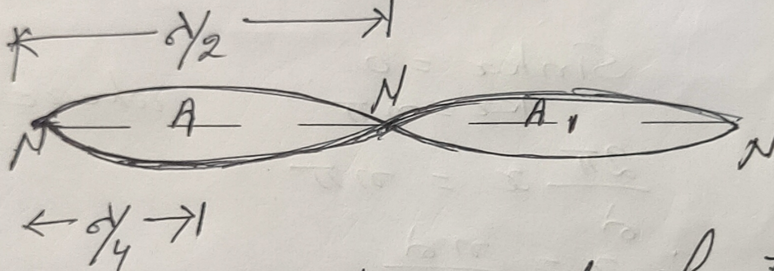
Stationary or Standing waves

when two similar waves propagate in a bounded medium in opposite directions then due to their superposition a new type of waves is obtained, which appears stationary in the medium. This wave is called stationary or standing waves.

Equation of a stationary wave,

$$y = 2a \sin \frac{2\pi t}{T} \cos \frac{2\pi x}{\lambda}.$$

Nodes (N) and antinodes (A) are obtained alternatively in a stationary waves.



At nodes, the displacement of the particles remains minimum, strain is maximum, pressure & density variations are maximum.
At antinodes, the displacement of the particles remains maximum, strain is minimum, pressure and density variations are minimum. The distance between two consecutive nodes or two consecutive antinodes $= \frac{\lambda}{2}$.
The distance between a node & adjoining antinode $= \frac{\lambda}{4}$.

All the particles between two nodes vibrate in same phase particles on two sides of a node vibrate in opposite phase.

n consecutive nodes are separated by $\frac{(n-1)\lambda}{2}$.

<u>position of Nodes:-</u> Nodes are the points on the string where the amplitude of oscillation of consituents is zero.

i.e $\quad \sin kx = 0 \quad$ where $n = 0, 1, \ldots$

$$kx = n\pi$$

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

$$\therefore x = \frac{n\lambda}{2}$$

<u>position of Antinodes:-</u> Antinodes are the points where the amplitude of oscillation of the constituents is maximum.

for maximum amplitude $\sin kx = \pm 1$

$$\Rightarrow \quad kx = (2n+1)\frac{\pi}{2} \quad \text{where } n = 0, 1, 2 \ldots$$

$$\frac{2\pi}{\lambda} x = (2n+1)\frac{\pi}{2}$$

or, $\quad x = (2n+1)\frac{\lambda}{4}$

For $n = 0, 1, 2 \ldots$