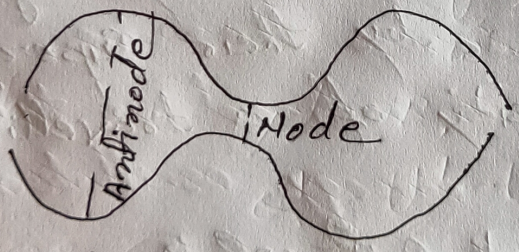
Some Important points Related with Stationary Waves

(i) Standing waves is an example of interference. Nodes means destructive interference and antinodes means Constructive interference.

(ii) Two identical waves moving in opposite directions along the string will still produced standing waves even, if their amplitudes are unequal. This is the case when an incident travelling wave is only partially reflected from a boundary, the resulting superposition of two waves having different amplitudes and travelling in opposite directions gives a standing wave pattern of waves whose envelope is shown in figure.



The Standing wave ratio (SWR) is defined as

$$\frac{A_{max}}{A_{min}} = \frac{A_i + A_r}{A_i - A_r}$$

where A_i and A_r are amplitude of incident and reflected ray respectively. For 100% reflection SWR = ∞. & for no reflection SWR = 1.

(iii) In this pattern, at antinode position, displacement is maximum and hence velocity is maximum, but strain is minimum.

Strain = slope of stationary wave pattern $\left(\frac{dy}{dx}\right)$

At nodal position, displacement and velocity is minimum but strain is maximum.

(iv) When a wave is reflected off a real surface, part of energy is absorbed by the surface. As a result, energy, intensity and amplitude of reflected wave is always less than that of incident wave. Two waves differ in their amplitude, having same frequency and wavelength and propagate in reverse or opposite direction always give stationary wave pattern by their superposition.

(v) The intensity of a travelling wave is given by

$$I = \frac{1}{2} \rho A^2 \omega^2 v$$

i.e. $I \propto A^2$

So, $\frac{I_1}{I_2} = \left(\frac{A_1}{A_2}\right)^2$ if ρ, ω & v are same for two waves.

For example,
when an incident travelling wave is partly reflected & partly transmitted from a boundry, then

$$\frac{I_i}{I_r} = \left(\frac{A_i}{A_r}\right)^2$$

as incident and reflected waves are in the same medium hence, they have same values of ρ and v.
But we cannot write

$$\frac{I_i}{I_t} = \left(\frac{A_i}{A_t}\right)^2$$

where A_t is the amplitude of transmitted wave as the have different value of ρ and v.

(vi) In standing waves nodes are permanently at rest, so no energy can be transmitted across them i.e, energy of one region is confined in that region. However, this energy oscillates between elastic PE and KE of the particles of the medium. when particles are at mean position, K.E is maximum while elastic PE is minimum. when particles are at their extreme positions K.E is minimum. while elastic PE is maximum.

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