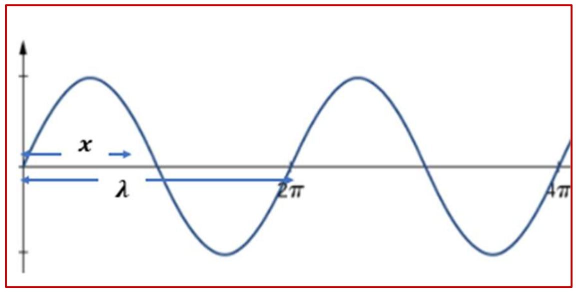
Relation between Phase difference and path difference:

$For\ path\ difference\ \lambda,\quad phase\ difference = 2\pi$

$For\ path\ difference\ 1,\quad phase\ difference = \frac{2\pi}{\lambda}$

$For\ path\ difference\ x,\quad phase\ difference = \frac{2\pi}{\lambda}x$



Hence, $\boldsymbol{phase\ difference = \frac{2\pi}{\lambda} \times path\ difference}$

NB:
Phase difference between two different points (particles) at same time: $\Delta\phi = k\,\Delta x$; $\Delta x = x_2 - x_1$
Phase difference of same point (particle) at different time: $\Delta\phi = w\Delta t$; $\Delta t = t_2 - t_1$

1. The distance between two points differing in phase by 60^o on a wave having wave velocity $360\ m/s$ and frequency $500\ Hz$ is:
   a) $0.72\ m$ b) $0.36\ m$ c) $0.18\ m$ d) $0.12\ m$
2. A wave of frequency $500Hz$ is travelling at a speed of $350\ m/s$. By how much the phase of a particle change in 10^{-3} seconds?
   a) π b) 180^o c) only (a) d) both (a) and (b)

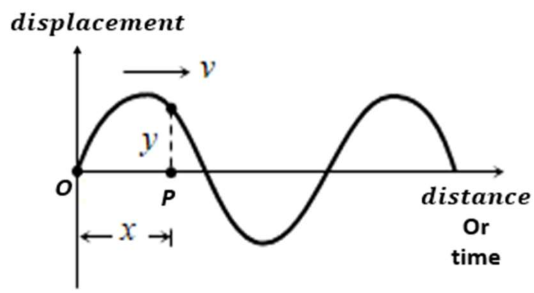
Progressive wave (Plane progressive wave)

A wave that moves forward with constant amplitude and constant frequency is called as progressive wave. *(Also with constant wavelength, constant velocity……)*

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.
As the wave propagates through the medium, the molecules within the medium exhibit SHM.
Considering the particle at point $\boldsymbol{O}$ to be the first vibrating particle, the equation of motion is written as:

$$\boldsymbol{y = a\sin\omega t \ldots\ldots\ldots (1);\quad a = amplitude}$$



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

$$\boldsymbol{y = a\sin(\omega t - \phi) \ldots\ldots\ldots (2)\quad ;\phi = phase\ difference\ between\ two\ points}$$

Equation (2) indicates the equation of plane progressive wave travelling along positive X-axis.
We have relation between path difference and phase difference as:

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