

# Contents

<b>Part 1</b>	<b>The Nature of Light</b>	
<b>Lesson 1</b>	<b>Thinking About Light</b>	<b>2</b>
	Inquiry 1.1 Cutlery Optics	4
	Inquiry 1.2 Special Glasses	5
	Inquiry 1.3 Lamp Light	6
	Inquiry 1.4 The Radiometer	7
	Inquiry 1.5 Colored Lightbulbs	8
	Inquiry 1.6 Looking Behind	9
	Inquiry 1.7 Missing Flesh	9
	Inquiry 1.8 Looking Through an Object	10
	<b>Using and Studying Light</b>	<b>12</b>
	<b>Light Pioneers</b>	<b>15</b>
	<b>The Sun: A Source of Light, Myth, and Tradition</b>	<b>16</b>
<b>Lesson 2</b>	<b>Where Does Light Come From?</b>	<b>20</b>
	Inquiry 2.1 Identifying Sources of Light	22
	Inquiry 2.2 How Is Light Produced?	22
	<b>Transforming Energy</b>	<b>27</b>
	<b>Sources of Light</b>	<b>28</b>
	<b>Life Light</b>	<b>30</b>
<b>Lesson 3</b>	<b>How Does Light Travel?</b>	<b>32</b>
	Inquiry 3.1 Looking at How Light Travels	34
	<b>Racing To Find the Speed of Light</b>	<b>35</b>
	<b>Light Speedsters</b>	<b>37</b>
	<b>Light Time</b>	<b>38</b>
<b>Lesson 4</b>	<b>How Light Spreads Out</b>	<b>40</b>
	Inquiry 4.1 Measuring Light and Distance	42
	<b>Light and Distance</b>	<b>46</b>
	<b>Doing the Math on Spreading Light</b>	<b>47</b>
<b>Lesson 5</b>	<b>Blocking the Light</b>	<b>48</b>
	Inquiry 5.1 Putting Objects in the Path of Light	50
	<b>Transparent, Translucent, and Opaque</b>	<b>51</b>
	Inquiry 5.2 Measuring Shadow Size	52
	Inquiry 5.3 Comparing Shadows	53
	<b>Astronomical Shadows</b>	<b>54</b>
	<b>Theater of Shadows</b>	<b>56</b>

<b>Lesson 6</b>	<b>The Pinhole Camera</b>	<b>58</b>
	Inquiry 6.1 Looking Through Your Pinhole Camera	61
	Inquiry 6.2 Modifying Your Pinhole Camera	63
	<b>Pictures Through a Pinhole</b>	<b>64</b>
<b>Lesson 7</b>	<b>Modeling Light</b>	<b>68</b>
	<b>Scientific Models</b>	<b>71</b>
	Inquiry 7.1 Using Particles To Model Light	72
	Inquiry 7.2 Using Waves To Model Light	74
	<b>Wave or Particle Models</b>	<b>77</b>
	<b>Seeing Waves</b>	<b>78</b>
	<b>Galloping Gertie Waves Goodbye</b>	<b>80</b>
<b>Lesson 8</b>	<b>Where Does Color Come From?</b>	<b>82</b>
	Inquiry 8.1 Using a Triangular Prism To Examine White Light	84
	<b>The Impurity of White</b>	<b>87</b>
	<b>Explaining a Rainbow</b>	<b>90</b>
	<b>Which Colors Are in a Rainbow?</b>	<b>91</b>
<b>Lesson 9</b>	<b>Color, Wavelength, and the Wider Electromagnetic Spectrum</b>	<b>92</b>
	Inquiry 9.1 Measuring Different Wavelengths	94
	<b>Measuring a Wave</b>	<b>95</b>
	Inquiry 9.2 Constructing the Spectrum	96
	<b>Color and Wavelength</b>	<b>96</b>
	<b>Infrared and Ultraviolet</b>	<b>96</b>
	Inquiry 9.3 Looking Outside the Visible Spectrum	97
	<b>The Hidden Spectrum</b>	<b>99</b>
	<b>Tuning In</b>	<b>101</b>
	<b>Viewing the World and Beyond in Infrared</b>	<b>102</b>
	<b>Burning Our Biggest Organ</b>	<b>105</b>
	<b>Ozone and the Ozone Layer</b>	<b>107</b>
<b>Lesson 10</b>	<b>Examining Spectra</b>	<b>108</b>
	<b>How the Piece of Plastic Separates Light</b>	<b>109</b>
	Inquiry 10.1 Using a Simple Spectroscope	110
	<b>The Science of Spectroscopy</b>	<b>114</b>

<b>Lesson 11</b>	<b>Looking at Colors</b>	<b>116</b>
	Inquiry 11.1 Looking at Spectra Through Transparent Colored Sheets	118
	Inquiry 11.2 Looking at Colors Through Filters	118
	<b>Why Objects Look Colored</b>	<b>120</b>
	<b>Printing in Color</b>	<b>123</b>
	<b>The Beginning of Modern Printing</b>	<b>124</b>
	<b>A Green Engine Driven by the Sun</b>	<b>127</b>
<b>Lesson 12</b>	<b>Colored Light</b>	<b>132</b>
	Inquiry 12.1 Mixing Colored Lights	133
	<b>About Color Vision and Color Mixing</b>	<b>134</b>
	<b>Red, Green, and Blue Entertainment</b>	<b>135</b>
<b>Lesson 13</b>	<b>Part 1 Assessment—How Far Have We Come?</b>	<b>138</b>
	Inquiry 13.1 Measuring Shadows	140
<b>Part 2</b>	<b>Reflection and Refraction</b>	
<b>Lesson 14</b>	<b>Introducing Mirrors</b>	<b>144</b>
	<b>Reflecting Light</b>	<b>146</b>
	Inquiry 14.1 Looking at Reflections	147
	Inquiry 14.2 Where Is the Image in the Mirror?	148
	Inquiry 14.3 Predicting and Recognizing Mirror Images	150
	<b>Mirror Makers</b>	<b>152</b>
	<b>Mirrors in Myth</b>	<b>153</b>
<b>Lesson 15</b>	<b>How Is Light Reflected?</b>	<b>154</b>
	Inquiry 15.1 Measuring Reflection	156
	Inquiry 15.2 Changing the Path of a Light Ray	158
	<b>Redirecting Light, Images, and the Law of Reflection</b>	<b>159</b>
	Inquiry 15.3 Constructing a Device To See Over Objects	160
	<b>Explaining the Virtual Image</b>	<b>161</b>
	<b>Abu Ali Hasan Ibn al-Haytham</b>	<b>163</b>

<b>Lesson 16</b>	<b>Bending Mirrors</b>	<b>166</b>
	<b>Types of Curved Mirrors</b>	<b>168</b>
	Inquiry 16.1 Looking at Convex Mirrors	168
	<b>Explaining Reflection From a Convex Mirror</b>	<b>170</b>
	Inquiry 16.2 Looking at Concave Mirrors	171
	<b>Explaining Reflection From a Concave Mirror</b>	<b>172</b>
	<b>Search and Reflect</b>	<b>175</b>
	<b>The Trouble With Hubble</b>	<b>178</b>
	<b>The Flying Telescope</b>	<b>185</b>
<b>Lesson 17</b>	<b>Introducing Refraction</b>	<b>186</b>
	Inquiry 17.1 Looking Through a Transparent Block	188
	Inquiry 17.2 Shining Light Into a Transparent Block	189
	<b>Reflection and Refraction</b>	<b>191</b>
	Inquiry 17.3 Measuring Refraction in a Transparent Block	191
	<b>Introducing Refraction</b>	<b>193</b>
	<b>Refractive Index and Wet Pants</b>	<b>196</b>
<b>Lesson 18</b>	<b>Getting Things Into Focus</b>	<b>200</b>
	<b>Introducing Lenses</b>	<b>202</b>
	Inquiry 18.1 Examining Images Made by Convex Lenses	
	Inquiry 18.2 Investigating Refraction in Convex Lenses	205
	<b>How a Convex Lens Focuses Light</b>	<b>206</b>
	<b>Some Important Features of a Convex Lens</b>	<b>206</b>
	<b>How a Convex Lens Forms an Image</b>	<b>207</b>
	Inquiry 18.3 Investigating a Concave Lens	208
	<b>How a Concave Lens Forms an Image</b>	<b>209</b>
	<b>A Colored Blur</b>	<b>210</b>
	<b>Movie Physics</b>	<b>211</b>
<b>Lesson 19</b>	<b>Modeling Reflection and Refraction</b>	
	Inquiry 19.1 Can Particles Model Reflection From a Plane Mirror?	
	Inquiry 19.2 Using Particles To Model Reflection From Curved Mirrors	217
	Inquiry 19.3 Using Waves To Model Reflection	217
	Inquiry 19.4 Modeling Refraction	218
	<b>The Greatest Scientific Argument of the Millennium?</b>	<b>221</b>

<b>Lesson 20</b>	<b>Part 2 Assessment—What Do You Know About the Characteristics and Behavior of Light?</b>	<b>224</b>
	Inquiry 20.1 Examining a Hand Lens	226
<b>Part 3</b>	<b>Using Light</b>	
<b>Lesson 21</b>	<b>Starting the Anchor Activity</b>	<b>230</b>
	Inquiry 21.1 Looking at Optical Devices	231
	Inquiry 21.2 Introducing the Anchor Activity	232
	<b>Optics in Action—Digital Data and Amazing Music</b>	<b>238</b>
	<b>Listening to Music the Analog Way</b>	<b>239</b>
	<b>Inside an Audio CD Player</b>	<b>240</b>
	<b>Light in Step—A Laser Component</b>	<b>241</b>
<b>Lesson 22</b>	<b>Combining Lenses</b>	<b>244</b>
	Inquiry 22.1 Making a Simple Telescope	246
	<b>How Telescopes Work</b>	<b>248</b>
<b>Lesson 23</b>	<b>Dissecting a Camera</b>	<b>252</b>
	Inquiry 23.1 Dissecting a Disposable Camera	254
	<b>Recording a Picture</b>	<b>258</b>
	<b>Making Pictures With Light: A Timeline for Some Important Events in the Development of Photography</b>	<b>260</b>
	<b>Mathew Brady—Recorder of History</b>	<b>262</b>
<b>Lesson 24</b>	<b>Animal Optics</b>	<b>266</b>
	Inquiry 24.1 Investigating Human Eyes	268
	<b>How the Eye Produces a Clear Image</b>	<b>270</b>
	Inquiry 24.2 Why Do You Have Two Eyes in the Front of Your Head?	272
	<b>Optical Illusions</b>	<b>273</b>
	Inquiry 24.3 Experiencing Some Optical Illusions	273
	<b>How Do You Detect Light?</b>	<b>278</b>
	<b>The Impossible Worlds of M.C. Escher</b>	<b>280</b>

## CONTENTS

<b>Lesson 25</b>	<b>Communicating With Light</b>	<b>284</b>
	Inquiry 25.1 Investigating an Optical Fiber	286
	Inquiry 25.2 Sending a Message Along an Optical Fiber	287
	<b>Light Messages</b>	<b>288</b>
	<b>An Inventive Flare</b>	<b>289</b>
<b>Lesson 26</b>	<b>End of Module Assessment: Bringing Some Ideas About Light Together</b>	<b>294</b>
	Inquiry 26.1 Canned Light	296
	<b>Glossary</b>	<b>299</b>
	<b>Index</b>	<b>305</b>
	<b>Photo Credits</b>	<b>311</b>