$$y = a \sin \frac{2\pi}{\lambda}(vt + x) \qquad \ldots(1 \cdot 4)$$

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

$$y = a \sin(\omega t - kx) \qquad \ldots(1 \cdot 5)$$

Here we have assumed that the displacement y is zero at $x = 0$ at time $t = 0$.

The above equations show the following properties of wave motion—

(a) For a fixed values of x, the displacement y is a simple harmonic oscillation in time. This shows that all points of the medium oscillate simple harmonically with the same amplitude and period.

(b) For a fixed value of t, the displacement y is a simple harmonic oscillation in space. It means that at a particular instant, the displacement varies sinusoidally from point to point which corresponds the change of phase from particle to particle.

(c) If x is increased by λ, then the displacement is given by

$$y_1 = a \sin \frac{2\pi}{\lambda} \{vt - (x+\lambda)\}$$

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

$$= a \sin \frac{2\pi}{\lambda} (vt - x) \quad [\because \ \sin(\alpha - 2\pi) = \sin\alpha]$$

$$= y.$$

This shows that at any time the displacement at points x, $x+\lambda$, $x+2\lambda$,......... is the same. Such points are said to be in the same phase of oscillation.

(d) If t is increased by δt and x by $v\,\partial t$, then the new displacement is

$$y' = a \sin \frac{2\pi}{\lambda} \{v\,(t+\partial t) - (x + v\partial t)\}$$

$$= a \sin \frac{2\pi}{\lambda} \{vt + v\partial t - x - v\partial t\}.$$

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

This shows that the disturbance at x at a time t is transferred to another distance $v\partial t$ away in time ∂t. That is, the disturbance is advancing with a velocity v without suffering any change in shape.

1·3. Particle velocity and A