SECTION 4

Torque and Simple Machines

SECTION OBJECTIVES

- **Distinguish between torque and force.**
- **Calculate the magnitude of a torque on an object.**
- **Identify the six types of simple machines.**
- **Calculate the mechanical advantage of a simple machine.**

ROTATIONAL MOTION

Earlier in this chapter, you studied various examples of uniform circular motion, such as a spinning Ferris wheel or an orbiting satellite. During uniform circular motion, an object moves in a circular path and at constant speed. An object that is in circular motion is accelerating because the direction of the object's velocity is constantly changing. This centripetal acceleration is directed toward the center of the circle. The net force causing the acceleration is a centripetal force, which is also directed toward the center of the circle.

In this section, we will examine a related type of motion: the motion of a rotating rigid object. For example, consider a football that is spinning as it flies through the air. If gravity is the only force acting on the football, the football spins around a point called its *center of mass*. As the football moves through the air, its center of mass follows a parabolic path. Note that the center of mass is not always at the center of the object.

ADVANCED TOPICS

See "Rotation and Inertia" and "Rotational Dynamics" in **Appendix J: Advanced Topics** to learn more about rotational motion.

Rotational and translational motion can be separated

Imagine that you roll a strike while bowling. When the bowling ball strikes the pins, as shown in **Figure 14,** the pins spin in the air as they fly backward. Thus, they have both rotational and linear motion. These types of motion can be analyzed separately. In this section, we will isolate rotational motion. In particular, we will explore how to measure the ability of a force to rotate an object.

Figure 14
Pins that are spinning and flying through the air exhibit both rotational and translational motion.