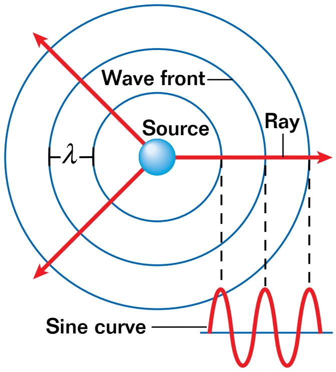

Figure 3
In this representation of a spherical wave, the wave fronts represent compressions, and the rays show the direction of wave motion. Each wave front corresponds to a crest of the sine curve. In turn, the sine curve corresponds to a single ray.

Spherical waves can be represented graphically in two dimensions with a series of circles surrounding the source, as shown in **Figure 3.** The circles represent the centers of compressions, called *wave fronts.* Because we are considering a three-dimensional phenomenon in two dimensions, each circle represents a spherical area.

Because each wave front locates the center of a compression, the distance between adjacent wave fronts is equal to one wavelength, λ. The radial lines perpendicular to the wave fronts are called *rays.* Rays indicate the direction of the wave motion. The sine curve used in our previous representation of sound waves, also shown in **Figure 3,** corresponds to a single ray. Because crests of the sine curve represent compressions, each wave front crossed by this ray corresponds to a crest of the sine curve.

Now, consider a small portion of a spherical wave front that is many wavelengths away from the source, as shown in **Figure 4.** In this case, the rays are nearly parallel lines, and the wave fronts are nearly parallel planes. Thus, at distances from the source that are great relative to the wavelength, we can approximate spherical wave fronts with parallel planes. Such waves are called *plane waves.* Any small portion of a spherical wave that is far from the source can be considered a plane wave. Plane waves can be treated as one-dimensional waves all traveling in the same direction, as in the chapter "Vibrations and Waves."

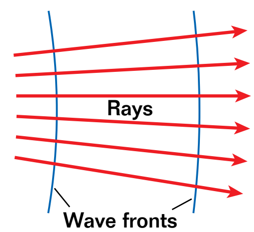

Figure 4
Spherical wave fronts that are a great distance from the source can be approximated with parallel planes known as *plane waves*.

Why it Matters

Conceptual Challenge

1. Music from a Trumpet Suppose you hear music being played from a trumpet that is across the room from you. Compressions and rarefactions from the sound wave reach your ear, and you interpret these vibrations as sound. Were the air particles that are vibrating near your ear carried across the room by the sound wave? How do you know?

2. Lightning and Thunder Light waves travel nearly 1 million times faster than sound waves in air. With this in mind, explain how the distance to a lightning bolt can be determined by counting the seconds between the flash and the sound of the thunder.