Sound

- Compressional (longitudinal) mechanical wave
- Remember the wave equation:
- $v = f\lambda$
- Speed of sound in air at 0°C is 332 m/s (Mach one is the speed of sound)
- Speed of sound is directly proportional to temperature
- **v = 332 m/s + (.6) (°C)**

Speed

- At typical room temperature
  - Speed of sound = 340 m/s
    …THAT'S 765 mph!
- Sound speed varies, depending on medium
  - Travel fastest in solids, slowest in gases
  - Travel fastest in the most dense media

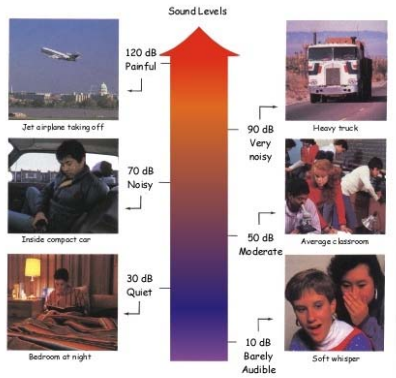
Sound

Sounds behave in certain ways because of the properties of sound waves. Some properties are:

- Speed
- Intensity & Loudness
- Frequency & Pitch

Intensity

- Intensity: the rate at which a wave's energy flows through an area
- Sound intensity depends on
  - Amplitude
  - Distance from source
- Measured in decibels (dB)



Decibel scale showing the intensity level of some familiar sounds.

Loudness

- *Subjective*! (This means it depends on the person who is hearing it.)
- Loudness is a personal, physical response to the intensity of sound.
- As intensity increases, so does loudness, but loudness also depends on the listener's ears and brain.

Frequency & Pitch

- Frequency of a sound wave depends on how fast the source of the sound is vibrating.
- Pitch is how we hear frequency of sound waves
- Pitch depends on frequency…high frequency sounds are high pitched, and low frequency sounds are low pitched.
- Pitch also depends on age and health

Ultrasound

- Most people hear sounds between 20 and 20,000 Hz.
  - Infrasound – sound at frequencies lower than people usually hear
  - Ultrasound – sound at frequencies higher than people usually hear
- Used in technologies such as sonar and ultrasound imaging

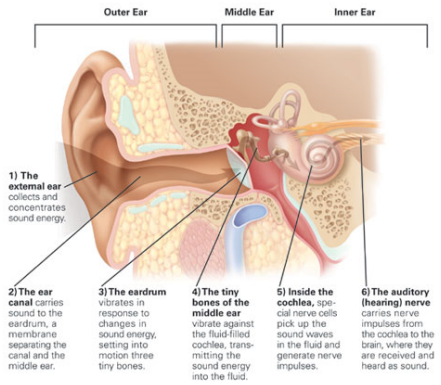
Ultrasound, ctd.

- Sonar – a technique used to determine the distance to an object under water.
- Ultrasound – medical technique used to take pictures of different organs (or a fetus!)

Hearing & the Ear

Ear consists of 3 main parts

- **Outer Ear** – gathers and focuses sound
- **Middle Ear** – receives and amplifies vibrations
- **Inner Ear** – uses nerve endings to sense vibrations and send signals to the brain



Sound

- As density of the medium increases velocity increases
- For sound in a substance as frequency increases wavelength decreases
- Frequency and pitch are related
- Amplitude and loudness are related
- Human hearing 20 - 20000 Hz

Sound

- **Natural Frequency**: the frequency at which a simple object wants to vibrate
- **Forced Vibration**: when one vibrating object causes another object to vibrate
- **Resonance**: occurs when the forced vibration is at an objects natural frequency

Tacoma Narrows Bridge

- In November, 1940, the newly completed Tacoma Narrows Bridge, opened barely four months before, swayed and collapsed in a 42 mile-per-hour wind. There were no casualties except a dog trapped in a car stranded on the bridge. A rescue was attempted (by the man with the pipe), but the frightened animal would not leave the car.