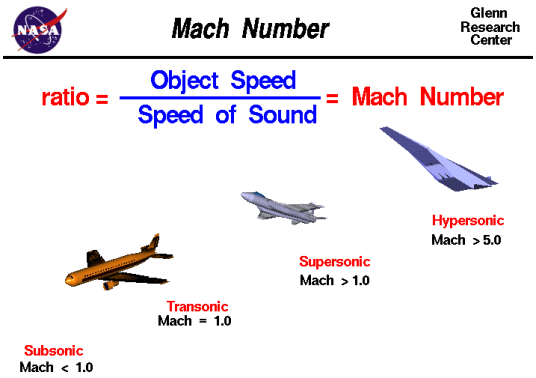
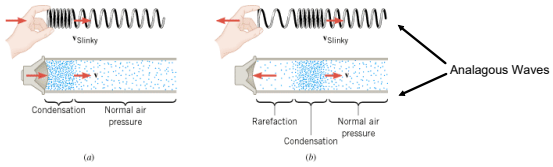
AP Phys 1 Unit 12.3 Notes - Speed of Sound

12.3 - Speed of Sound, Sound Waves



How Sound Waves Work

Sound waves traveling through fluids (both gases and liquids) are primary longitudinal waves (travel back & forth, not side/side).



Sound travels as a disturbance propagating through space: the leading edge of this is a region of high pressure called condensation, followed by a low pressure region called rarefaction.

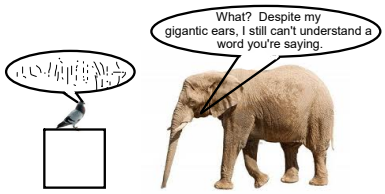
Infrasound

Different sound types depend on frequencies.

Infrasonic Range: Less than 20 Hz. My hand is an infrasonic generator.

Other sources: Earthquakes, Nuclear testing.

Elephants and pigeons hear infrasound (1 Hz and 0.1 Hz, respectively).

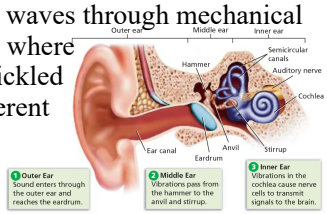


Audible

Audible Range: What the human ear can hear.
We can hear from 20 Hz to 20,000 Hz.

Those frequencies initiate nerve responses in our ears which our brains perceive as sounds.

Ear parts of note: Hammer, anvil, and stirrup bones in the ear transmit sound waves through mechanical motion to the cochlea, where the auditory nerve is tickled such that we hear different frequencies.



Ultrasound

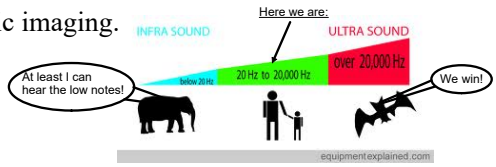
Ultrasonic Range: Greater than 20 kHz (20,000 Hz).

Dogs hear up to 40 kHz, cats to 70 kHz, and bats go all the way to 100 kHz!

SONAR (SOund Navigation And Ranging) is used to navigate in shallow water, and to detect submarines.

Ultrasonic cleaning baths blast tiny dirt particles off with sound waves.

Ultrasonic imaging.



1. Speed of Sound in Air: Physics Democracy!

Consider two containers of air: one at 50 degrees and one at 500 degrees.
Which one has a faster speed of sound?

Vote Now!

50 Degrees	500 Degrees

Speed of Sound in Air Answer

Cold objects typically have a higher density than hot ones, so air particles in the cold sample are closer together.
However, particle speed is greater in hot objects.
In air, it takes less time for a hot particle to bump into its neighbor (and transmit a sonic pulse).

The hotter the air, the faster the speed!

Speed of Sound

Speed of sound depends on the elasticity and density of the transmission medium.

It's also affected by temperature, crystal structure, etc.

Solids have greater elasticity, with speed of sound three to four times that of gaseous media.

v_{sound} Examples (Resources P. 9):
Al = 5100 m/s, glass = 5200 m/s, Cu = 3500 m/s

Water = 1500 m/s

Air $_{(0\,^{\circ}C)}$ = 331 m/s, H_2 = 1284 m/s, O_2 = 316 m/s.

Calculating Speed of Sound in Air

Sound waves in air are affected by temperature:

$$v = (331 + 0.6T_C)$$

v = Speed of Sound m/s
T_C = Celsius Temperature

2. Speed of Sound Example

What is the v_{sound} at room temperature: 23 ºC?

$$v = (331 + 0.6T_C)$$

$$v = (331 + 0.6 \bullet 23\,^{\circ}C)$$

$$v = 345 m/s$$

Homework

12.3 Problems
Due: Next Class.