Topic Page: Sound

Definition: **sound** from *Dictionary of Energy*

Physics. **1.** a pressure disturbance that propagates through a medium due to the stress or displacement of the medium from its equilibrium state. **2.** the auditory sensation that is induced by such a disturbance, which in humans is perceived by the ears. Sound moves through dry air at a speed of about 331 meters per second (740 miles per hour), assuming standard atmospheric pressure and a temperature of 0°C.

Summary Article: **sound**
From *The Columbia Encyclopedia*

any disturbance that travels through an elastic medium such as air, ground, or water to be heard by the human ear. When a body vibrates, or moves back and forth (see vibration), the oscillation causes a periodic disturbance of the surrounding air or other medium that radiates outward in straight lines in the form of a pressure wave. The effect these waves produce upon the ear is perceived as sound. From the point of view of physics, sound is considered to be the waves of vibratory motion themselves, whether or not they are heard by the human ear.

Generation of Sound Waves

Sound waves are generated by any vibrating body. For example, when a violin string vibrates upon being bowed or plucked, its movement in one direction pushes the molecules of the air before it, crowding them together in its path. When it moves back again past its original position and on to the other side, it leaves behind it a nearly empty space, i.e., a space with relatively few molecules in it. In the meantime, however, the molecules which were at first crowded together have transmitted some of their energy of motion to other molecules still farther on and are returning to fill again the space originally occupied and now left empty by the retreating violin string. In other words, the vibratory motion set up by the violin string causes alternately in a given space a crowding together of the molecules of air (a condensation) and a thinning out of the molecules (a rarefaction). Taken together a condensation and a rarefaction make up a sound wave; such a wave is called longitudinal, or compressional, because the vibratory motion is forward and backward along the direction that the wave is following. Because such a wave travels by disturbing the particles of a material medium, sound waves cannot travel through a vacuum.

Characteristics of Sound Waves

Sounds are generally audible to the human ear if their frequency (number of vibrations per second) lies between 20 and 20,000 vibrations per second, but the range varies considerably with the individual. Sound waves with frequencies less than those of audible waves are called subsonic; those with frequencies above the audible range are called ultrasonic (see ultrasonics).

A sound wave is usually represented graphically by a wavy, horizontal line; the upper part of the wave (the crest) indicates a condensation and the lower part (the trough) indicates a rarefaction. This graph, however, is merely a representation and is not an actual picture of a wave. The length of a sound wave, or the wavelength, is measured as the distance from one point of greatest condensation to the next following it or from any point on one wave to the corresponding point on the next in a train of waves. The wavelength depends upon the velocity of sound in a given medium at a given temperature and upon the frequency of vibration. The wavelength of a sound can be determined by dividing the numerical value for the velocity of sound in the given medium at the given temperature by the frequency of vibration. For example, if the velocity of sound in air is 1,130 ft per second and the frequency of vibration is 256, then the wave length is approximately 4.4 ft.

The velocity of sound is not constant, however, for it varies in different media and in the same medium at different temperatures. For example, in air at 0 degrees Celsius. it is approximately 1,089 ft per second, but at 20 degrees Celsius. it is increased to about 1,130 ft per second, or an increase of about 2 ft per second for every centigrade degree rise in temperature. Sound travels more slowly in gases than in liquids, and more slowly in liquids than in solids. Since the ability to conduct sound is dependent on the density of the medium, solids are better conductors than liquids, liquids are better conductors than gases.

Sound waves can be reflected, refracted (or bent), and absorbed as light waves can be. The reflection of sound waves can result in an echo—an important factor in the acoustics of theaters and auditoriums. A sound wave can be reinforced with waves from a body having the same frequency of vibration, but the combination of waves of different frequencies of vibration may produce “beats” or pulsations or may result in other forms of interference.

Characteristics of Musical Sounds

Musical sounds are distinguished from noises in that they are composed of regular, uniform vibrations, while noises are irregular and disordered vibrations. Composers, however, frequently use noises as well as musical sounds. One musical tone is distinguished from another on the basis of pitch, intensity, or loudness, and quality, or timbre. Pitch describes how high or low a tone is and depends upon the rapidity with which a sounding body vibrates, i.e., upon the frequency of vibration. The higher the frequency of vibration, the higher the tone; the pitch of a siren gets higher and higher as the frequency of vibration increases. The apparent change in the pitch of a sound as a source approaches or moves away from an observer is described by the Doppler effect. The intensity or loudness of a sound depends upon the extent to which the sounding body vibrates, i.e., the amplitude of vibration. A sound is louder as the amplitude of vibration is greater, and the intensity decreases as the distance from the source increases. Loudness is measured in units called decibels. The sound waves given off by different vibrating bodies differ in quality, or timbre. A note from a saxophone, for instance, differs from a note of the same pitch and intensity produced by a violin or a xylophone; similarly vibrating reeds, columns of air, and strings all differ. Quality is dependent on the number and relative intensity of overtones produced by the vibrating body (see harmonic), and these in turn depend upon the nature of the vibrating body.

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