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Progressive and Stationary Waves

The Progressive Waves are those Waves that start from a Point in a Medium and Propagate in all the possible directions and never returns. Once a Progressive Wave falls on a hard Surface and is reflected, the incident wave and the reflected wave Superpose to form a standing wave and this wave is called a Stationary Wave. The amplitude of each Particle in this type of Wave changes with the Position along the direction of the Propagation of the incident Wave.

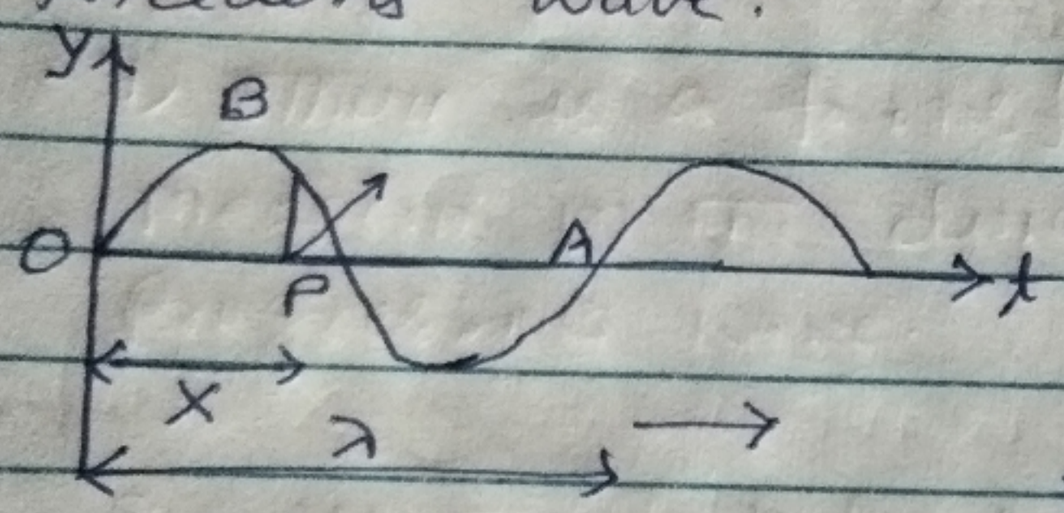

fig-7 Plane Progressive Wave

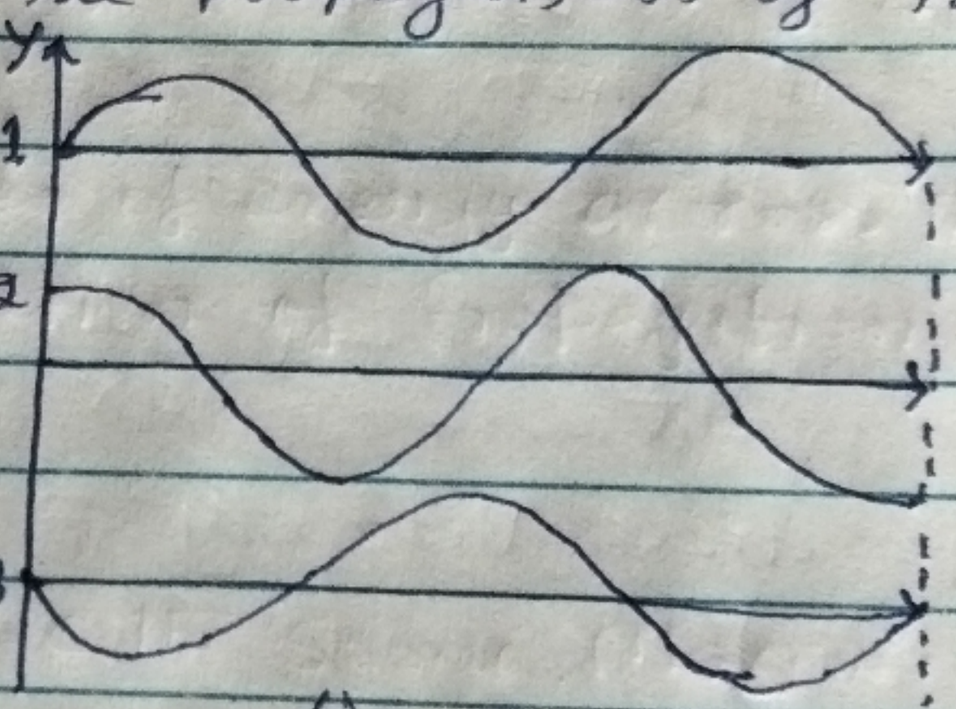

fig-8

A Progressive wave is defined as the onward transmission of the vibratory motion of a body in an elastic medium from one Particle to the Successive Particle.

A Wave which travels Continuously in a medium in the Same direction without any change in its amplitude is called a Progressive Wave or a travelling wave.

A Progressive wave may be transverse or longitudinal in nature. Phase difference between waves ① and ③ is π, which means if the shape of the wave in ① is given by $y = \sin x$, the shape of the wave in ③ is given by $y = \sin(x + \pi) = -\sin x$

Characteristics of Progressive Wave

Following are the characteristics of the Progressive wave:

① Each Particle of the medium executes vibration about its mean position. The disturbance progresses onward from one particle to another.

② The particles of the medium vibrate with same amplitude about their mean positions.

③ Each successive particle of the medium performs a motion similar to that of its predecessor along the propagation of the wave, but later in time.

④ The phase of every particle changes from 0 to 2π.

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5) The Particle remains permanently at rest. Twice during each Vibration, the Particles are momentarily at rest at extreme Positions; different Particles attain the Position at different time.

6) Transverse Progressive Waves are Characterised by Crests and troughs. Longitudinal waves are characterised by Compressions and rarefactions.

7) There is a transfer of energy across the medium in the direction of Propagation of Progressive wave.

8) All the Particles have the same Maximum velocity when they Pass Through the Mean Position.

9) The displacement velocity and acceleration of the Particle Seperated by $n\lambda$ are the same, where n is an integer.

Displacement Relation for a Progressive Wave

1.) In Case Plane wave is travelling in a medium along the +ve X-direction, the displacement Y of a Particle located at x at time t is specified as

$$Y(x,t) = A \sin(\omega t - Kx)$$

where, A = Amplitude of the wave

$\omega = 2\pi/T$ or $2\pi\nu$ is angular frequency

$K = \left(\frac{2\pi}{\lambda}\right)$ i.e. angular wave Number.

2.) If a wave is travelling along the -ve x-direction, Then we have $Y(x,t) = A \sin(\omega t + Kx)$

3) Phase Change with Position :-

If the Phase of two Particles is ϕ_1 and ϕ_2 whose distance from origin are x_1 and x_2, respectively Then we have

$\phi_1 = (\omega t - Kx_1)$ and $\phi_2 = (\omega t - Kx_2)$

$\Rightarrow \Delta\phi = K(\Delta x) \Rightarrow (\Delta\phi) \Rightarrow \phi_1 - \phi_2$

$= K(x_2 - x_1)$

Thus, Phase difference is given by

$\Delta\phi = \frac{2\pi}{\lambda} \times$ Path difference (Δx)