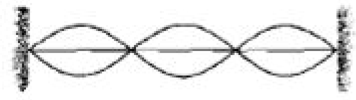
Q- Figure shows the standing wave oscillating at frequency f_o.

(a) How many antinodes will there be if the frequency is soubled to $2f_o$.

(b) If the tension in the string is increased by a factor of four for what frequency will the string continye to oscillate as a standing wave with three antinodes?



The frequency f, wave velocity c and the wavelength λ for a wave are related as

$$c = f * \lambda \qquad \text{--------------- (1)}$$

The velocity of a transverse wave on a stretched string is given by

$$c = \sqrt{\frac{T}{\mu}} \qquad \text{--------------- (2)}$$

Here T is the tension in the string and μ is the mass per unit of the string.

Substituting value of c from equation 1 in equation 2 we get

$$f\lambda = \sqrt{\frac{T}{\mu}}$$

Or $$\lambda = \frac{1}{f}\sqrt{\frac{T}{\mu}} \qquad \text{--------------- (3)}$$

Antinodes are the points of maximum amplitude (peaks) and the distance between two nearest antinodes is λ/2. λ is halved so the number of loops formed in the same length will be doubled.

a) from equation (3) if the tension in the string remains constant, we get

$$\lambda \propto \frac{1}{f}$$

Hence if the frequency is doubled the wavelength will be halved and hence the number of antinodes will be doubled i.e. becomes **6**.

b) From equation (3) again if the string continues to oscillate with three antinodes, the wavelength remains unchanged and hence for the two situations we can write the equations as

$$\lambda = \frac{1}{f_0}\sqrt{\frac{T}{\mu}}$$

And $$\lambda = \frac{1}{f}\sqrt{\frac{4T}{\mu}}$$

Equating the two we get

$$\frac{1}{f_0}\sqrt{\frac{T}{\mu}} = \frac{1}{f}\sqrt{\frac{4T}{\mu}}$$

Gives $f = 2f_0$

Hence for the frequency of **$2f_0$** the string will still oscillate with three antinodes.