

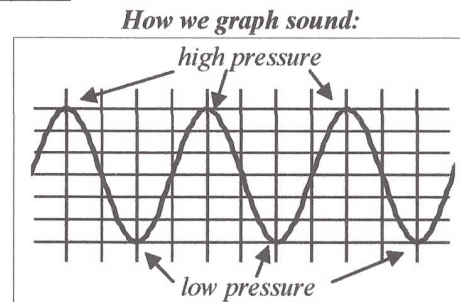
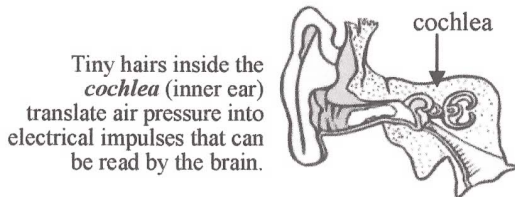
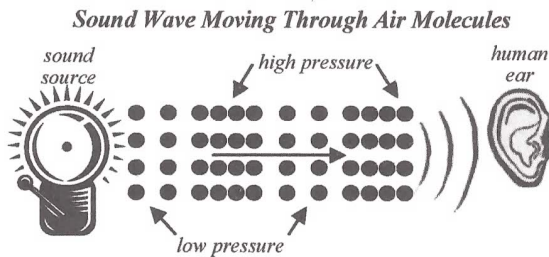
Sound

What is Sound?

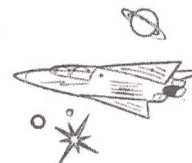
Sound is the movement of compression waves (longitudinal waves) hitting our ears. These compression waves are alternating high and low pressure areas. The air molecules vibrate back and forth, but don't move.



Speakers imitate sounds by pushing air and causing vibrations.



Sound needs a *medium* to travel through. Sound cannot travel through the vacuum of space. **Space is silent** (no matter what you hear in the movies).

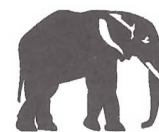


Frequency = Pitch

We hear the frequency of sound as **pitch**. A higher frequency we hear as a higher pitch. A lower frequency we hear as a lower pitch.

Higher Frequency = Higher Pitch

Frequency (f)	Wavelength (λ)	Source
20 Hz	17 m	rumble of thunder
100 Hz	3.4 m	bass guitar
2,000 Hz	17 cm	fire truck siren
5,000 Hz	7 cm	highest note of piano
10,000 Hz	3.4 cm	whine of a jet turbine



Elephants and submarines use **infrasonic** sound (too low to hear) to communicate over long distances. Very low frequencies (very bass) travel for very long distances and can penetrate through water (just like thru cars).

Humans can hear frequencies that are between 20 Hz and 20,000 Hz!

Dog whistles use **ultrasonic** frequencies — frequencies above human hearing, but perfect for dog ears!



Amplitude = Loudness

We hear pressure (the amplitude) of sound as **loudness**. It takes more energy to create a louder sound. Too loud of a sound can cause **deafness**.

Loudness is measured in decibels (dB)

10 - 15 dB	A quiet whisper, 3 feet away
30 dB	A house in the country
65 dB	Ordinary conversation, 3 feet away
70 dB	City traffic
90 dB	A jackhammer, 10 feet away
120 dB	The threshold of physical pain from loudness

A +10 dB change we hear as twice as loud.

A 30 dB sound is twice as loud as a 20 dB sound.

A -10 dB change we hear as half as loud.

A 30 dB sound is half as loud as a 40 dB sound.

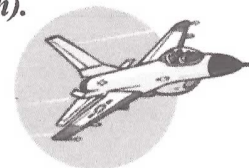
Speed of Sound (v_s)

The speed of sound changes. Hotter (faster) molecules conduct sound faster. Also, just as heat travels faster in solids, so does sound.

Material	V _s (m/sec)
Air	340
Helium	965
Water	1530
Wood	2000
Gold	3240
Steel	5940

The speed of sound in air is about 340 m/sec (660 mph).

You can use $v_s = f\lambda$ to find frequency or wavelength.
AND use $S = D/T$ to find distance or time (using v_s for S).



Ex. Find the wavelength of a 200 Hz sound.

$v_s = 340 \text{ m/s}$	$v = f\lambda$ so $\lambda = v/f$
$f = 200 \text{ Hz}$	$\lambda = (340 \text{ m/s}) \div (200 \text{ Hz})$
$\lambda = ?$	$\lambda = 1.7 \text{ m}$

Ex. If you hear a sound 3 seconds after you see the motion. How far away is it?

$V_s = 340 \text{ m/s}$	$v_s = D/T$ so $D = v_s T$
$T = 3 \text{ sec}$	$D = (340 \text{ m/s}) \times (3 \text{ sec})$
$D = ?$	$D = 1020 \text{ m}$

Motion faster than sound is called **supersonic**. Supersonic planes give their speed in multiples of **Mach** (1 X the speed of sound).

Mach 1 = 340 m/s (660mph)
Mach 2 = 680 m/s (1320 mph)

A **sonic boom** is caused by an object breaking through the sound barrier. Supersonic planes, bullets, and bullwhips all make sonic booms.