- **Amplitude** – Maximum displacement of the constituents of the medium from their equilibrium position.
  y may be positive or negative, but a is positive

- **Phase of the wave** – The quantity $(kx - \omega t + \phi)$ appearing as the argument of the sine function is called the phase of wave.

- **Wavelength** – Minimum distance between two points having the same phase.

$$\lambda = \frac{2\pi}{k}$$

- where k is the angular wave number or propagation constant, Its SI unit is radian per metre or rad m^{-1}.

- **Period** – Time taken for one complete oscillation

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

where ω is called angular frequency of the wave whose SI unit is rad s^{-1}.

- **Frequency** – Number of oscillations per second.

$$\nu = \frac{1}{T} = \frac{\omega}{2\pi}$$

It is measured in hertz

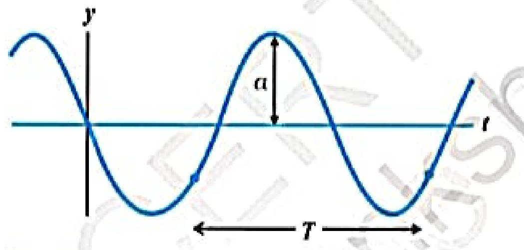

Fig. 15.7 An element of a string at a fixed location oscillates in time with amplitude a and period T, as the wave passes over it.

- The speed of a travelling wave

Here too single travelling wave taken in a small interval Δt.
The entire wave moves through a distance Δx in interval Δt.

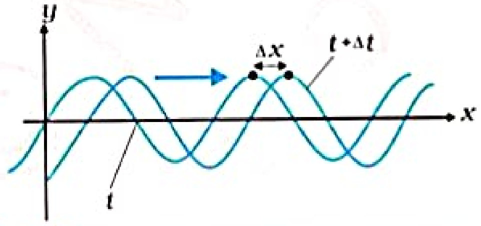

Fig. 15.8 Progression of a harmonic wave from time t to $t + \Delta t$, where Δt is a small interval. The wave pattern as a whole shifts to the right. The crest of the wave (or a point with any fixed phase) moves right by the distance Δx in time Δt.

Let us consider a crest shown by point A in the figure. As the time changes, the position of the crest changes from A to B. Since the phase remains constant

$$\therefore \quad kx - \omega t = k(x + \Delta x) - \omega(t + \Delta t)$$
$$kx - \omega t = kx + k\Delta x - \omega t - \omega\Delta t$$
$$k\Delta x = \omega\Delta t$$
$$\frac{\Delta x}{\Delta t} = \frac{\omega}{k}$$

Taking Δx and Δt very small,
$$v = \frac{dx}{dt} = \frac{\omega}{k}$$

Also, we have $\omega = 2\pi/T$ & $k = 2\pi/\lambda$

$$v = \frac{\lambda}{T} \quad \text{or} \quad v = f\lambda$$

- Speed of transverse wave on stretched string

The speed of a mechanical wave is determined by the restoring force setup in the medium when it is disturbed and the intertial properties (mass density) of the medium.
For waves on a string, the restoring force is provided by tension T.

$$V = \sqrt{\frac{T}{\mu}}$$ where, T = Tension in the string
μ = linear mass density of string

- Speed of a longitudinal wave

The speed of a longitudinal wave also depends on inertial property as well as elastic property of the medium.

- In liquids, $V = \sqrt{\frac{\beta}{\rho}} = \sqrt{\frac{\text{Bulk modulus}}{\text{Density of liquid}}}$

- In solids, $V = \sqrt{\frac{Y}{\rho}} = \sqrt{\frac{\text{Young's modulus}}{\text{Density of solid}}}$

- In gases, Newton, assumed that when sound waves propagate through a gas, the change in pressure and volume of the gas are isothermal.

The amount of heat produced during compressions is lost to the surroundings and the amount of heat lost during rarefactions is gained from the surroundings. Therefore, the temperature of gas remains constant.
The speed of longitudinal waves in an ideal gas is

$$V = \sqrt{\frac{P}{\rho}}$$

This relation is known as Newton's formula.