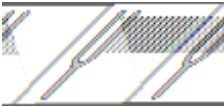


Sound

Sound Waves



- The origin of any sound is a vibrating object
 - Usually the frequency of the sound is the same as that of the vibrating object
- Frequency Range:
 - Sound: 20 Hz - 20,000 Hz
 - Ultrasound: >20,000 Hz
 - Infrasound: < 20 Hz

Forced Vibration & Resonance

- forced vibration - example -- strike tuning fork and hold the stem against the table
- sounding board -- used to amplify sound in music boxes and all string
- resonance -- when the frequency of forced vibrations matches the object's natural frequency, a dramatic increase in amplitude occurs

Speed of Sound

- depends on wind conditions, temperature, and humidity
- does NOT depend on loudness or frequency of the sound
- all sounds travel at the same speed in the same medium in dry air at 0°C ~ 330 m/s (1200 km/h)
- Sound travels faster through warm air than cold air.
- In air, $v_{\text{sound}} = 330 \text{ m/s} + (0.6 \text{ m/s/C}^\circ) * T_C$

Pitch & Loudness

- Pitch - frequency

Double frequency - go up an octave

- Loudness - amplitude

$Energy \propto Amplitude^2$

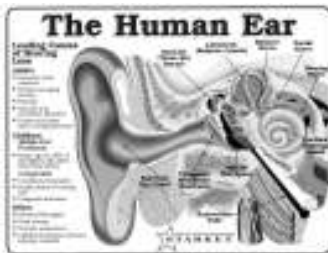
$Intensity = \frac{Energy}{time * area} = \frac{Power}{area}$



Decibel Scale

- incredibly sensitive
- can hear everything from fingertip brushing lightly over fabric to a loud jet engine
- sound of jet engine is about 10^{12} times more powerful than smallest audible sound
- a big difference!
- **decibel scale** -- smallest audible sound is 0 dB
- A sound 10 times more powerful is 10 dB
- A sound 100 times more powerful than near total silence is 20 dB

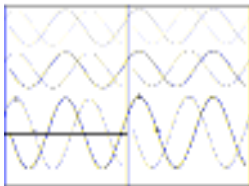
Decibel Scale is logarithmic



Decibel Levels

- Near total silence - 0 dB
- A whisper - 15 dB
- Normal conversation - 60 dB
- A lawnmower - 90 dB
- A car horn - 110 dB
- A rock concert or a jet engine - 120 dB
- A gunshot or firecracker - 140 dB

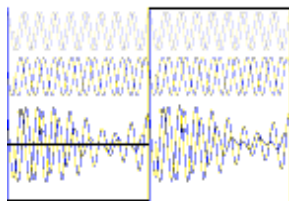
Waves Moving in and Out of Phase



- When the 2 waves are in phase, the resulting disturbance has a maximum amplitude.
- When the 2 waves are out of phase, the resulting disturbance has a minimum amplitude.

Beats

- Waves of slightly different frequencies form a pattern of alternating maximum and minimum amplitude.
- The packets of maximum amplitude are called beats.

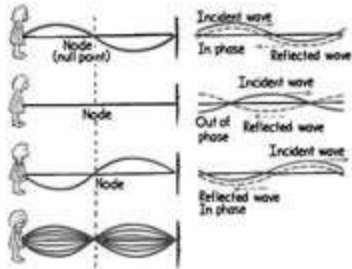


Noise Canceling

- tiny microphones, one on each earpiece, detect ambient noise before it gets to your ears.
- noise-cancellation circuitry inverts the captured signal, turning the noise's sound wave upside down.
- noise-cancellation system adds the sonic opposite of the external noise to whatever you're listening to
- eliminating most of the pollution and leaving you with just your music.



Standing Waves



• <http://phet.colorado.edu>

Fundamental & Harmonics

