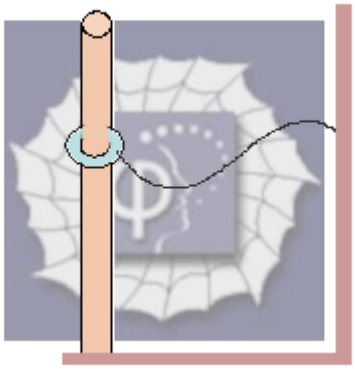
137.

Problem 19.51 (RHK)

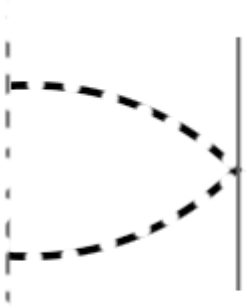
One end of a 120-cm *string is held fixed. The other end is attached to a weightless ring that can slide along a frictionless rod. We have to find the three longest possible wavelengths for standing waves in the string. We will sketch the corresponding standing waves.*



Solution:

As the one end of the string is held fixed and the other end is attached to a weightless ring that can slide along a frictionless rod, when the standing waves are set in the string, the fixed end will be a node and the other end tied to the ring will be an antinode. The length of the string is 120 cm. We will show the configuration of standing waves of three longest wavelengths in this system.

The longest wavelength will correspond to the configuration shown in the figure.

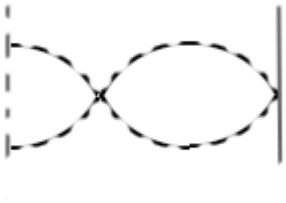


In this case we have a quarter wave, which implies

$$\frac{\lambda_1}{4} = L = 120 \text{ cm},$$

or, $\lambda_1 = 480 \text{ cm}$.

The second longest wavelength will correspond to the configuration shown in the figure.



In this case we have a three-quarter wave, which implies

$$\frac{3\lambda_2}{4} = L = 120 \text{ cm}.$$

Or, $\lambda_2 = 160 \text{ cm}$.

The third longest wavelength will correspond to the configuration in the figure.

In this case we have

$$\frac{5\lambda_3}{4} = L = 120 \text{ cm}.$$

Or, $\lambda_3 = 96 \text{ cm}$.