Optical Fibers Module
(Grades 9-12)

What are the essential questions for this module?

• What are optical fibers?
• How does light reflect on a surface?
• Why does light bend when it travels from one material to another?
• What determines how much light bends?
• Can a transparent substance behave like a mirror?
• How does light travel in an optical fiber?

What central concepts are discussed?

Reflection, Refraction and Snell’s Law, Total Internal Reflection, Optical Fibers, Fermat’s Principle

What National Science Education Standards are addressed?

• Physical Science. Content Standard B.
  Interactions of Energy and Matter

• Science and Technology. Content Standard E.
  Abilities of Technological Design
  Understanding about Science and Technology

What do students need to know to work with this module?

Understandings

• Light is a form of energy
• Light travels in straight lines
• Transparent materials let light go through
• Opaque materials will either absorb or reflect light

Skills

• Correct use of a protractor to measure angles in degrees
• Correct use of a scientific calculator.
• Familiarity with the use of computers and the internet
• Basic reading skills
<table>
<thead>
<tr>
<th>WHAT WILL STUDENTS UNDERSTAND AS A RESULT OF THEIR WORK WITH THIS MODULE?</th>
<th>HOW WILL STUDENTS COME TO THIS UNDERSTANDING?</th>
<th>HOW WILL STUDENTS DEMONSTRATE THIS UNDERSTANDING?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light interacts differently with different materials. Light can be absorbed, reflected, or transmitted through a material.</td>
<td>They will read and analyze information.</td>
<td>They will categorize a list of materials based on how each interacts with light.</td>
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<td>Fermat's Principle states that light will take the path of least time to get from point A to point B. For reflection, the shortest time is also the shortest distance between the two points.</td>
<td>They will use a simulation to find the shortest distance between two points, one on an incident ray and one on a reflected ray.</td>
<td>They will derive the law of reflection based on the analysis of their measurements using a simulation.</td>
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<tr>
<td>The &quot;law of reflection&quot; states that the angle of incidence is always equal to the angle of reflection. These angles are measured with respect to an imaginary line perpendicular to the reflective surface (normal line).</td>
<td>They will explore the relationship between angle of incidence and angle of reflection using a simulation.</td>
<td>They will properly measure the angle of incidence and angle of reflection using a protractor.</td>
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<tr>
<td>Light is bent when it passes from one transparent medium to another. This phenomenon is called refraction. The light is bent toward the normal when it enters a medium where it slows down and away from the normal when it speeds up.</td>
<td>They will properly measure the angle of incidence and angle of reflection using a protractor.</td>
<td>They will use a calculator to determine the index of refraction from measurements in a simulation.</td>
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<td>The relationship between how much light bends when traveling from one transparent medium to another and the index of refraction of the medium is called Snell's Law.</td>
<td>They will explore using a simulation what happens to light when it passes from one medium to another.</td>
<td>They will predict the direction in which light bends depending on the density of the materials involved and the location of the light source.</td>
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<td>When light passes from water or glass to air, it can be refracted so far away from the normal that it travels parallel to the surface. The incident angle at which this occurs is called the critical angle. For angles of incidence larger than the critical angle, light is reflected back into the water or glass. This phenomenon is called total internal reflection.</td>
<td>They will properly measure the angle of incidence and angle of reflection using a protractor.</td>
<td>They will answer conceptual questions.</td>
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<td>Light travels through an optical fiber by total internal reflection. The amount of light trapped inside the fiber depends on the properties of the fiber’s material and the width of the fiber.</td>
<td>They will identify the conditions necessary to produce total internal reflection in a system.</td>
<td>They will answer conceptual questions.</td>
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<td>They will properly measure the critical angle for various pairs of materials.</td>
<td>They will apply their knowledge to the design of an optical fiber.</td>
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<td>They will identify the conditions that are necessary to trap a light ray inside an optical fiber.</td>
<td>They will design using a simulation an optical fiber to send a light signal from one place to another.</td>
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