



## Physics

### Connections to Other Sciences

Here are some examples of how the concepts you studied in this chapter relate to other sciences.

#### Waves

**Biology** Nerve cells transmit messages from the brain to the muscles through waves of electrical impulses. These electrical waves are associated with the motion of positive and negative ions into and out of the nerve cells.

**Chemistry** Light waves can transmit energy that is absorbed by molecules. Similarly, molecules can emit energy in the form of light waves.

**Earth Science** Water waves play an important role in shaping land masses. Like all waves, water waves carry energy. This energy can be used to break up rocks, move sand around, and redefine the contours of beaches and inlets.

#### Vibrating Strings

**Biology** Vocal cords are similar to vibrating strings. Since the length remains the same, tightening the vocal cords increases the wave speed in the cords and the frequency of vibration increases.

**Chemistry** Polymers are long-chain molecules found in rubber and plastics that can vibrate like strings. By studying those vibrations, chemists can determine the composition and structure of the polymers.

**Earth Science** Standing waves similar to those set up in vibrating strings can occur in the ground when the soil is saturated with water during an earthquake. This phenomenon increases the destructive power of the earthquake.

#### Refraction

**Biology** Cells are somewhat transparent to light. By observing light as it refracts through cells, biologists can learn about cell structure.

**Chemistry** Different combinations of a set of elements, such as  $\text{FeO}$ ,  $\text{Fe}_2\text{O}_3$ , and  $\text{FeO}_2$ , refract light differently. Chemists can use this refraction pattern to determine the particular elemental combination in a sample.

**Earth Science** The refraction of light passing through Earth's atmosphere during a lunar eclipse allows some light to pass into the shadow of Earth on the Moon. This light, which is predominantly in the red region, gives rise to the "blood moon" phenomenon.

#### Lenses

**Biology** Eyes are equipped with variable focal length lenses that allow us to form clear images of objects by adjusting the focus.

**Chemistry** Lenses made of material other than glass allow focusing of images from non-visible spectral lines to assist in compound identification.

**Earth Science** Telescopes have lenses that magnify images of the planets. The gravitational lens effect of distant galaxies helps determine their mass.

#### Mirrors and Reflection

**Biology** Tigers and other animals can hunt successfully at night due to a reflective layer of cells inside their eyes. This layer allows light a second chance to interact with the light detecting cells of the eye, improving night vision. Such animals can often be spotted at night due to the reflection of light from their eyes.

**Chemistry** Chemists analyze the structure of organic compounds using infrared spectrophotometers. These instruments use a light source, a series of mirrors, and a light detector to determine the functional groups in a compound.

**Earth Science** We see the Moon because sunlight is reflected by the Moon. Similarly, when astronauts are in space, they see Earth only because it is reflecting sunlight.

#### Color

**Biology** Color plays an important role in nature. Birds and insects may be attracted to a plant by its color, and thus aid in pollination. The colors of some animals can provide camouflage, making it more difficult for predators or prey to spot them, or color can serve as an attraction to mates.

**Chemistry** Many substances change color as a reaction to chemical environment. Substances used to measure pH change color as a reaction to the pH content of a given solution. Other substances change color depending on their valence state.

**Earth Science** The color of the minerals in a rock is an important indicator in rock identification. Rocks are scraped across porcelain plates and the streaks that are left are analyzed for their color.

