

CHAPTER- 11 SOUND

Sound

- a) The sensation felt by our ears is called sound.
- b) Sound is a form of energy which makes us hear.
- c) Law of conservation of energy is also applicable to sound.
- d) Sound travels in form of wave.

Production of Sound

Sound is produced when object vibrates.

- Example: Sound of our voice is produced by vibration of two vocal cords in our throat
- Sound of a drum or table is produced by vibration of its membrane when struck

Sound can be produced by following methods:

- a) By vibrating string (sitar)
- b) By vibrating air (flute)
- c) By vibrating membrane (table, drum)
- d) By vibrating plates (bicycle bell)
- e) By friction in objects
- f) By scratching or scrubbing the objects etc.

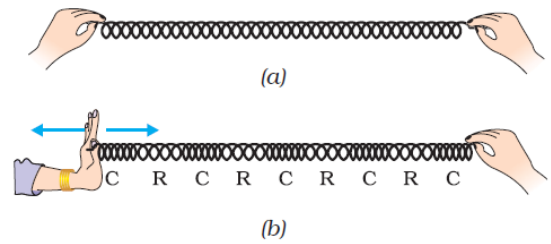
Propagation of Sound

- The substance through which sound travels is called a medium.
- The medium may be solid, liquid or gas.
- When an object vibrates, then the air particles around it also start vibrating in exactly the same way and displaced from their stable position.
- These vibrating air particles exert a force on nearby air particles so they are also displaced from their rest position and start to vibrate.
- This process is continued in the medium till sound reaches our ears.
- The disturbance produced by sound travels through the medium (not the particles of the medium).
- Wave is a disturbance which travels through a medium and carries energy.
- So sound travels in wave form known as mechanical waves.

Longitudinal wave

A wave in which the particles of the medium vibrate back and forth in the same direction in which the wave is moving, is called a longitudinal wave.

- The direction of vibrations of the particles is parallel to the direction of wave.



Transverse wave

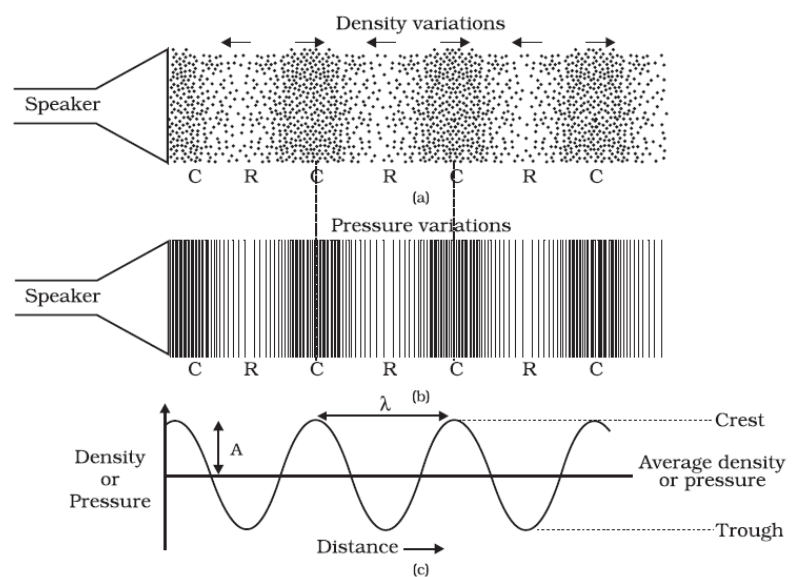
When one end of a slinky is moved up and down rapidly whose other end is fixed, it produces transverse wave.

- Thus, in transverse wave particles of the medium vibrate up and down at right angles to the direction of wave.

Characteristics of Sound Wave

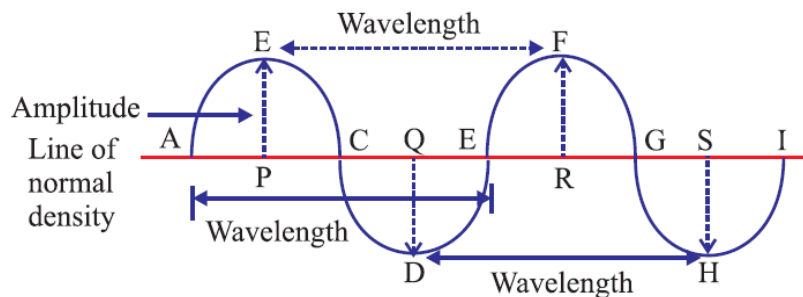
The characteristics of sound waves are: wavelength, frequency, amplitude, time period and velocity.

- When a wave travel in air the density and pressure of air changes from their mean position.
- Compression is shown by crest while rarefaction is shown by trough.
- Compression is the region of maximum density or pressure.
- Rarefaction is the region of minimum density or pressure.



1. Wavelength:

In sound waves the combined length of a compression and an adjacent rarefaction is called its wavelength. It is denoted by the Greek letter **lamda λ**. Its SI unit is meter.



2. Frequency:

Number of complete waves produced in one second or number of vibrations per second is called frequency.

- The SI unit of frequency is hertz (Hz). The symbol of frequency is ν (nu).
- 1 Hertz: One Hz is equal to 1 vibration per second.
- Bigger unit of frequency is kilohertz kHz = 1000 Hz.

3. Time Period:

Time taken to complete one vibration is called time period.

- SI unit of time period is second (s). Time period is denoted by T.
- The frequency of a wave is the reciprocal of the time period.

$$\nu = \frac{1}{T}$$

4. Amplitude:

The maximum displacement of the particle of the medium from their original undisturbed position is called amplitude of the wave. Amplitude is denoted by A and its SI unit is meter (m).

5. Velocity:

The distance travelled by a wave in one second is called velocity of the wave.

Its SI unit is meter per second (ms^{-1}).

$$\text{Velocity} = \frac{\text{Distance travelled}}{\text{Time taken}}$$

$$V = \frac{\lambda}{T}$$

(λ is the wavelength of the waves travelled in one time period T)

$$V = v\lambda, \quad \left(\frac{1}{T} = v\right)$$

$$\boxed{\text{Velocity} = \text{Wavelength} \times \text{Frequency}}$$

This is the wave equation.

Speed of Sound in Various Mediums

- Speed of sound depends on the nature of material through which it travels. It is slowest in gases, faster in liquids and fastest in solids.
- Speed of sound increases with the rise in temperature.
- Speed of sound increases as humidity of air increases.
- Speed of light is faster than speed of sound.
- In air, speed of sound is 344 ms^{-1} at 22°C .

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