Class : 11th Physics
Chapter- 15 : Waves

Waves

Relation b/w wave velocity (v) Wavelength (y) & frequency (v)

$v = \nu\lambda$

Time period (T) $= \dfrac{1}{\text{Frequency}} = \dfrac{1}{\nu}$

Angular Frequency (ω) $= 2\pi\nu$

Wave number, $\nu = \dfrac{1}{\text{wavelength}} = \dfrac{1}{\lambda}$

Beats

Difference in frequencies of two superposing waves,

$\nu_{beat} = \nu_1 \sim \nu_2$

Displacement relation in a plane progressive wave

$y\,(x, t) = A\,sin\,(-kx + t)\,\omega_\phi$

$y\,(x,t) = A \sin 2\pi\left(\dfrac{t}{T} - \dfrac{x}{\lambda}\right)$

Velocity amplitude $v_0 = A\omega^2$

Acceleration Amplitude $a_0 = A\omega^2$

Principle of superposition of waves

When two or more waves are propagating with different displacements then the net displacement of collective wave is given as $Y = y_1 + y_2 + y_3 + \ldots + y_n$

Stationary Waves

Stationary waves

(i) In string: Fundamental Frequency, $\nu = \dfrac{1}{2l}\sqrt{\dfrac{T}{m}}$

(ii) In organ pipe:

(a) Open at both ends,

Fundamental freq. or I harmonic $\nu = \dfrac{v}{2l}$

(b) Closed at one end $\nu = \dfrac{v}{4l}$

(iii) • In open organ pipe, higher harmonics, both odd & even.

• In closed organ pipe, higher harmonics, odd only.

Dopoler Effect

General Formula,
Apparent Frequency

$n^1 = n\left(\dfrac{v \pm v_s \pm v_m}{v \mp v_0 \pm v_m}\right)$

Here, v = speed of sound,

v_0 = observer speed

v_s = source speed

v_m = medium speed

Types

Matter Waves

Waves associated with particles like-electrons, protons, neutrons, atoms, molecules etc.

Mechanical Waves

Require material medium for their propagation

Electromagnetic Waves

Do not require any material medium for their propagation e.g., light waves

Transverse Waves

Individual particles of the medium oscillate perpendicular to the direction of propagation of wave

Speed of transverse wave in a stretched string

$V = \sqrt{\dfrac{T}{m}}$, T = tension & M = mass/length

Longitudinal Waves

Individual particles of the medium oscillate along the direction of propagation of wave.

Speed of a longitudinal wave speed of sound, $V = \sqrt{\dfrac{B}{\rho}}$

$= \sqrt{\dfrac{Y}{\rho}} = \sqrt{\dfrac{P}{\rho}} = \sqrt{\dfrac{\gamma P}{\rho}}$ for air, $\gamma = 7/5$

Properties

Essential properties for propagation

- Elasticity
- Inertia
- Minimum friction