Physics
Chapter 11: Vibrations and Waves
Chapter 12: Sound

Section 12.1

Sound Waves

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Sound Waves

--Sound waves are <u>longitudinal waves</u>, with regions of <u>compressions</u> and <u>rarefactions</u>.

--In compressions, the density and pressure of the air increases.

--In rarefactions, the density and pressure decreases.

Characteristics of Sound Waves

--Sound that is in the normal range of human hearing is called audible sound.

--Audible sound has a frequency range between 20 Hz and 20,000 Hz.

--Infrasonic or subsonic sounds have a frequency of less than 20 Hz.

--Ultrasonic sounds have frequencies greater than 20,000 Hz.

--Other animals can hear frequencies of sound above and below the frequencies that are audible to humans.

(Chapter 12, 70526 html)

Pitch

--Pitch is how high or low we perceive a sound to be.

--The pitch of a sound is related to the frequency of the sound waves:

higher frequency = higher pitch.

Speed of Sound

--Sound travels faster in solids than in gases, because the molecules of a solid are closer together, enabling the sound energy to be transferred more quickly between molecules.

--In general, $V_{solid} > V_{liquid} > V_{gas}$; but there are exceptions.

Medium	v (m/s)
Gases	
air (0°C)	331
air (25°C)	346
air (100°C)	366
helium (0°C)	972
hydrogen (0°C)	1290
oxygen (0°C)	317
Liquids at 25°C	
methyl alcohol	1140
sea water	1530
water	1490
Solids	
aluminum	5100
copper	3560
iron	5130
lead	1320
vulcanized rubber	54

(See Table 12-1, page 410).

--The speed of sound increases as the temperature of the medium increases.

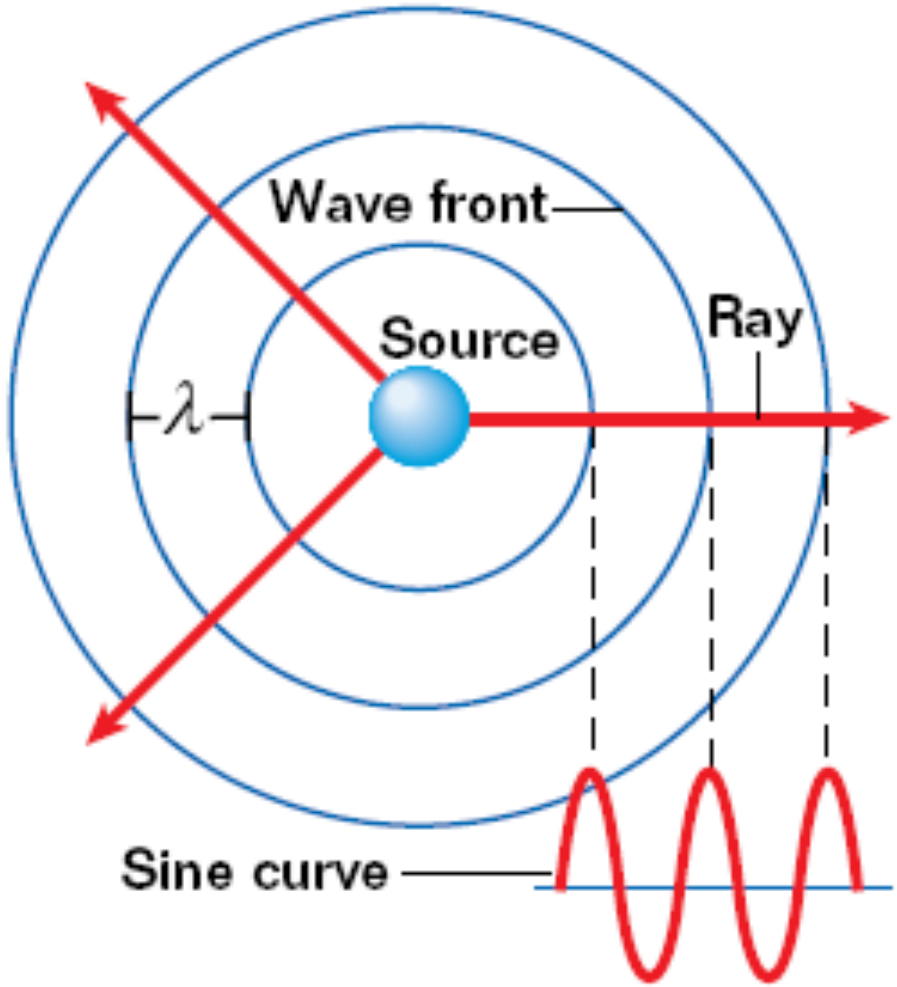
--This increase in speed is more true of gases such as air than of liquids or solids due to the increased motion of the molecules in a gas. (See Table 12-1, page 410)

Propagation of Sound Waves

--Sound waves propagate (spread out through space) in three dimensions.

--Three dimensional sound waves are spherical.

--In two dimensions the propagation of sound waves can be represented with a wave front; each circle in 2-D represents a sphere in 3-D.

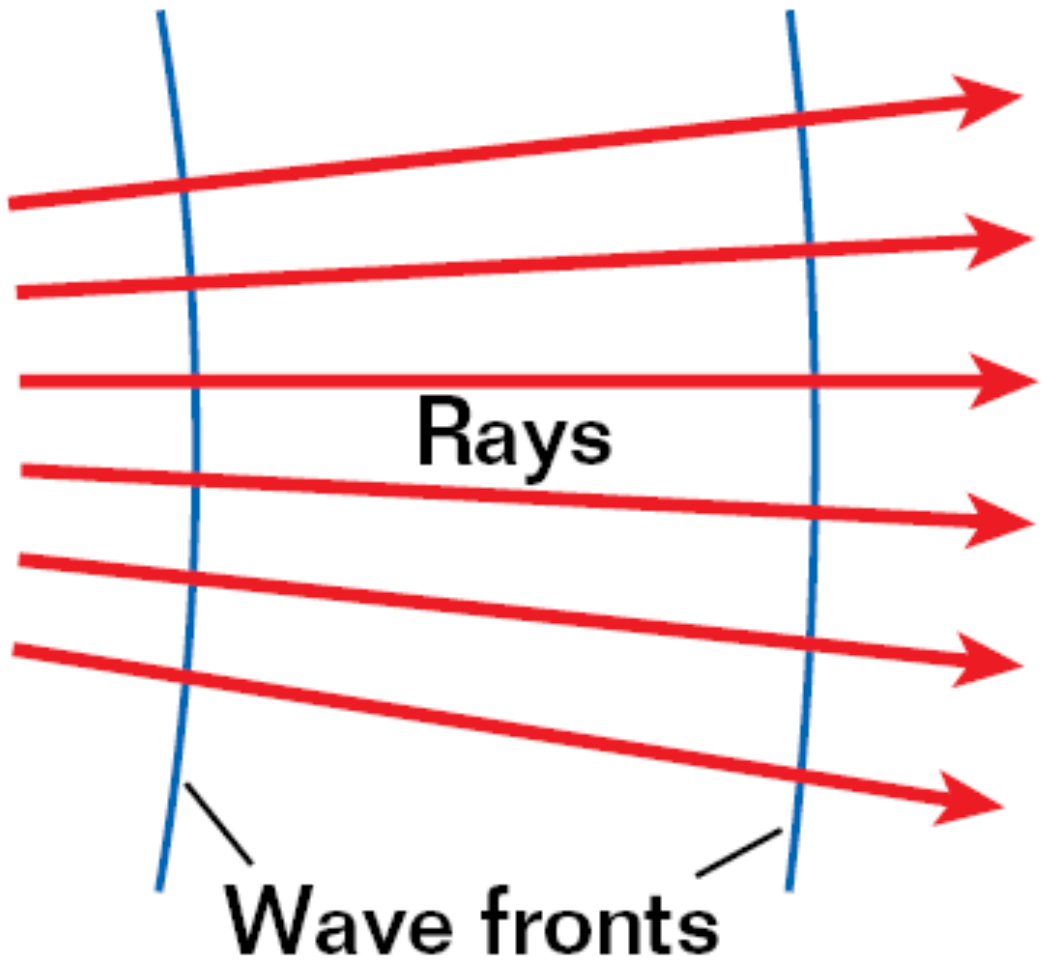

Wave front
Source
Ray
λ
Sine curve

--The distance between adjacent wave fronts is the wavelength, λ .

--A <u>ray</u> is a radial line perpendicular to the wave front.

--Rays indicate the direction of motion of the wave front.

--At large distances from the source compared to the wavelength, the wave front may be treated as a <u>plane wave</u>, with the rays parallel to each other.


Rays
Wave fronts

The Doppler Effect

--When a moving source of sound (such as the horn of a train or car) passes an observer on the ground, the pitch of the sound drops as the source passes the observer.

--This change is pitch is known as the <u>Doppler effect</u>.

--It is caused by the apparent change in wavelength and frequency of the sound waves as the source passes the observer.

--As the source is approaching the observer, the number of waves reaching the observer per second increases because the source is moving towards the observer.

--After the source has passed the number of waves reaching the observer decreases, producing the observed changes in frequency. (See Figure 12-5, page 412; Transparency T57)

--The Doppler effect also works for a stationary source of sound with a moving observer or any other combination of <u>relative motion</u>.

(Chapter 12, 70647 html)