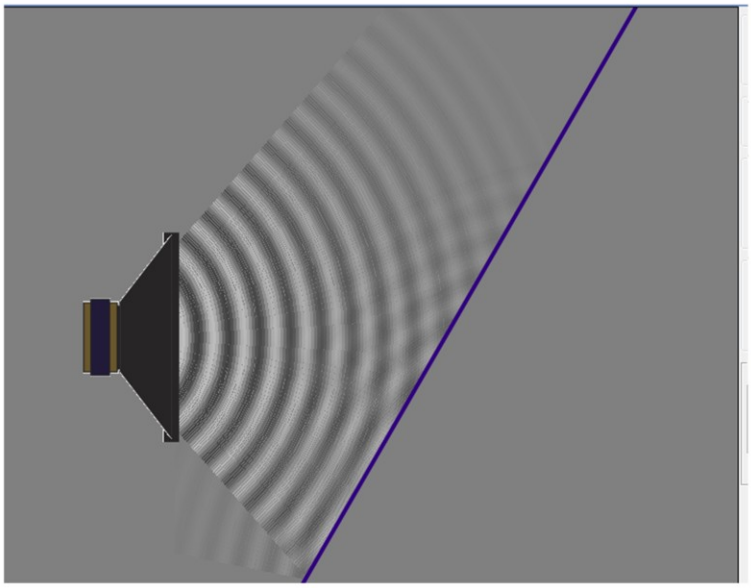
Echolocation, Intensity and Intensity Level

Echolocation

batlab

Sound bounces off of different materials



Listen for echoes

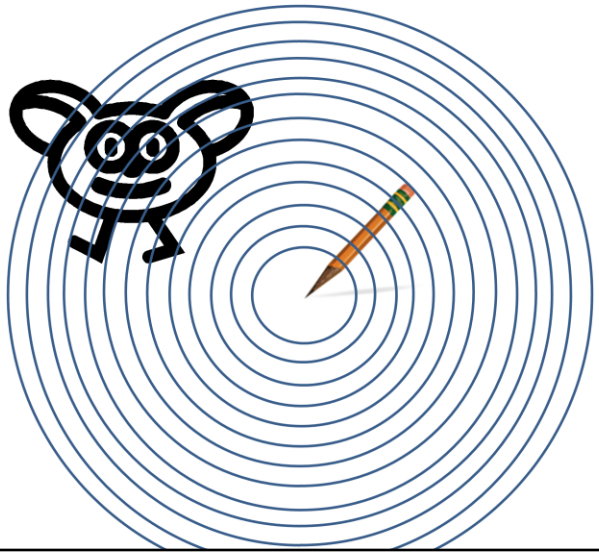
- Echolocators listen for the sounds bouncing back
- Most produce their own sounds (such as clicks) and listen for them to come back.
- People do this subconsciously
- The rate of clicking increases when more information is needed.

Results of Monday's Project:

- How many times did someone grab an object successfully?
- What was hardest location?
- Was everyone equally as good?

- Could you tell the short side of the room?

Locating sounds



Listen for the delay

- The delay tells the brain how far away an object is.
- If one ear hears it first, then it knows the object is on that side.

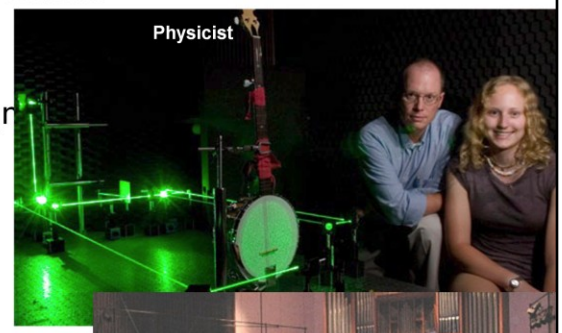
Acousticians

- Animal bioacousticians
- Underwater acousticians
- P &P : Physical and Psychological
- Audiologists

Psychology

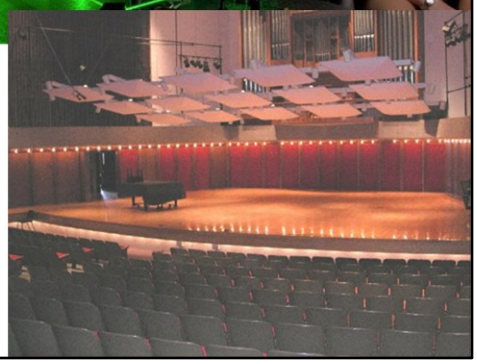
Acousticians

- Musical Instrument Design



- Medical acoustics

- Architectural acousticians
  - Concert Halls
  - Vibration (ie. Bridges)



Intensity

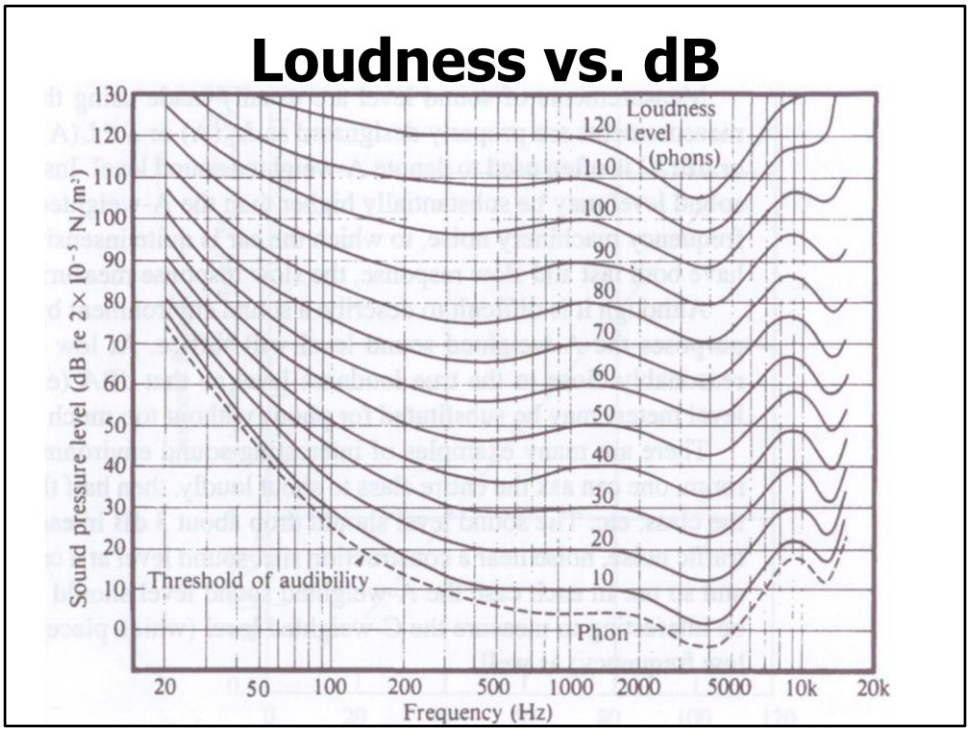
- Intensity is Power per Area
- Power is Energy per time
- Intensity is “rate energy flows per unit area”

What is Loudness?

- Ears are sensitive to an phenomenal range of pressure changes.
  - Change of pressure in the inner ear: 3×10^{-5} Pa to 29 Pa (1 atm is 1×10^{5} Pa)
  - 3 parts in 10 billion!
  - Movement of 1/10 the size of an air molecule!
- sound intensities 1×10^{-12} W/m^2 to 1 W/m$^{2.}$
- Decibels
  - Logarithmic scale for comparing Intensity of a source to a reference Intensity

What is Loudness?

- But … that's still just measuring the motion of air molecules.
- Loudness is how we ***perceive*** Intensity Level (Decibels - dB)
- Similarly pitch is how we ***perceive*** frequency



Decibels are not actually a measure of loudness. Loudness is how our ears perceive sound intensity. Phons are the actual unit that have been determined experimentally. The above graph shows the relationship between dB, frequency and phons.

Equations

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

$$\text{dB} = 10 \log \left(\frac{I}{I_o} \right)$$

$I_o = 1 \times 10^{-12}$ W/m^2

- Determine the intensity level of a sound if you are 3.0 meters from a 110 Watt source.

120 dB

I have students work on this while they can see the equations. Then I do it on the board.

- Now determine how far away you need to be for the intensity level to be 114 dB.

6.0 m

This is the 6 dB rule. Move twice as far away and the sound level drops off by 6 dB.