

FIGURE 11-24
(a) Transverse wave;
(b) longitudinal wave.

11-8 Types of Waves: Transverse and Longitudinal

When a wave travels down a rope—say, from left to right as in Fig. 11-21—the particles of the rope vibrate up and down in a direction transverse (that is, perpendicular) to the motion of the wave itself. Such a wave is called a **transverse wave** (Fig. 11-24a). There exists another type of wave known as a **longitudinal wave**. In a longitudinal wave, the vibration of the particles of the medium is *along* the direction of the wave's motion. Longitudinal waves are readily formed on a stretched spring or Slinky by alternately compressing and expanding one end. This is shown in Fig. 11-24b, and can be compared to the transverse wave in Fig. 11-24a. A series of compressions and expansions propagate along the spring. The *compressions* are those areas where the coils are momentarily close together. *Expansions* (sometimes called *rarefactions*) are regions where the coils are momentarily far apart. Compressions and expansions correspond to the crests and troughs of a transverse wave.

An important example of a longitudinal wave is a sound wave in air. A vibrating drumhead, for instance, alternately compresses and rarefies the air in contact with it, producing a longitudinal wave that travels outward in the air, as shown in Fig. 11-25.

As in the case of transverse waves, each section of the medium in which a longitudinal wave passes oscillates over a very small distance, whereas the wave itself can travel large distances. Wavelength, frequency, and wave velocity all have meaning for a longitudinal wave. The wavelength is the distance between successive compressions (or between successive expansions), and frequency is the number of compressions that pass a given point per second. The wave velocity is the velocity with which each compression appears to move; it is equal to the product of wavelength and frequency, $v = \lambda f$ (Eq. 11-12).

A longitudinal wave can be represented graphically by plotting the density of air molecules (or coils of a Slinky) versus position at a given instant, as shown in Fig. 11-26. Such a graphical representation makes it easy to illustrate what is happening. Note that the graph looks much like a transverse wave.

Transverse and longitudinal waves

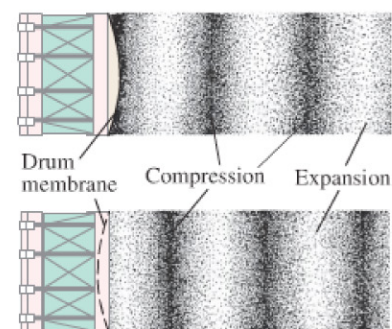


FIGURE 11-25 Production of a sound wave, which is longitudinal, shown at two moments in time about a half period ($\frac{1}{2}T$) apart.

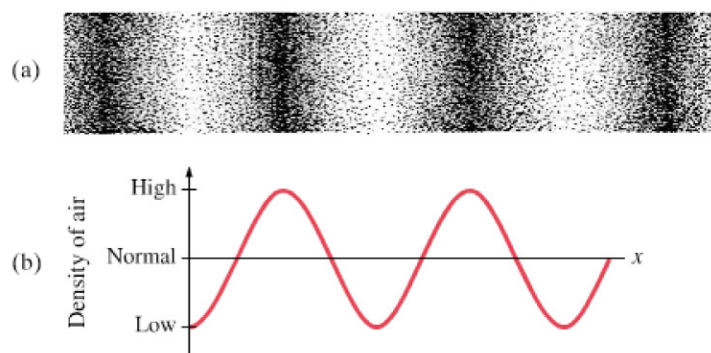


FIGURE 11-26
(a) A longitudinal wave with
(b) its graphical representation
at a particular instant in time.