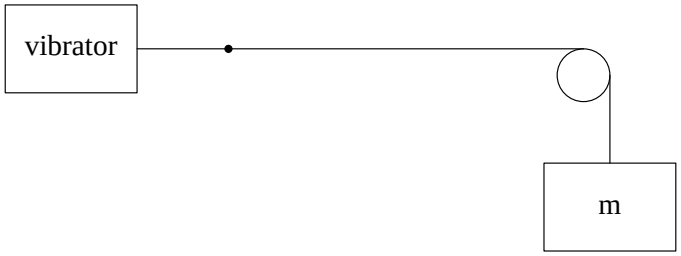
4. (20 pts.) A violin string has length $L = 0.327\text{m}$, mass $2.8 \times 10^{-4}\text{kg}$, and is clamped at both ends. When vibrating in the fundamental mode, the string has a frequency $f = 440\text{Hz}$ (an A note).

a. (10 pts.) What is the tension in the string?

b. (10 pts.) In order to play higher notes, the player shortens the string by holding a portion of the string against the fingerboard. How far from the end of the string must the violinist put her finger in order to play a C note, $f = 523\text{Hz}$? (Assume that the tension in the string does not change.)

4. (25 pts.) A string of mass 0.005 kg and total length 2.5 m is connected to a vibrator at one end, passes over a light pulley, and is attached to a hanging mass at the other end. The distance from the vibrator to the pulley is 2.0 m.



a. (15 pts.) When the hanging mass is 16 kg, standing waves with 4 loops are observed. What is the frequency of the vibrator?

b. (10 pts.) If the frequency of the vibrator is unchanged, what hanging mass would be required to give rise to standing waves with 3 loops?

5. (20 pts) A cellist tunes the C-string of her instrument to a fundamental frequency of $65.4\,\text{Hz}$. The vibrating portion of the string is $0.60\,\text{m}$ long and has a mass of $14.4\times10^{-3}\,\text{kg}$. What fractional increase in tension is required to increase the frequency from $65.4\,\text{Hz}$ to $73.4\,\text{Hz}$ (an increase from a C note to a D note)? (Recall that fractional increase is defined as $\frac{new-old}{old}$.)