Sound

Definition

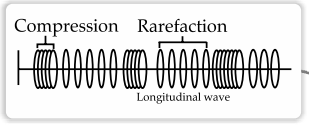
Sound is the form of energy which causes the sensation of hearing. Sound is produced by a vibrating body and it reaches us through the vibrations of a particle.

Characteristics of sound

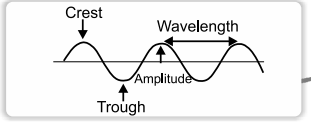
- **Pitch or shrillness** — It is that characteristic of sound by virtue of which a sharp note can be differentiated from a flat note.
- **Quality or timbre** — When two sounds of same pitch and same loudness originating from two different sources can be distinguished.
- **Loudness and intensity**
  - **Loudness** is the property of sound that enables to distinguish loud sound from a faint sound when both have same pitch and quality.
  - **Intensity** of sound at a point of medium is the amount of energy flowing per second across a unit area at that point
  - **Factors affecting loudness/ intensity of sound**
    - Amplitude — $L \propto A^2$
    - Distance — $L \propto \frac{1}{d}$
    - Surface area of vibrating body — Loudness ∝ Surface Area
    - Density of medium — Loudness ∝ Density of medium
    - Resonant body — Loudness ∝ Resonance

Types of waves

- **Graphical representation**
  - Longitudinal



  - Transverse



- **Mechanical waves (elastic waves)** — Waves that require material medium for their propagation eg. sound waves, water waves
- **Non-mechanical waves** — Waves that do not require material medium for their propagation eg. all electromagnetic waves
- **Types of mechanical waves**
  - Longitudinal wave — Waves in which particle of medium vibrates about their mean position along the line of direction of propagation of wave.
  - Transverse waves — Waves in which particle of medium vibrates about their mean position at right angle to the direction of propagation of wave.

Terms related to the wave motion

- Amplitude — It is the maximum displacement of the particle of a medium on the either side of its mean position.
- Time period — It is the time taken by the particle of the medium to complete one oscillation or vibration
- Frequency — It is the number of oscillations completed by a particle in one second.
- wavelength — Distance between two successive (i) crests or troughs, (ii) compressions or rarefactions.
- wave velocity — Distance travelled by a wave in one second
- Relation
  - $Tf = 1$ — T & f
  - $v = f\lambda$ — v, f, λ

Vibrations

It is a mechanical phenomenon in which oscillation occur about an equilibrium point if a disturbance is caused in the body

- **Types of vibrations**
  - Forced vibration — Vibration that takes place in a body under the influence of an external periodic force eg. swing, tuning fork
  - Damped vibrations — Periodic vibrations of continuously decreasing amplitude due to presence of resistive force are called damped vibrations eg. vibration of simple pendulum in air
  - Free vibrations — Vibration produced in a body on being slightly disturbed and remain sustained in absence of any external force eg. simple pendulum, musical instruments (piano, flute)

Resonance

It is the phenomenon in which the frequency of an external force is equal to the natural frequency of the body on which the force acts thereby leading to vibrations with an increased amplitude.

- **Difference between forced and resonant vibration**

Difference between forced and resonant vibrations

Forced vibrations	Resonant vibrations
These vibrations of a body are produced by an external periodic force that has a frequency different from the natural frequency of the body.	These vibrations of a body are produced by an external periodic force that has a frequency equal to the natural frequency of the body.
The amplitude of vibration is usual small.	The amplitude of vibration is very large.
The vibrations produced in the body are out of phase with the external periodic force.	The vibrations produced in the body are in phase with the external periodic force.
Once the external periodic force ceases to act these vibrations last for a very small time.	These vibrations last for a long time even after the external periodic force has eased in act.

Echo

The sound heard after reflection from a distant object after the original sound from the given source dies off.

- Minimum time — The sensation of any sound persists for 0.1 second. If a sound after reflection reaches the ear in less than 0.1 s, it cannot be distinguished from the original sound.
- Relation — $v = \frac{2d}{t}$ — (v, d, t)
- Minimum distance — The minimum distance required between the source of sound and reflecting surface to hear an echo is 17m in air.
- wavelength — Wavelength of sound should be less than the size of the reflecting body.

Difference between light waves and sound waves

Light waves	Sound waves
These are electromagnetic waves, *i.e.* non-mechanical in nature.	These are mechanical or elastic waves.
These can travel in vacuum.	These cannot travel in vacuum : required a material medium for propagation
These are transverse waves.	These can be transverse as well as longitudinal waves.
The speed of light waves in air is 3.0×10^8 m s^{-1}	The speed of sound waves in air is 330 m s^{-1}
The frequency of visible light waves is in the range of 3.75×10^{14}- 7.5×10^{14}Hz	The frequency of audible sound waves is in the range of 20-20,000 Hz.

Trace the Mind Map

- First Level
- Second Level
- Third Level