PHYSICS

CLASS NOTES FOR CBSE

Chapter 16. Waves

01. Wave Motion

- When a particle moves through space, it carries energy with itself.
- (Wave motion) to transport energy from one part to space to other without any bulk motion of material together with it.

Examples of waves

Ripples on a pond (water waves), visible light, radio and TV signals

02. Classification of waves

Based on medium necessity

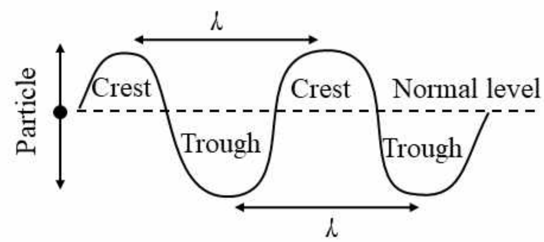
The waves which require medium for their propagation are called mechanical waves. In the propagation of mechanical waves elasticity and density of the medium is important therefore mechanical waves are known as **elastic waves**.

Based on energy propagation

Based on direction of propagation

Based on the motion of particles of medium

Mechanical transverse waves produce in such type of medium which have shearing property



03. Speed of transverse wave on string

As a wave travels along the x-axis, the points on the string oscillate back and forth in the y-direction.

$$y(x,t) = A\sin(kx - wt + \phi_o)$$

$$v_y = \frac{dy}{dt} = -\omega A cos(kx - \omega t + \phi_o)$$

The maximum velocity of a small segment of the string is $v_{\max} = \omega A$.

NOTE ☞ Creating a wave of larger amplitude increases the speed of particles in the medium, but it does not change the speed of the wave through the medium.

04. Characteristics of wave motion

The disturbance travels through the medium due to repeated periodic oscillations. The energy is transferred from place to another without any actual transfer of the particles of the medium. There is a regular phase difference between one particle and the next. The velocity with which a wave travels is called as wave velocity. The wave velocity remains constant in a given medium

05. Some Important Terms Connected with Wave Motion

Wavelength (λ)
The distance between any two nearest particles, medium, vibrating in the same phase.
Frequency (n)
Number of vibrations (Number of complete wavelengths) complete by a particle in one second.
Time period (T)
Time taken by wave to travel a distance equal to one wavelength.
Amplitude (A)
Maximum displacement of vibrating particle from its equilibrium position.
Angular wave number (k)

It is defined as $k=\dfrac{2\pi}{\lambda}$

Wave number $(\vec{\nu})$

It is defined as $\vec{\nu}=\dfrac{1}{\lambda}=\dfrac{k}{2\pi}$

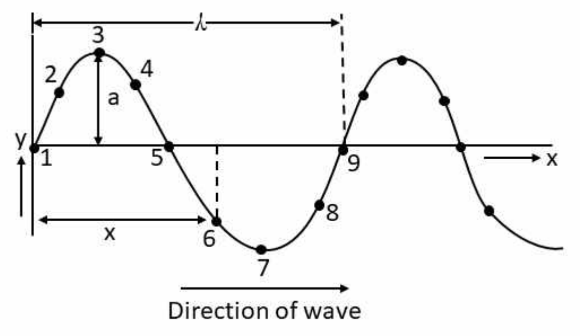
06. The General Equation of Wave Motion

$$\frac{\partial^2 y}{\partial t^2}=v^2\frac{\partial^2 y}{\partial x^2} \qquad ...(i)$$

The general solution of this equation is of the from $y(x,t)=f(ax\pm bt)$ ...(ii)
Thus, any function of x and t and which satisfies equation (i) or which can be written as equation (ii) represent a wave. The only condition is that it should be finite everywhere and at all times.

Speed of wave (v) is given by $v=\dfrac{coefficient\ of\ t}{coefficient\ of\ x}=\dfrac{b}{a}$

07. Equation of a Plane Progressive Wave



$$y = a \sin \omega\left(t - \frac{x}{v}\right) \qquad But\ \omega = 2\pi n,\ \ y = a \sin(\omega t - kx)\ \left(k = \frac{\omega}{v}\right) \text{...(i)}$$

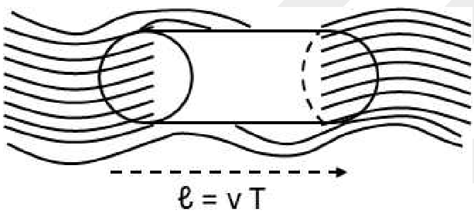
$$y = a \sin\left[\frac{2\pi}{T}t - \frac{2\pi}{\lambda}x\right] \quad \text{Also } k = \frac{2\pi}{\lambda} \qquad \text{...(ii)}$$

$$y = a \sin 2\pi\left[\frac{t}{T} - \frac{x}{\lambda}\right] \qquad \text{...(iii)}$$

This is the equation of a simple harmonic wave travelling along +x direction. If the wave is travelling along the –x direction then inside the brackets in the above equations, instead of minus sign there will be plus sign.

08. Intensity of Wave

The amount of energy flowing per unit area and per unit time is called the intensity of wave. It is represented by I. Its units are J/m^2s or watt/metre^2. $I = 2\pi^2 f^2 A^2 \rho v$ i.e. $I \propto A^2$ and $I \propto f^2$.



If P is the power of an isotropic point source, then intensity at a distance r is given by,

$$I = \frac{P}{4\pi r^2} \text{ or } I \propto \frac{1}{r^2} \text{ (for a line source)}$$

If P is the power of a line source, then intensity at a distance r is given by,

$$I = \frac{P}{2\pi r \ell} \text{ or } I \propto \frac{1}{r} \text{ (for a line source) As, } I \propto A^2$$

Therefore, $A \propto \frac{1}{r}$ (for a point source) and $A \propto \frac{1}{\sqrt{r}}$ (for a line source)