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. (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?

$L = \frac{1}{2}\lambda \Rightarrow \lambda = 2L$

$v = \lambda f = (2L)(f) = 2(0.327)(440) = 287.8\,\text{m/s}$

[Ex. 11-13] $v = \sqrt{F_T/\mu} \Rightarrow F_T = \mu v^2$

$\mu = \dfrac{2.8\times10^{-4}\,\text{kg}}{0.327\,\text{m}} = 8.5627\times10^{-4}\,\text{kg/m}$

$F_T = \mu v^2 = \boxed{70.9\ \text{N}}$

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.)

Now want

$L_C = \frac{1}{2}\lambda_C$

$f_C = 523\ \text{Hz}.$

$v$ unchanged $= 287.8\ \text{m/s}$

$v = \lambda_C f_C \Rightarrow \lambda_C = \dfrac{v}{f_C} = \dfrac{287.8\,\text{m/s}}{523\ \text{Hz}} = 0.5503\,\text{m}$

$L_C = \frac{1}{2}\lambda_C = \boxed{0.275\,\text{m}}$

change is $0.327 - 0.275 = \boxed{0.0518\,\text{m}}$