



## Physics

### Connections to Other Sciences



The fundamental ideas you have studied in this chapter are also basic to many other sciences that you will study in the future. Appreciating the connections among science disciplines helps scientists achieve a richer understanding of nature. Science research in the twenty-first century depends heavily upon the way these different disciplines interact, with areas such as biophysics and geophysics becoming major areas of study.

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

#### Response Time

**Biology** An animal's response time may be critical for its survival. A bird that responds too slowly to a hawk, or a fly that fails to evade a frog's tongue, will not survive long.

**Chemistry** The time it takes a chemical to respond to light, and then bond with other chemicals, is one of the criteria for determining film speed for cameras.

**Earth Science** The response of the polar ice caps due to global warming may take hundreds of years to become completely visible.

#### Circular Motion

**Biology** Many birds will soar in circles on thermals—rising columns of warm air. The birds bank their wings to provide a centripetal force toward the center of the thermal and the lifting force of the rising air.

**Chemistry** Magnetic fields cause charged molecular fragments to travel in a circle. The larger the circle, the more massive the charged fragments must be, giving chemists an idea of what the composition of these parts may be.

**Earth Science** Most of the weather systems on Earth are examples of large masses of air that circle around a central position due to the Coriolis force that is experienced by air masses moving on a rotating Earth. This force is part of the reason for Earth's global winds and ocean currents.

#### Speed and Velocity

**Biology** The speeds obtainable by living organisms vary, from that of a diving peregrine falcon (almost 200 mi/h or 322 km/h) to that of a slime mold (1 mm/h or 0.04 in./h).

**Chemistry** The high speed gained by molecules in a chemical explosion is responsible for the damage they do.

**Earth Science** The speed of advance of a glacier may be as much as several feet per day.

#### Acceleration

**Biology** The fastest land animal, the cheetah, is able to accelerate from rest to a speed of 60 mi/h in only 3 seconds, or almost  $9 \text{ m/s}^2$  ( $30 \text{ ft/s}^2$ )!

**Chemistry** Electrons are accelerated to a very high speed and collide with molecules in a device known as a mass spectrometer, which is used in forensics for solving crimes.

**Earth Science** An earthquake may accelerate the floor of the ocean upward for a very short time, causing a tsunami that is capable of damaging large sections of a coastline.

#### Doppler Effect

**Biology** The velocity measurement of blood flow in arteries and veins, based on the Doppler effect, is an effective tool for diagnosis of vascular problems.

**Chemistry** The random motion of atoms of a gas due to their kinetic energy results in a shift in the frequency of the light emitted by the atoms due to the Doppler effect. Thus, the light emitted by a gas has a wider range of frequencies than that of a single atom.

**Earth Science** The expansion rate of the universe is determined by astronomers who use the Doppler effect to calculate the speed of moving galaxies.