Q- A 1.2 m long tube is closed at one end. A stretched wire is placed near the open end. The wire is 0.330 m long and has a mass of 9.60 g. It is fixed at both ends and oscillates in its fundamental mode. By resonance it sets the air column in the tube into oscillation at the column's fundamental frequency. Find

(a) The frequency of air column. And

(b) The tension in the wire.

Solution:

(a)

The fundamental frequency of a closed pipe is given by

n = c/4L ---------------------------- (1)

Here c is the velocity of sound in air and L is the length of the tube (neglecting end correction)

As the velocity of sound in air is c = 340 m/s and the length of the tube L = 1.20 m we get

n = 340/(4*1.20) = **70.83 Hz**

(b)

The frequency of transverse oscillations of a stretched string is given by

$$n = \frac{1}{2\pi}\sqrt{\frac{T}{\mu}}$$ ---------------------------- (2)

Here T is the tension in the wire and μ is the mass per unit length.

As the two are in resonance of fundamental mode the frequencies must be equal and hence substituting frequency from equations (1) we get

$$\frac{1}{2\pi}\sqrt{\frac{T}{\mu}} = n$$

Gives $T = 4\pi^2 n^2 \mu = 4 * 9.87 * 5017.36 * \left(\frac{9.60*10^{-3} kg}{0.330\ m}\right)$

Or **T = 5762.5 N**