

Energy: Conservation and Transfer



6.P.3 Understand characteristics of energy transfer and interactions of matter and energy.

6.P.3.1 Illustrate the transfer of heat energy from warmer objects to cooler ones using examples of conduction, radiation and convection and the effects that may result.

6.P.3.2 Explain the effects of electromagnetic waves on various materials to include absorption, scattering, and change in temperature.

6.P.3.3 Explain the suitability of materials for use in technological design based on a response to heat (to include conduction, expansion, and contraction) and electrical energy (conductors and insulators).

Conduction
Energy is transferred by direct contact.



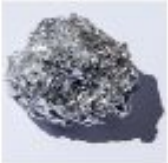





Keep Your Cool

What is conduction?

- Energy as heat can be transferred in three main ways: conduction, convection, and radiation.
- **Conduction** is the transfer of energy as heat from one substance to another through direct contact.
- As long as two objects are in contact, conduction continues until the temperatures of the objects are equal.

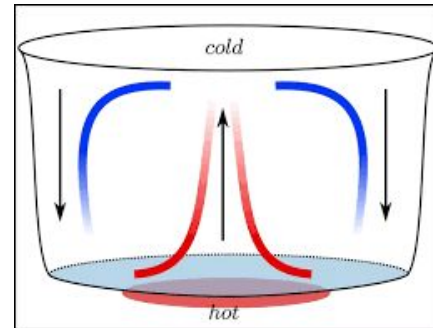
What is conduction?

- A **conductor** is a material that transfers heat very well.
- Metals are typically good conductors.
- An **insulator** is a material that is a poor conductor of heat.
- Wood, paper, and plastic foam are examples of good insulators.

Conductors	Insulators
 <p data-bbox="1166 539 1315 565">Aluminum</p>	 <p data-bbox="1620 539 1696 565">Wood</p>
 <p data-bbox="1205 787 1277 813">Steel</p>	 <p data-bbox="1615 787 1711 813">Plastic</p>
 <p data-bbox="1205 967 1277 993">Gold</p>	 <p data-bbox="1609 967 1715 993">Rubber</p>

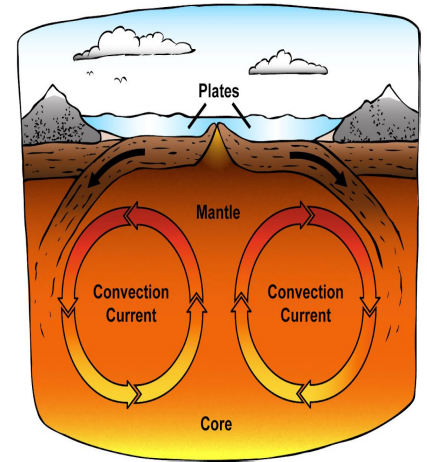
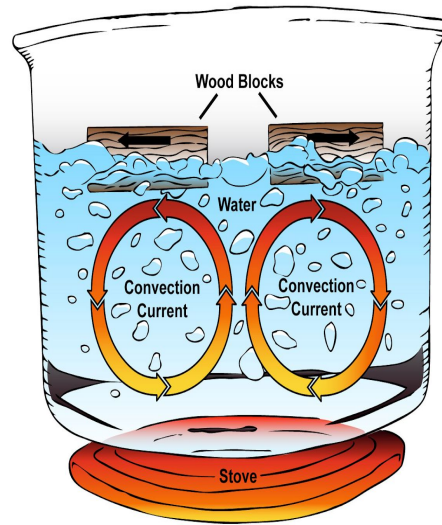
What is convection?

- **Convection** is the transfer of energy as heat by the movement of a liquid or gas.
- Convection occurs when a cooler, denser mass of gas or liquid replaces a warmer, less dense mass of gas or liquid by pushing it upward.



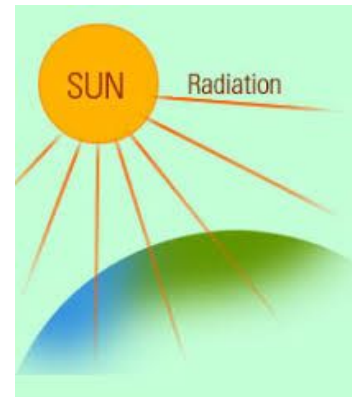
What is convection?

- When water is boiled, the water moves in roughly circular patterns because of convection.
- This motion is due to density differences that result from temperature differences.
- The motion is called a *convection current*.



What is radiation?

- **Radiation** is the transfer of energy by electromagnetic waves.
- All objects, including the sun and all living things, emit radiation.
- When radiation is emitted from one object and is absorbed by another, the result is often a transfer of heat.
- Radiation can travel through empty space.



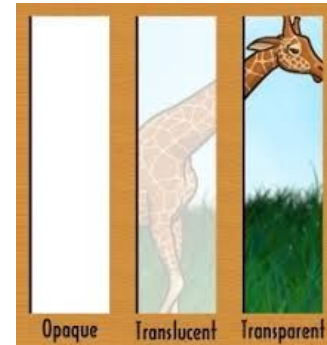
RADIATION



Shedding Light on the Matter

How can matter interact with light?

- Three forms of matter-light interactions play an important role in how people see light.
- When light enters a medium, the medium lets all, some, or no light pass through.



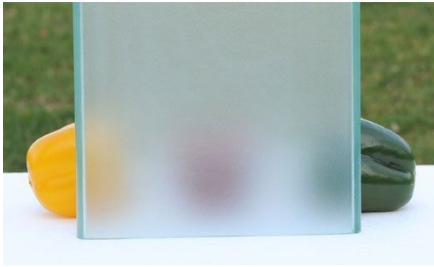
How can matter interact with light?

- Matter that transmits light is **transparent**.
- Matter that transmits light but scatters it in all directions is **translucent**.
- Matter can absorb light. When light enters a material but does not leave it, the light is absorbed.



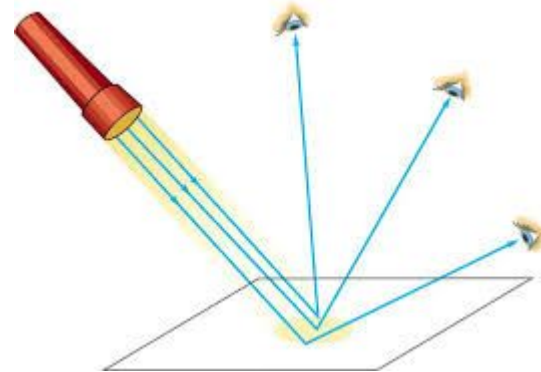
How can matter interact with light?

- **Absorption** is the transfer of light energy to matter.
- **Opaque** materials do not let any light pass through them because they reflect light, absorb light, or both.



How can matter interact with light?

- Matter can reflect light. **Reflection** is the bouncing of light off a surface.
- When light strikes a smooth surface, the light bounces off at an angle equal to the angle at which it hit the surface, producing a clear image.



How can matter interact with light?

- When light strikes an uneven surface, the light is reflected in many directions. You see the object but do not see a reflected image of yourself.
- Nearly everything we can see, we see because light is reflected off a surface.

Color Me Impressed!

What determines the color of objects we see?

- When white light strikes an object, the color of the object depends on how the object transmits, reflects, or absorbs the colors of light.
- An object that reflects a certain color of light appears to be that color.

What determines the color of objects we see?

- A frog appears green because its skin absorbs all colors but green.
- An object that reflects every color appears white.
- An object that absorbs every color appears black.



What determines the color of objects we see?

- When light is transmitted through an object, the object can absorb some colors and allow other colors to pass through.
- The color that passes through a transparent or translucent object determines the color of that object.
- Some matter absorbs certain types of electromagnetic waves and allows other types of electromagnetic waves to pass through.

What determines the color of objects we see?

- Sometimes the color of an object depends on what light shines on it.
- If a red filter is placed between a green frog and white light, the filter will absorb all colors of light except red, orange, and yellow.
- The frog reflects no light, and you perceive the frog's color as gray or black.

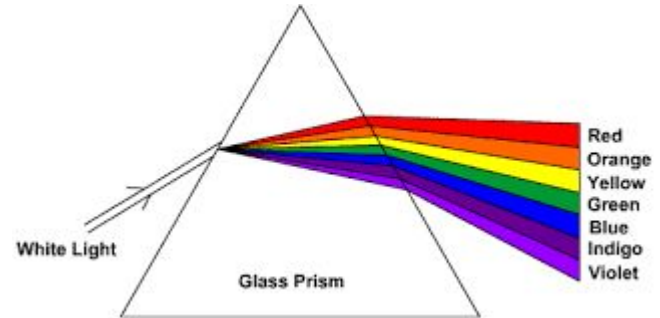
Matter Scatter

What happens when light waves interact with matter?

- Light travels 300 million miles per second through a vacuum. This is called the *speed of light*.
- When light waves pass through a medium, the medium can change properties of the light.
- Light travels more slowly when it passes through matter. Shorter wavelengths of light are slowed more than longer wavelengths of light.

What happens when light waves interact with matter?

- Light bends when it passes at an angle from one medium to another.
- The bending of a wave as it passes from one medium to another is called **refraction**.



What happens when light waves interact with matter?

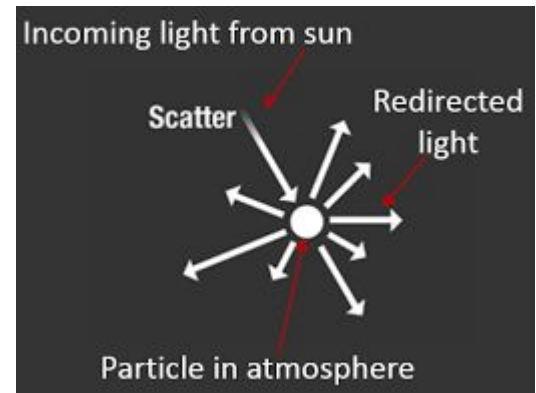
- Refraction occurs because light changes speed as it enters a medium at an angle.
- When light slows in a medium, it bends inward, creating a smaller angle.
- Light waves with shorter wavelengths bend more.

What happens when light waves interact with matter?

- The waves that make up white light have different wavelengths.
- As white light passes through a prism, the wavelengths refract at different angles and you see a spectrum of colors.

What happens when light waves interact with matter?

- When light strikes matter, the light can change direction. This is called **scattering**.
- Light scattering allows us to see objects that are not in the direct path of the light source.



What happens when light waves interact with matter?

- Another result of scattered light is the color of the sky. Blue light is scattered more than other colors, so the sky appears blue.
- When the sun strikes Earth at an angle, light waves pass through more of the atmosphere. Only the long-wavelength red light reaches Earth.

What are some of the materials of technology?

- Technology has allowed people to change raw materials into modified materials.
- The modification and study of materials is the field of **materials science**.
- Many materials used every day, such as plastic, polyester, and steel, were developed by materials scientists.

What are some of the materials of technology?

- Materials are classified into categories based on their composition.
- Classifications include metals, ceramics, polymers, semiconductors, composites, and exotic materials.
- Simple materials, such as glass, paper, and wood, are still used in technology applications.

Decisions, Decisions ...

How are materials chosen?

- Materials are chosen because of their characteristics.
- The characteristics of a material include the material's physical and chemical properties.
- These properties influence the way a material functions.

How are materials chosen?

- Chemical properties describe a material's ability to take part in a chemical reaction.
- Some materials are chosen because they are nonreactive and don't take part in chemical reactions easily, such as stainless steel and some plastics.
- Other materials are chosen because they do react chemically. For example, ammonia is used in cleaners because it reacts with and dissolves grease.

How are materials chosen?

- Physical properties are the characteristics of a material that can be observed or measured without changing the material's composition.
- Physical properties of materials include density, boiling point, and hardness.
- Other physical properties include transparency, the ability to let light pass through, and conductivity, the ability to carry electrical current.

What limits a material's use?

- Even though a material might be ideal for one reason, it could be a bad choice for other reasons.
- A material may not be available for use in technology. Other materials may be more common and easier to obtain.
- When a material is scarce or difficult to make, it is usually expensive. If a material is too expensive, an alternative should be found.
- Sometimes a material is too hazardous to be widely used.