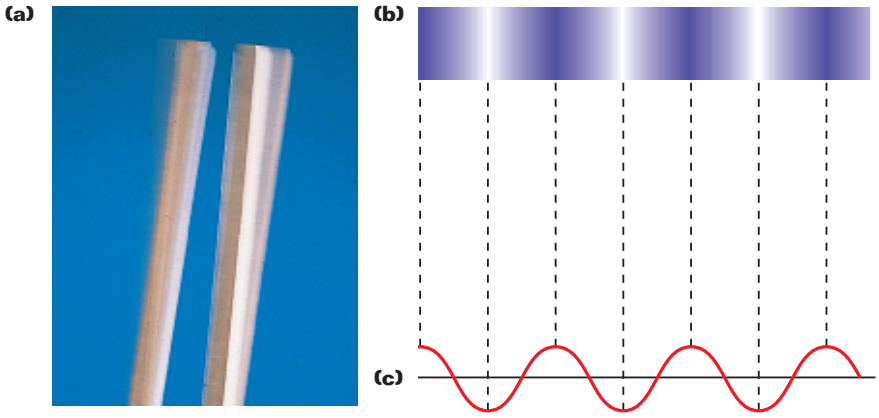

Figure 2
(a) As this tuning fork vibrates, **(b)** a series of compressions and rarefactions moves away from each prong. **(c)** The crests of this sine wave correspond to compressions, and the troughs correspond to rarefactions.

Sound waves are longitudinal

In sound waves, the vibrations of air molecules are parallel to the direction of wave motion. Thus, sound waves are longitudinal. The simplest longitudinal wave produced by a vibrating object can be represented by a sine curve. In **Figure 2,** the crests correspond to compressions (regions of higher pressure), and the troughs correspond to rarefactions (regions of lower pressure). Thus, the sine curve represents the changes in air pressure due to the propagation of the sound waves. Note that **Figure 2** shows an idealized case. This example disregards energy losses that would decrease the wave amplitude.

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CHARACTERISTICS OF SOUND WAVES

As discussed earlier, *frequency* is defined as the number of cycles per unit of time. Sound waves that the average human ear can hear, called *audible* sound waves, have frequencies between 20 and 20 000 Hz. (An individual's hearing depends on a variety of factors, including age and experiences with loud noises.) Sound waves with frequencies less than 20 Hz are called *infrasonic* waves, and those above 20 000 Hz are called *ultrasonic* waves.

It may seem confusing to use the term *sound waves* for infrasonic or ultrasonic waves because humans cannot hear these sounds, but these waves consist of the same types of vibrations as the sounds that we can hear. The range of audible sound waves depends on the ability of the average human ear to detect their vibrations. Dogs can hear ultrasonic waves that humans cannot.

Did you know?

Elephants use infrasonic sound waves to communicate with one another. Their large ears enable them to detect these low-frequency sound waves, which have relatively long wavelengths. Elephants can effectively communicate in this way, even when they are separated by many kilometers.

Frequency determines pitch

The frequency of an audible sound wave determines how high or low we perceive the sound to be, which is known as **pitch.** As the frequency of a sound wave increases, the pitch rises. The frequency of a wave is an objective quantity that can be measured, while pitch refers to how different frequencies are perceived by the human ear. Pitch depends not only on frequency but also on other factors, such as background noise and loudness.

pitch

a measure of how high or low a sound is perceived to be, depending on the frequency of the sound wave