Name: _____

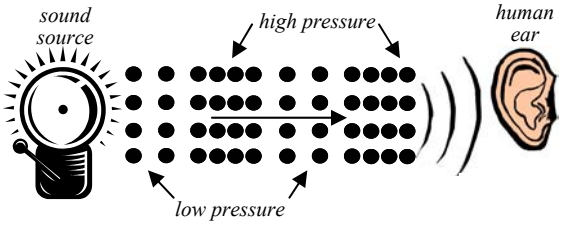
Period: _____

Sound

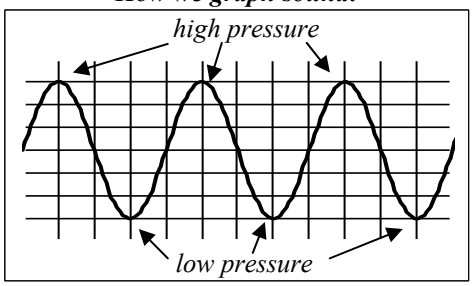
What is Sound?

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.

Sound Wave Moving Through Air Molecules

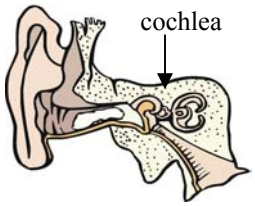


How we graph sound:

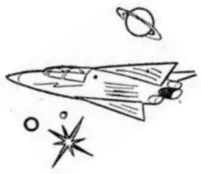


Speakers imitate sounds by pushing air and causing vibrations.

Tiny hairs inside the ***cochlea*** (inner ear) translate air pressure into electrical impulses that can be read by the brain.



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).



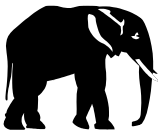
Frequency = Pitch

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

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



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).

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 in air is about 340 m/sec (660 mph).

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

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 m/s f = 200 Hz λ = ?	v = fλ so λ = v/f λ = (340 m/s) ÷ (200 Hz) λ = 1.7 m

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

Vs = 340 m/s T = 3 sec D = ?	v_s = D/T so D = v_sT D = (340 m/s) X (3 sec) D = 1020 m

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

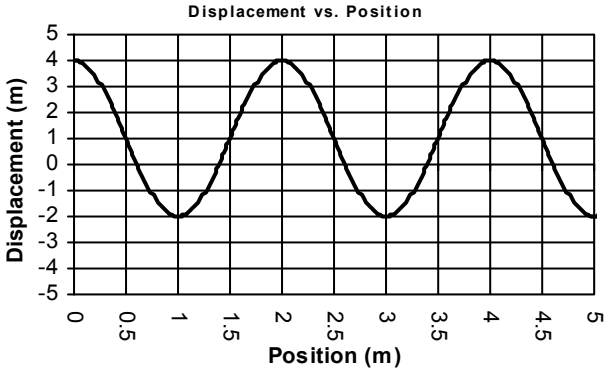
Mach 1 = 340 m/s (660mph)
Mach 2 = 680 m/s (1320 mph)

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

Name: _____

Period: _____

1. Sound	A. Faster than the speed of sound.	1. Pitch	A. Where there is no sound because of its vacuum.
2. Sonic boom	B. A wave caused by alternating high and low pressure.	2. dB	B. How we hear changes of frequency of sound.
3. Supersonic	C. The organ that detects sound waves.	3. Space	C. 340 m/s in air.
4. Ultrasonic	D. A pressure wave caused by an object going faster than sound.	4. Loudness	D. How we measure loudness.
5. Cochlea	E. A sound higher than humans can hear.	5. v_s	E. The amplitude or strength of a sound.



Use the graph to answer these questions: λ = _____

1 cycle is from 1 m to _____; 1/2 cycle is from 0 m to _____.

Amplitude (A) = _____ Total cycles: _____;

It is a sound wave; find frequency:

Is this frequency audible to humans (can we hear it)?

A wave's velocity is 90 m/sec with a frequency of 6 Hz. What is it's wavelength?

A sound wave has a wavelength of 20 m. Find its frequency.

If a sound wave's frequency is 100 Hz. What is its period?

What is the above wave's wavelength?

A railroad crew is repairing a rail. You hear the hammer 0.5 seconds after it is swung. How far away is the crew?

You hear a plane 4 seconds after you see it. Find the distance to the plane.

Why is space silent?

If I increase the energy I give a sound wave what changes:

If a wave's fourth harmonic has a frequency of 40 Hz, what is its natural frequency and what is the frequency of H_6?

If a wave's fundamental is 6 Hz, what harmonic has a frequency of 48 Hz?

If a sound is 40 dB loud. Answer how many dB these would be:

1) A sound twice as loud:

2) A sound half as loud:

Compared to a 50 dB sound, you would hear a 60 dB as:

Find its period: _____

What harmonic is this? _____

Could a human hear this frequency?_____

Mark the nodes and anti-nodes.

How many wavelengths is it?_____

Find the fundamental frequency:

_____

5th harmonic frequency:

_____

80 Hz