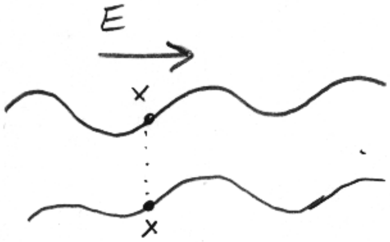
WAVES

- wave model
- Mechanical Waves
  - transfer by the motion of a substance through which they move (medium)
  - Wave moves as atoms in the medium are displaced from equilibrium. (like a spring)
  - created by a source
  - medium does not travel, the energy does.
- Differ from Electromagnetic waves (light)
  No medium needed.

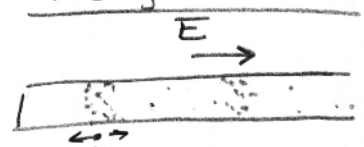
Transverse vs. Longitudinal

Transverse



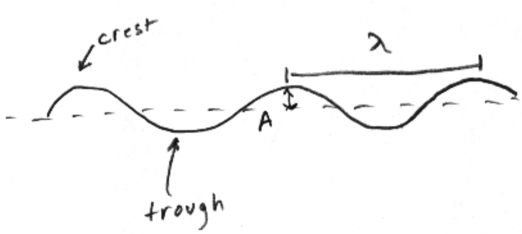
Medium vibrates perpendicular to energy direction

Longitudinal



medium vibrates parallel to energy direction

Waves on strings



V = speed of wave

$VT = \lambda$ $\qquad \frac{m}{s} \cdot s = m$

$\boxed{\lambda f = v}$ wave theory

- String waves are transverse.
- once a pulse is sent it moves due to internal dynamis of the string
  - The wave speed is a property of the medium.
    - Not affected by
      - distance traveled
      - Amplitude
      - source

Speed in a string is due to mass to length ratior

linear density $\mu = \frac{m}{L}$ Fat strings will have greater linear densities

- Tension will also affect wave speed.

$$V_{string} = \sqrt{\frac{T_s}{\mu}}$$

- Wave speed for Gas

$$V_{Sound} = \sqrt{\frac{\gamma R T}{M}}$$

T = temp (Kelvin)
M = molar mass kg/mol
γ = constant for specific gas
R = gas constant 8.31 J/mol K

air 0°C = 331 m/s
air 20°C = 343 m/s
Helium 0°c = 970 m/s

H_2O = 1,480 m/s
Aluminum = 5,100 m/s
Diamond = 12,000 m/s

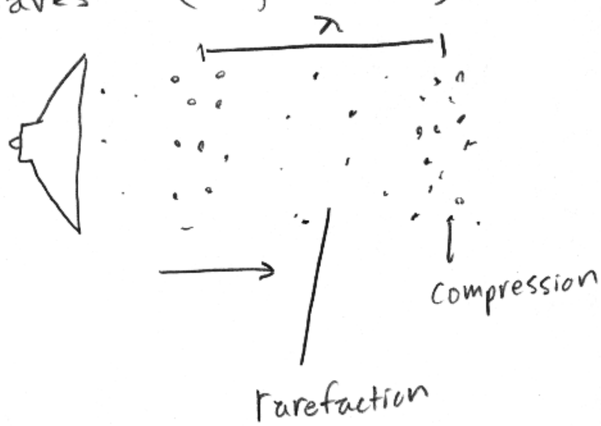
Description of Wave

Skip $$y = A\cos 2\pi\left(\frac{x}{\lambda} \pm \frac{t}{T}\right)$$

right movement (−)

left movement (+)

Sound waves (longitudinal) Compression



Human Hearing

What are the wavelengths?

20Hz to 20,000 Hz

(17m) λ   (1.7cm) λ

echolocation

- why at high-frequencies

Power and Intensity

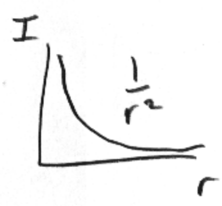
$$I = \frac{P}{A}$$ Power to area ratio

Waves radiat outward in 3 dimensions

Surface Area of sphere

$$I = \frac{P}{4\pi r^2}$$

$$I \propto \frac{1}{r^2}$$



Loudness

Decibel Scale

$$\beta = (10 dB) \log_{10}\left(\frac{I}{I_0}\right)$$

beta

threshhold of hearing

$$I_0 = 1.0 \times 10^{-12} W/m^2$$ Watts/m^2

$\beta(dB)$ of $\emptyset$

logarithm works like this.

base -10 logarithm

$$\log_{10}(1000) = \log_{10}(10^3) = 3$$

$$\beta = (10 dB) \log_{10}(1) = (10 dB) \log_{10}(10^0) = \emptyset$$

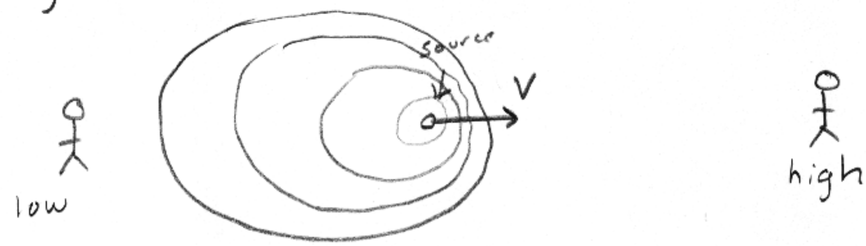
Wilson's voice? 90dB?

I		
whisper	$1 \times 10^{-10} W/m^2$	20dB
Normal convo	$1 \times 10^{-6} W/m^2$	60dB
Rock Concert	$1 W/m^2$	120dB
Threshold of Pain	$10 W/m^2$	130 dB

Wilson

Doppler Effect

- Occurs when wave source or observer are moving relative to each other.



$$f_D = \frac{V \pm V_D}{V \mp V_s} f_s$$

+ toward
− away

for Detector moving

+ away
− toward

for source moving