Rao IIT Academy

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Subject : Physics

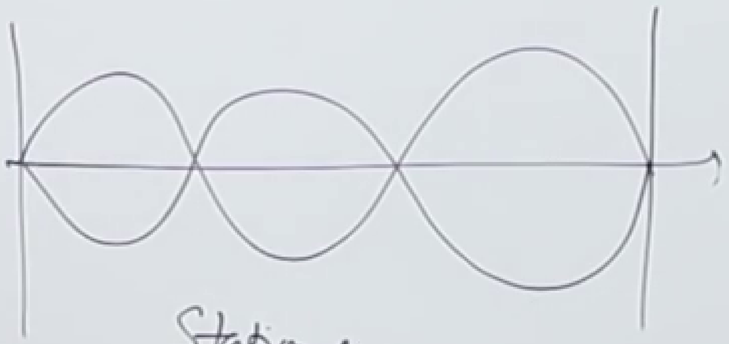
Class : 12^{Th} (HSC board)

Chapter : Stationary Waves

Professor : Ganesh Shankar Singh

Stationary waves

Study of vibration in finite medium:



Stationary wave

Stationary waves

Formation of stationary wave on a string:

$$y_1 = a \sin 2\pi\left(nt - \frac{x}{\lambda}\right)$$

$$y_2 = a \sin 2\pi\left(nt + \frac{x}{\lambda}\right)$$

$$y = y_1 + y_2$$

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

$$\sin C + \sin D = 2\sin\left(\frac{C+D}{2}\right) \cdot \cos\left(\frac{C-D}{2}\right)$$

$$\cos(-\theta) = \cos\theta$$

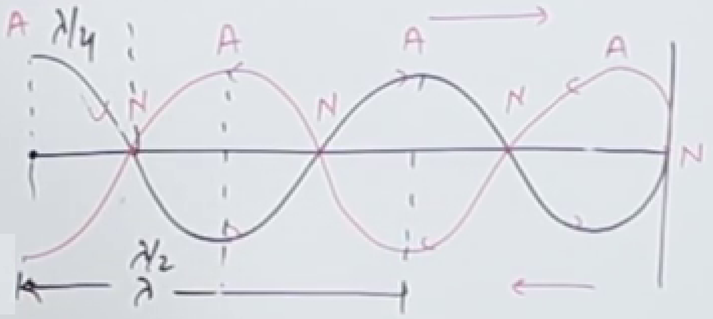
$$y = 2a \sin\left[\frac{2\pi\left(nt - \frac{x}{\lambda} + nt + \frac{x}{\lambda}\right)}{2}\right] \cdot \cos\left[\frac{2\pi\left(nt - \frac{x}{\lambda} - nt - \frac{x}{\lambda}\right)}{2}\right]$$

$$y = 2a \sin 2\pi nt \cdot \cos\frac{2\pi x}{\lambda}$$

$$y = A \sin 2\pi nt \qquad A = 2a \cos\frac{2\pi x}{\lambda}$$

Stationary waves

Formation of stationary wave on a string:



Condition of antinode:

$$Y = 2a \sin 2\pi nt \cos \frac{2\pi x}{\lambda}$$

$$2\pi n = \omega$$

$$Y = A \sin \omega t$$

$$A = 2a \cos \frac{2\pi x}{\lambda}$$

$$A = 2a \cos \frac{2\pi x}{\lambda}$$

$$2a \cos \frac{2\pi x}{\lambda} = \pm 2a$$

$$\cos \frac{2\pi x}{\lambda} = \pm 1$$

$$\frac{2\pi x}{\lambda} = 0, \pi, 2\pi, 3\pi, \ldots$$

$$\frac{2\pi x}{\lambda} = p\pi$$

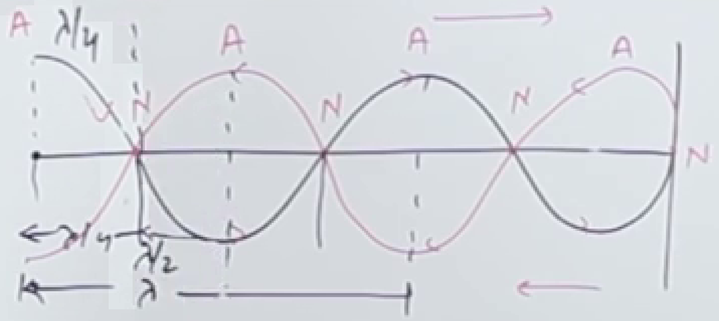
$$p = 0, 1, 2, 3, \ldots$$

$$x = p\left(\frac{\lambda}{2}\right)$$

$$x = 0, \lambda/2, \lambda, \frac{3\lambda}{2}$$

Stationary waves

Formation of stationary wave on a string:



Condition for nodes:

$$A = 2a\cos\frac{2\pi x}{\lambda}$$

$$A = 0$$

$$2a\cos\frac{2\pi x}{\lambda} = 0$$

$$0, \frac{\lambda}{2}, \lambda, \frac{3\lambda}{2} \cdots$$

$$\frac{\lambda}{4}, \frac{3\lambda}{4}, \frac{5\lambda}{4}$$

$$\cos\frac{2\pi x}{\lambda} = 0$$

$$\frac{2\pi x}{\lambda} = \frac{\pi}{2}, \frac{3\pi}{2}, \frac{5\pi}{2}, \cdots$$

$$\frac{2\pi x}{\lambda} = (2p-1)\frac{\pi}{2}$$

$$p = 1, 2, 3, \cdots$$

$$x = (2p-1)\frac{\lambda}{4}$$

$$x = \frac{\lambda}{4}, \frac{3\lambda}{4}, \frac{5\lambda}{4}, \cdots$$

Stationary waves

Properties of stationary waves:

[redacted]

ese waves are formed due to superposition of two waves travelling in opposite direction

point with maximum amplitude is antinode.

point with zero amplitude is node

between two consecutive node is $\lambda/2$

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" " succesive node & antinode is $\lambda/4$

ves are peroodic in space & time.

(8) These waves are standing waves so velocity is zero.

(9)

Stationary waves

Properties of stationary waves:

(1) These waves are formed due to superposition of two waves travelling in opposite direction

(2) The point with maximum amplitude is antinode.

(3) The point with zero amplitude is node

(4) Gap between two consecutive node is $\lambda/2$

(5) Gap between two consecutive antinode is $\lambda/2$

(6) " " " succesive node & antinode is $\lambda/4$

(7) These waves are periodic in space & time.

(8) These waves are standing waves so velocity is zero.

(9)

$\frac{3\lambda}{4} - \frac{\lambda}{4} = \frac{2\lambda}{4} = \frac{\lambda}{2}$

$0, \frac{\lambda}{2}$

$\frac{\lambda}{2} - 0 = \frac{\lambda}{2}$

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