B.Sc Physics (Hons), Part I (1)

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Q// (a) What are stationary wave?

(b) Show that in stationary waves for waves in a linear bounded medium), the net transmission of energy is zero.

Ans (a) In a bound medium, when two identical progressive waves travelling along the same line but in opposite direction are superimposed, a new kind of wave is produced known as stationary wave. These wave ~~don't~~ do not appear to progress in any direction.

(b) Energy Transmission in Stationary waves:→

The equation of pressure variation in a medium due to stationary waves

$$\Delta p = K\frac{4\pi a}{\lambda}\cos\frac{2\pi x}{\lambda}\cdot\cos\frac{2\pi \upsilon t}{\lambda}$$

$$= P_x \cos\frac{2\pi\upsilon t}{\lambda}$$

Where $P_x = +K\frac{4\pi a}{\lambda}\cdot\cos\frac{2\pi x}{\lambda}$

Similarly the particle velocity is

$$\frac{\partial y}{\partial t} = u = \frac{4\pi a\upsilon}{\lambda}\sin\frac{2\pi x}{\lambda}\cdot\sin\frac{2\pi\upsilon t}{\lambda}$$

or $u = U_x \sin\frac{2\pi\upsilon t}{\lambda}$

where $U_x = +\frac{4\pi a\upsilon}{\lambda}\cdot\sin\frac{2\pi x}{\lambda}$

The work done or energy transferred per unit area in an infinitesimal time dt is

$$\Delta E = p.u.dt$$

Transfer of energy in a period T will be

$$E = \int\Delta E = \int_0^T pu\,dt$$

The rate of transfer of energy $= \frac{E}{T}$

$$= \frac{1}{T}\int_0^T pu\,dt$$

$$= \frac{1}{T}\int_0^T P_x \cos\frac{2\pi vt}{\lambda}\, u_x \sin\frac{2\pi vt}{\lambda}\,dt$$

$$= \frac{P_x u_x}{T}\int_0^T \sin\frac{2\pi vt}{\lambda}\cdot\cos\frac{2\pi vt}{\lambda}\,dt$$

$$= \frac{P_x u_x}{2T}\int_0^T \sin\frac{4\pi vt}{\lambda}\,dt$$

$$= \frac{P_x u_x}{2T}\left[\frac{-\cos\frac{2\pi vt}{\lambda}}{4\pi v/\lambda}\right]_0^T$$

$$= \frac{P_x u_x}{2T}\left[-\frac{T}{4\pi}\cos\frac{4\pi t}{T}\right]_0^T$$

$$= \frac{P_x u_x}{2T}\left(\frac{-T}{4\pi}\right)\left[\cos 4\pi - \cos 0\right]$$

$$= 0$$

Thus there is no transfer of energy across any plane in a stationary wave. The energy remains in the medium are alternately transfered into vibrational K.E and elastic P.E.