where ϕ is the Phase lag since it is evident that the Particle situated towards the right of O must be always behind the Particle at O in Phase if the wave is travelling towards the right.

We know that for a path difference λ, the Phase change is ϕ $\therefore \frac{2\pi}{\lambda} = \frac{\phi}{x}$ or $\phi = \frac{2\pi x}{\lambda}$

Again, $\omega t = \frac{2\pi}{\lambda} \cdot t = \frac{2\pi v}{\lambda}$ $\left[\because v = \frac{\lambda}{T}\right]$

$\therefore$ from equation (2) we get,

$$y = a \sin\left\{\frac{2\pi}{\lambda} \cdot vt - \frac{2\pi}{\lambda} \cdot x\right\}$$

$$\text{or } y = a \sin \frac{2\pi}{\lambda}(vt - x) \longrightarrow (3)$$

This equation gives us the complete form of a plane Progressive wave of amplitude (a) with a velocity of Propagation v in the Positive direction of X-axis. When x is measured opposite to the direction of Propagation the above equation becomes,

$$y = a \sin \frac{2\pi}{\lambda}(vt + x) \longrightarrow (4)$$

The quantity $\frac{2\pi}{\lambda} = 2\pi\bar{\nu} = k$ is called Propagation constant, while $\frac{1}{\lambda} = \bar{\nu}$ is called the wave number. Hence eqn (3) reduces to

$$y = a \sin(\omega t - kx) \longrightarrow (5)$$

at $t = 0$, $x = 0$, and $y = 0$

All the above equations from eqn (1) to eqn (5) represent the equation of a plane Progressive wave in different forms.

Properties :— For a fixed value of x, the displacement y is a simple harmonic oscillation in time, shows with the same amplitude and Period.

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