Sound

Sound is a longitudinal wave.

- Has compressions and rarefactions
- Needs a medium to propagate
- Speed of sound in air – 340 m/s
- Produced by vibrations
- There must a be a vibrating source for sound to be produced

Propagation of sound

- Source vibrates
- Immediate surrounding particles vibrate
- Collide with subsequent surrounding particles
- Sound energy/disturbance passed on
- Sound wave forms!

Compressions = higher pressure
Rarefactions = lower pressure

Human hearing of sound

- Sound waves reach our ears
- Series of high and low pressure regions impinge upon the eardrum
- Arrival of a compression pushes eardrum inward ; arrival of rarefaction pulls the eardrum outward
- Continuous arrival of high and low pressure regions sets the eardrum to vibrate
- Vibrations are transmitted to the fluid of the inner ear where they are converted to electrical nerve impulses which are sent to the brain.

Eardrums

- Faintest audible sound results in eardrum vibrating with an amplitude of 10^{-11}m
- 10 times smaller than diameter of hydrogen atom
- The ear is an extremely sensitive organ

Factors affecting speed of sound

- Probability of particle collision
    - Depends on nature of particles and speed of individual particles
- Differences in particle arrangement and interatomic forces
- Disturbance (compressions and rarefactions) propagates faster in **denser medium**
- Speed of sound in Solid > Liquid > Gas
- Temperature
    - more temperature = more energy = faster moving particles
    - increase in temperature = increase in speed of sound
- Humidity
    - More water molecules = less intermolecular spacing
    - Speed of sound is higher when humidity is higher
- Wind conditions
    - Wind in same direction of sound causes speed increase
    - Wind in opposing direction of sound causes speed decrease

Reflection of Sound

- When sound wave hits a hard object, part of it may be absorbed but part of the sound waves may be reflected
- This may produce an echo: a reflected sound heard distinctly from the original sound

While doing sound speed, time and distance calculations, assume that **time taken for light to travel is negligible**.

Loudness

- Proportional to amplitude of wave.
- Greater amplitude = louder sound

Pitch

- Proportional to frequency of wave
- Higher frequency = higher pitch
- Middle c = 261 Hz

Infrasound and Ultrasound

- Human hearing range is between 20Hz and 20 KHz
- Sound below the human hearing range is called **infrasound** (lower than 20Hz)
- Sound above human hearing range is called **ultrasound** (higher than 20KHz)
- Ultrasonic cleaners – cleaning devices that use ultrasound to clean delicate items
- Prenatal Scans
- SONAR – Sound Navigation Ranging
    - Work by bouncing of sound waves off objects to determine location.

Cathode-Ray oscilloscope

- Converts sound waves into electrical signals and displays the waveform on a screen
- Used normally, an oscilloscope plots a graph of voltage (y-axis) against time (x-axis)
- The scales on the x and y axes can be adjusted using the time base
- CRO typically displays a displacement-time graph of the wave