

Q-1(s)

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### Equation of a Progressive wave [contd....]

Hence the displacement at P at any instant  $t$  can be obtained by substituting  $(t - \frac{x}{v})$  in place of  $t$  in the above eqn. (1)

$$\therefore y = a \sin \omega \left( t - \frac{x}{v} \right) \quad \text{--- (2)}$$

$$\because \omega = 2\pi n$$

$$\therefore y = a \sin 2\pi n \left( t - \frac{x}{v} \right) \quad \text{--- (3)}$$

Again  $\omega = \frac{2\pi}{T}$

$$\therefore y = a \sin 2\pi \left( t - \frac{x}{vT} \right)$$

The period  $T$  is the time required for the wave to travel a distance of one wavelength  $\lambda$ , so that  $vT = \lambda$ . Thus

$$y = a \sin 2\pi \left( \frac{t}{T} - \frac{x}{\lambda} \right) \quad \text{--- (4)}$$

But this may also be written as

$$y = a \sin \frac{2\pi}{\lambda} \left( \frac{\lambda t}{T} - x \right) \quad \text{---}$$

$$\text{But } \lambda/T = v$$

$$\therefore y = a \sin \frac{2\pi}{\lambda} (vt - x) \quad \text{--- (5)}$$

also  $\frac{2\pi}{\lambda} = k$  is called propagation const.

Hence the above eq<sup>n</sup>. becomes

$$y = a \sin k (vt - x) \quad \text{--- (6)}$$

$$\therefore v = n\lambda = \frac{\omega}{2\pi} \cdot \lambda = \frac{\omega}{2\pi/\lambda} = \frac{\omega}{k}$$

$$\therefore \text{~~a~~ } y = a \sin k \left( \frac{\omega}{k} \cdot t - x \right)$$

$$\therefore y = a \sin (\omega t - kx) \quad \text{--- (7)}$$

Eq<sup>n</sup> (2), (3), (4), (5), (6) & (7) represent the different forms of eq<sup>n</sup>. of plane progressive wave travelling along +x-direction, where it has been assured that the displacement y is zero at the point x=0 and t=0. The general expression for the wave motion may be written as

$$y = a \sin (\omega t - kx + \phi)$$

where  $\phi$  is called phase constant which represents the phase difference between the above wave travelling along +x-direction and another wave.