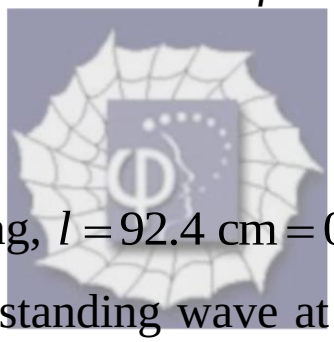
139.

Problem 19.53 (RHK)

In an experiment on standing waves, a string 92.4 cm *long is attached to the prong of an elastically driven tuning fork, which vibrates perpendicular to the length of the string at a frequency of* 60 Hz. *The mass of the string is* 44.2 g. *We have to calculate the tension in the string if it is to vibrate with four loops.*



Solution:

Length of the string, $l = 92.4 \text{ cm} = 0.924 \text{ m}$.

Frequency of the standing wave at resonance is equal to the frequency of the tuning fork, f = 60 Hz.

Mass of the string, $m = 44.2 \text{ g} = 44.2 \times 10^{-3} \text{ kg}$.

Mass per unit length of the string,

$\mu = m/l = 44.2 \times 10^{-3} / 0.924 \text{ kg m}^{-1} = 0.0478 \text{ kg m}^{-1}$.

As the string is vibrating with four loops, wavelength of the standing wave and its length are related as $2\lambda = l$.

So, $\lambda = l/2 = 0.462 \text{ m}$.

Velocity of wave in the string,

$v = f\lambda = 60 \times 0.462 \text{ m s}^{-1} = 27.72 \text{ m s}^{-1}.$

Tension in the string,

$F = \mu v^2 = (27.72)^2 \times 0.0478 \text{ N} = 36.7 \text{ N}.$