BRAIN MAP

WAVES

Class XI

TYPES OF WAVES

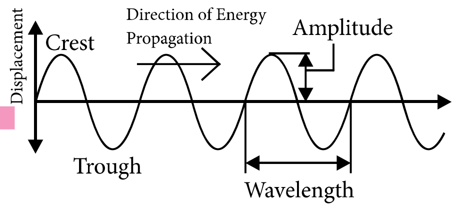
Electromagnetic Waves
Waves propagating in form of oscillating electric and magnetic fields.
Do not require medium for propagation.

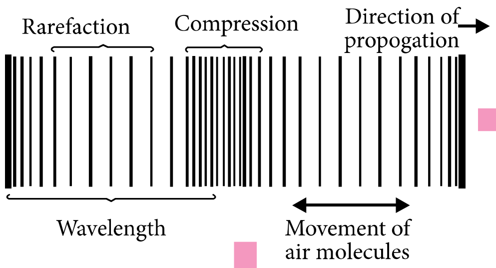
Matter Waves
Waves associative with microscopic particles such as electrons, protons etc. in motion are called matter waves.

Mechanical Waves
Waves which require a material medium for their propagation are called mechanical waves.

Transverse Waves
The individual particles of the medium oscillate perpendicular to the direction of wave propagation.

Longitudinal Waves
The individual particles of medium oscillate along the direction of wave propagation.





Velocity of Transverse Wave in Solids and Strings
- In solids, $v=\sqrt{\frac{\eta}{\rho}}$
  where η is modulus of rigidity and ρ is density of solids.
- In stretched string, $v=\sqrt{\frac{T}{m}}$
  here, T is tension in string and m is mass per unit length of string.

Velocity of Longitudinal Waves
- In a solid of bulk modulus κ, modulus of rigidity η and density ρ is
  $$v=\sqrt{\frac{\kappa+\frac{4}{3}\eta}{\rho}}$$
- In a fluid of bulk modulus κ and density ρ is
  $$v=\sqrt{\frac{\kappa}{\rho}}$$
- Newton's formula for the velocity of sound in a gas is
  $$v=\sqrt{\frac{\kappa_{iso}}{\rho}}=\sqrt{\frac{P}{\rho}}\ (P=\text{pressure of the gas})$$

WAVE MOTION

Progressive Waves
- **Displacement,** $y=A\sin(\omega t-kx+\phi_0)$
  $$y=A\sin 2\pi\left(\frac{t}{T}-\frac{x}{\lambda}\right)=A\sin\frac{2\pi}{\lambda}(vt-x)$$
- **Phase,** $\phi=2\pi\left(\frac{t}{T}-\frac{x}{\lambda}\right)+\phi_0$
  where ϕ_0 is the initial phase.
- **Phase change:**
  (a) with time $\Delta\phi=\frac{2\pi}{T}\Delta t$
  (b) with position $\Delta\phi=\frac{2\pi}{\lambda}\Delta x.$

Doppler's Effect in Sound
- If v, v_0, v_s and v_m are the velocities of sound, observer, source and medium respectively, then the apparent frequency,
  $$\upsilon'=\frac{v+v_m-v_0}{v+v_m-v_s}\times\upsilon$$
- If the medium is at rest, $(v_m=0)$ then
  $$\upsilon'=\frac{v-v_0}{v-v_s}\times\upsilon$$

Superposition of Waves
Identical waves of same speed superposes in opposite direction

Waves with same speed and different frequency superposes in same direction

Stationary Waves
- Wave formed by the superposition of incident wave and reflected wave is given by $y=\pm 2a\sin\frac{2\pi x}{\lambda}\cos\frac{2\pi t}{T}$
- Position of antinodes: $x=0,\frac{\lambda}{2},\lambda,\frac{3\lambda}{2}$
- Position of nodes: $x=\frac{\lambda}{4},\frac{3\lambda}{4},\frac{5\lambda}{4}...$
- Frequency of vibration of a string fixed at both ends, $\upsilon=\frac{nv}{2L}=\frac{n}{2L}\sqrt{\frac{T}{m}}$
  L = length of string, n = mode of vibration

Organ Pipes
- **Open organ pipe:**
  Fundamental mode,
  $\upsilon_1=v/2L=\upsilon$ (1st harmonic)
  n^{th} mode, $\upsilon_n=nv/2L$ (n^{th} harmonic and $(n-1)^{th}$ overtone)
- **Closed organ pipe:**
  Fundamental mode,
  $\upsilon_1=v/4L=\upsilon$ (1st harmonic)
  n^{th} mode, $\upsilon_n=(2n-1)\upsilon$
  [$(2n-1)^{th}$ harmonic or $(n-1)^{th}$ overtone]

Beats Formation
- **Beat frequency** = Number of beats sec^{-1}
  = Difference in frequencies of two sources.
  $\upsilon_{beat}=(\upsilon_1-\upsilon_2)$ or $(\upsilon_2-\upsilon_1)$
  $\therefore\ \upsilon_2=\upsilon_1+\upsilon_{beat}$
- If prongs of tuning fork is filed υ increases.
- If prongs is loaded with a wax υ decreases.
- **Uses:**
  - For tuning musical instruments
  - For detection of marsh gas in mines
  - For using as a low frequency oscillator.