Sound

Sound is a longitudinal wave produced by a vibrating source that requires a medium for travel.

Sound is a longitudinal wave

- Sound is a vibration that causes the particles of the material to vibrate in a direction parallel to the direction of motion of the wave.

Speed of Sound

- The speed of sound in air at room temperature is 340 m/s
- The speed of sound in water is 1,440 m/s
- The speed of sound in glass is 4,500 m/s
- The speed of sound in aluminum is 5,100 m/s.

Echo

- A source produces a sound wave that travels across a canyon, reflects off the walls, and returns back to the source. The distance traveled is 2x the distance across the canyon.
- Given the echo time you must divide by 2 to get the time to travel across the canyon once.
- Example: echo time 5 s, so the canyon is 340 m/s x 2.5 s = 850 m wide

Distance from lightning

- A rule of thumb that tells how close lightning has hit is: one mile for every five seconds before thunder is heard. For every second before thunder is heard the sound has traveled 340 m. For two seconds before thunder is heard the sound has traveled 680 m.

Amplitude has the energy and loudness

- “Loudness” is by means of the amplitude of the wave.
- Greater amplitude means more energy and louder sound.
- Lesser amplitude means less energy and softer sound.

Resonance

- Everything has its own natural frequency of vibration.
- Example: guitar string, violin string, swing on a playground, goblet, Tacoma Narrows Bridge

Resonating string (vibrating at its own natural frequency)

- One string length is the fundamental or first harmonic. One string length = ½ of the wavelength of the sound produced by string.
- A string with a node at the center is at the second harmonic with wavelength = one string length.
- A string with two nodes in the center is at the third harmonic with wavelength = 3/2 string length.

Resonating frequencies of a string

Resonanting frequencies for a string

Wavelength	# nodes	loops	frequency
2L	2	1	f
L	3	2	2f
2/3 L	4	3	3f
½ L	5	4	4f

Sounding board/box

- Musical instruments have a board or a box that have more surface area relative to the air and so can amplify the sound of a vibrating string. The sound board/box produces a much strong sound wave than the string itself.

Doppler Effect

- When a source is approaching an observer, there are more sound waves striking the observer, so the observer receives a higher frequency (higher pitch) (D dec => f inc)
- When a source is traveling away from an observer, fewer sound waves are striking the observer, so the observer receives a lower frequency (lower pitch)   (D inc => f dec)

Expanding galaxies

- Ever since the Big Bang 13.7 billion years ago, galaxies have been traveling apart from each other. Since the source of their light is traveling away from earth, the frequency of their light observed on earth is “shifted” to a lower frequency “red shift.”
- Therefore, the Doppler Effect does apply to light from expanding galaxies.

Group Activity

- Sound travels through air at room temperature at 340 m/s.
- Given the following frequencies for various "notes" calculate the wavelength.
- 1. high C at 524 Hertz
- 2. middle C at 262 Hertz
- 3. G at 392 Hertz
- 4. E at 330 Hertz
- 5. B at 494 Hertz