Learning Objectives

1) Understand that light is energy that can be seen.

2) Know that light travels in the form of a transverse wave.

3) Identify certain sections of a transverse wave. In the video, a diagram depicts a transverse wave oscillating up and down (please note that ordinary light waves from the sun or a lamp vibrate in all directions perpendicular to the direction of travel – not just up and down). The high points on the wave are called **crests** and the low points are called **troughs**.

4) Know some basic properties of waves.

   a) **Amplitude:** Amplitude describes the height of a wave. It is the distance between the center of the wave and the crest or trough.
   b) **Wavelength:** Wavelength is the distance (usually measured in meters) of one cycle of a wave. It is determined by measuring the distance between two crests or two troughs.
   c) **Frequency:** Frequency is the measurement of the number of cycles that pass a certain point in a given time period (per second).

5) Understand that light waves are electromagnetic waves. Electromagnetic waves carry both electric and magnetic energy. All electromagnetic waves fit into the electromagnetic spectrum. All electromagnetic waves travel at the same speed (300,000,000 meters per second), but they have different wavelengths and frequencies (the higher the frequency, the shorter the wavelength). Please note that not all forms of energy travel in electromagnetic waves (e.g., sound).

6) Identify some of the different types of waves that are found on the electromagnetic spectrum, and know where light waves fit on the spectrum. From lowest wavelength to highest wavelength, the electromagnetic spectrum consists of radio waves, infrared rays, visible light, x-rays, and gamma rays.

7) Realize that light waves have unique properties.

   a) **No Medium Required:** Unlike other waves light/electromagnetic waves do not need a medium in which to travel. So even though space is a vacuum with no air, light from the sun and distant stars can be seen from earth.

   b) **Photons:** Because of their short wavelength and high frequency, light waves act like a moving particle. These "particles" are actually packets of moving energy called photons.

8) Know how light interacts with objects. When light hits an object, three things can occur.

   a) **Absorption:** Light can be absorbed (taken in) by the object. When light is absorbed by an object, the energy is turned into **heat**.
   b) **Transmission:** The object can transmit light, which means that the light passes through it.
   c) **Reflection:** Light can bounce off the object.
   d) In most cases a combination of all three (absorption, transmission, and reflection) occurs.

9) Realize that the way light reflects off of an object depends on the object's surface. When light hits a rough object, it is reflected in many directions, and no image can be seen in the object. However, when light hits a smooth object (e.g., a mirror), it is reflected in one direction, and an image can be seen in the object.

10) Understand what is meant by the words: opaque, transparent, and translucent.

   a) **Opaque:** An object is opaque when it reflects or absorbs all the light that strikes it.
   b) **Transparent:** An object that transmits light is called transparent.
   c) **Translucent:** If an object only allows some light to pass through, it is called translucent.

11) Understand the principle of light refraction. Refraction is the bending of light rays as they enter a new medium. It is refraction that causes objects to appear bent as they are placed into water. Refraction occurs because as light passes from one medium to another, it experiences a change in velocity (speed) causing the light to bend. This changes the way a person perceives the object's placement. Magnifying glasses and reading glasses are based on the principle of refraction.

12) Know about the colors of light and know how they interact with objects.

   a) The colors of light (the rainbow) in order of increasing wavelength are: Red, Orange, Yellow, Green, Blue, Indigo, and Violet (ROY G BIV). Each color represents a small change in frequency within the visible light portion of the electromagnetic spectrum. White light consists of all the colors of the rainbow.
   b) Light comes in three primary colors: Red, Blue, and Green. It is from those three colors that all the other colors of light are created. If all three primary colors are mixed together in equal amounts, white light is formed.

13) Know how light is seen and how it related to reflection and absorption. The color that is seen when light hits an object depends on which one is reflected and which ones are absorbed by the object. A red object appears red because it absorbs other colors of light and reflects red light. When light hits something white, all of the colors are reflected by the object. When light hits something that is black, the object absorbs all of the colors.

Suggested Activities

1) Experiment with Gels: Gels are pieces of colored plastic used by the entertainment industry to achieve certain lighting effects. They work by allowing only specific wavelengths of light to pass through them. For example, a red gel only lets red light to pass. Pass out a set of gels (blue, red, and green), clipboard, and some paper to each student or group. Ask the student look at certain objects in the classroom or on the campus through each of the gels. Have the write down what they see and explain why the objects appear the way they do. For example, one might say that a red apple appears black through a blue gel because the red apple reflects only red light (it absorbs all the other colors), but the blue gel only lets blue light pass through it; so no light is being reflected back to the eye (the absence of light = black). Have the students discuss their findings with the class.

Vocabulary

Beam/Ray — A line of light

Electromagnetic Spectrum — The range of electromagnetic waves in order of frequency

Medium — Any solid, liquid, or gas

Prism — A uniquely shaped object that can separate white light into individual colors

Transverse Wave — A wave in which the oscillations are perpendicular to the direction of travel

Wave — A disturbance created by the transfer of energy