SECTION 2

Measuring Simple Harmonic Motion

SECTION OBJECTIVES

- Identify the amplitude of vibration.
- Recognize the relationship between period and frequency.
- Calculate the period and frequency of an object vibrating with simple harmonic motion.

amplitude

the maximum displacement from equilibrium

period

the time that it takes a complete cycle to occur

frequency

the number of cycles or vibrations per unit of time

AMPLITUDE, PERIOD, AND FREQUENCY

In the absence of friction, a moving trapeze always returns to the same maximum displacement after each swing. This maximum displacement from the equilibrium position is the **amplitude.** A pendulum's amplitude can be measured by the angle between the pendulum's equilibrium position and its maximum displacement. For a mass-spring system, the amplitude is the maximum amount the spring is stretched or compressed from its equilibrium position.

Period and frequency measure time

Imagine the ride shown in **Figure 6** swinging from maximum displacement on one side of equilibrium to maximum displacement on the other side, and then back again. This cycle is considered one complete cycle of motion. The **period,** T, is the time it takes for this complete cycle of motion. For example, if one complete cycle takes 20 s, then the period of this motion is 20 s. Note that after the time T, the object is back where it started.

The number of complete cycles the ride swings through in a unit of time is the ride's **frequency,** f. If one complete cycle takes 20 s, then the ride's frequency is $\frac{1}{20}$ cycles/s, or 0.05 cycles/s. The SI unit of frequency is s^{-1}, known as hertz (Hz). In this case, the ride's frequency is 0.05 Hz.

Period and frequency can be confusing because both are concepts involving time in simple harmonic motion. Notice that the period is the time per cycle and that the frequency is the number of cycles per unit time, so they are inversely related.

$$f = \frac{1}{T} \text{ or } T = \frac{1}{f}$$

This relationship was used to determine the frequency of the ride.

$$f = \frac{1}{T} = \frac{1}{20\text{ s}} = 0.05\text{ Hz}$$

In any problem where you have a value for period or frequency, you can calculate the other value. These terms are summarized in **Table 2** on the next page.

Figure 6
For any periodic motion—such as the motion of this amusement park ride in Helsinki, Finland—period and frequency are inversely related.