# Case Study - 4

Properties of progressive wave

**The displacement** from the equilibrium position may be denoted by y. A sinusoidal travelling wave is then described by: $y(x, t) = a\sin(kx - \omega t + \phi)$.The term $\phi$ in the argument of sine function. This equation represents a sinusoidal (harmonic) wave travelling along the positive direction of the x-axis. On the other hand, a function $y(x, t) = a\sin(kx + \omega t + \phi)$. Represents a wave travelling in the negative direction of x-axis.

**Where y(x,t) : displacement as a function of position x and time t**

**a: amplitude of a wave**

**$\omega$ : angular frequency of the wave**

**k: angular wave number**

**$kx - \omega t + \phi$ : initial phase angle**

**Amplitude (a) and phase ():** Amplitude represents the maximum displacement of the constituents of the medium from their equilibrium position and the quantity $(kx - \omega t + \phi)$ appearing as the argument of the sine function is called the phase of the wave.

**Wavelength ($\lambda$) and Angular Wave Number ($k$):** The minimum distance between two points having the same phase is called the wavelength of the wave, usually denoted by $\lambda$.

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

k is the angular wave number or propagation constant; its SI unit is radian per meter or rad $m^{-1}$.

1. **The displacement from the equilibrium position travelling in the negative direction of x-axis Is represented by**
   a. $y(x, t) = a\sin(kx - \omega t + \phi)$.
   b. $y(x, t) = a\sin(kx + \omega t + \phi)$.
   c. None of these

2. **SI unit of angular wave number is**
   a. rad $m^{-1}$.
   b. rad-m
   c. Hertz

d. None of the above

**3. Define wavelength of progressive wave**

**4. Define angular wave number**

**5. Define amplitude and phase**

## Answer key- 4

1. B
2. A
3. The minimum distance between two points having the same phase is called the wavelength of the wave, usually denoted by $\lambda$.

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

4. Angular wave number is defined as number of wave cycles per unit distance. Usually denoted by k and given by

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

5. Amplitude represents the maximum displacement of the constituents of the medium from their equilibrium position and the quantity $(kx - \omega t + \phi)$ appearing as the argument of the sine function is called the phase of the wave.

## Case Study - 5

Speed of traveling wave is the distance traveled by a given point on the wave in a given interval of time. Speed is determined by properties of medium like density young's modulus and shear modulus etc. and given by V= $\frac{\lambda}{T}$.
Speed of a Transverse Wave on Stretched String is given by V=$\sqrt{\frac{T}{\mu}}$ . Where T is tension in string and $\mu$ is mass per unit length or linear density of string.
The speed of longitudinal waves in a solid bar is given by V==$\sqrt{\frac{Y}{\rho}}$ . Where Y is young's modulus and $\rho$ is mass per unit volume.

1. **On increasing  the tension in a string , the speed of the wave**
   a. Increases
   b. Decreases
   c. Remains constant
   d. None of these

2. **Speed of sound in different medium is different. True or false?**
   a. True
   b. False

3. **Define speed of travelling wave.**

4. **Give formula for speed of transverse waves. On which fact does it depend?**

5. **Give formula for speed of longitudinal waves. On which fact does it depend?**

### Answer key - 5

1. A

2. A

3. . Speed of traveling wave is the distance traveled by a given point on the wave in a given interval of time. Speed is determined by properties of

medium like density young's modulus and shear modulus etc. and given by $V = \frac{\lambda}{T}$.

4. Speed of a Transverse Wave on Stretched String is given by $V = \sqrt{\frac{T}{\mu}}$ . Where T is tension in string and μ is mass per unit length or linear density of string. Speed of transverse wave is depends on
   a. Tension in string
   b. Linear mass density(mass per unit length)

5. The speed of longitudinal waves in a solid bar is given by V==$\sqrt{\frac{Y}{\rho}}$ . Where Y is young's modulus and ρ is mass per unit volume. The speed of longitudinal waves is depends upon
   a. Young's modulus
   b. Mass per unit volume