet Home	140
Part 2	Electrical Components in Circuits	
Lesson 14	Electrical Devices	144
	Inquiry 14.1 Looking Inside	146
	Amazing Grace: The Contributions of Grace Hopper	148
	Magnetrons, Melted Chocolate, and Microwave Ovens	152

Lesson 15	Resistors in Electrical Circuits	156
	Inquiry 15.1 Putting Resistors in Circuits	158
	Inquiry 15.2 Investigating Energy Changes in Resistors	158
	Inquiry 15.3 Measuring Resistance	159
	Measuring Resistance	160
	The Lightbulb: A Bright Idea	163
	Georg Simon Ohm: Taking a Different Approach	166
Lesson 16	Wires in Electrical Circuits	168
	Inquiry 16.1 Investigating the Resistance of Wire Segments	170
	Electrical Wires	170
	Inquiry 16.2 Investigating the Effect of Changing the Wire Segments	171
	Superconductivity	172
Lesson 17	Diodes	174
	Inquiry 17.1 Putting Diodes in Electrical Circuits	176
	Inquiry 17.2 Investigating LEDs	177
	Inquiry 17.3 Designing a Circuit With LEDs	177
	The Magic Sandwich	178
	Shrinking Circuits	181
Lesson 18	Capacitors	186
	Inquiry 18.1 Putting Capacitors in Circuits	188
	Inquiry 18.2 Observing Voltage and Current in Capacitor Circuits	189
	Electrical Engineer Extraordinaire	191
	Getting a Charge Out of Capacitors	194
Lesson 19	Solar Cells	196
	Inquiry 19.1 Putting Solar Cells in Circuits	198
	Inquiry 19.2 Investigating Current, Voltage, and Solar Cells	199
	Inquiry 19.3 Using More Than One Solar Cell in a Circuit	200
	Finding New Ways to Brighten Our World	201
	Solar-Powered Space Station	206

Lesson 20	Assessment for Part 2	210
	Inquiry 20.1 Finding Out What's Inside the Boxes	212
Part 3	Electrical Systems	
Lesson 21	Systems	216
	Inquiry 21.1 Investigating Systems	217
	Robots at Work	219
	What is a Systems Engineer?	222
Lesson 22	Feedback Systems	224
	Open-Loop and Closed-Loop Systems	226
	Inquiry 22.1 Building a Sensor Circuit	227
	Inquiry 22.2 Using Feedback From a Sensor	228
	Remote-Control Technology	230
Lesson 23	An Electrical Control System	232
	Inquiry 23.1 Investigating a Bimetallic Strip	235
	Inquiry 23.2 Building a Control System	236
	Homeostasis: The Stabilizing System	239
	Coming to a Lawn Near You	242
Lesson 24	A Circuit Design Challenge	244
	Inquiry 24.1 Designing and Building Your Own System	246
	Supplying Enough Electrical Power	247
	Creating Television	249
	Glossary	253
	Index	255
	Photo Credits	263