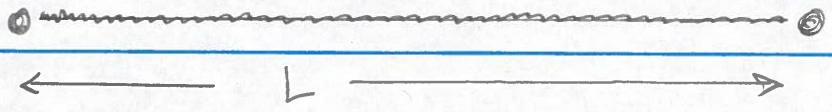
Midori is building a violin. She ties one string on to the body



The string has length $L = 0.291$ m and mass $m = 0.2008$ grams. Midori wishes to produce a perfect "A" note, with frequency $f = 440$ Hz.

How tight should she stretch the string?

linear mass density $\mu = \frac{m}{L}$

speed of wave $v_s = \sqrt{\frac{T}{\mu}}$ ← tension in string

But we also know for resonance, the time to travel down-and-back along the string should be equal to the period of the wave

$$t = \frac{2L}{v_s} = P$$

But $P = \frac{1}{f}$ period is reciprocal of frequency

If we put all this information together, we can figure out the proper tension T.

$$v_s^2 = \frac{T}{\mu}$$

Substitute into

$$t = \frac{2L}{v_s} = \frac{1}{f}$$

Square both sides

$$\left(\frac{2L}{v_s}\right)^2 = \left(\frac{1}{f}\right)^2$$

$$\frac{4L^2}{v_s^2} = \frac{1}{f^2}$$

$$\frac{4L^2}{T/\mu} = \frac{1}{f^2}$$

Solve for T:

$$T = 4L^2 \mu f^2$$

$$= 4(0.291\ m)^2 \left(\frac{2.008 \times 10^{-4}\ kg}{0.291\ m}\right)(440\ Hz)^2$$

$$\boxed{T = 45\ N}$$