Progressive wave (Plane progressive wave) [also called as travelling wave]

A wave that moves forward with constant amplitude and constant frequency is called as progressive wave.

As a progressive wave propagates through a medium, each molecule of the medium oscillates with same amplitude but different phases.

Consider a plane progressive wave travelling in a medium along positive X-axis, as shown in figure.

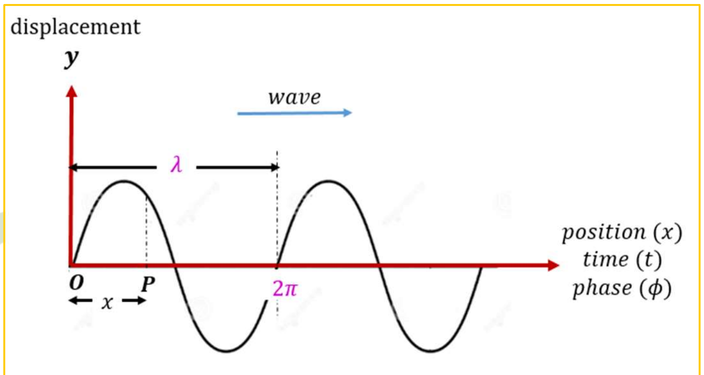

Figure: a progressive wave travelling along x − axis

As the wave propagates through the medium, the molecules within the medium exhibit SHM.

Considering the particle at point ***O*** to be the first vibrating particle, the equation of motion is written as:

$y = a \sin \omega t$ … … … ….. (1) $a = amplitude$

We consider another particle at point *P*, along the direction of propagation of wave at distance *x* (path difference) from point *O*. As the disturbance at point *P* reaches later than at point *O*, the equation of motion of particle at point *P* with respect to that at point *O* is:

$y = a \sin(\omega t - \phi)$ … … … (2) $\phi = phase\ difference\ between\ two\ points$

Equation (2) indicates the equation of plane progressive wave travelling along positive X-axis.

We have relation between path difference and phase difference as:

$$phase\ difference = \frac{2\pi}{\lambda} \times path\ difference \quad ;\ \text{where, } \frac{2\pi}{\lambda} = k\ (wave\ number)$$

Hence, $\phi = \frac{2\pi}{\lambda} \times x$ or (propagation constant)

Or $\phi = k\,x$ … … … (3)

Using equation (3) in equation (2), we get

$y = a \sin(\omega\, t - k\, x)$ … … … (4) : Equation of plane progressive wave.

Principle of superposition:

Statement:

When a large number of waves are travelling simultaneously through a medium, the resultant displacement of a particle at any point is equal to the vector sum of displacements produced by each individual wave.

If y_1, y_2, y_3,… …. … are the displacements at a point due to different waves independently and if those waves travel simultaneously through the point, then the resultant displacement (y) of the point is:

$$\vec{y} = \vec{y_1} + \vec{y_2} + \vec{y_3} + \dots \dots \dots$$