Practice Problem:

20. Suppose an instrument string is **68 cm** long, and when the open string is plucked, its frequency is **220 Hz.**

a. For purposes of tuning, we care about the *fundamental* vibration of the string. On the diagram to the right, label the position of the bridge and the nut. In this case, how many wavelengths does the vibrating string represent?

$L = \frac{\lambda}{2}$ — 

b. What is the full wavelength of the waves that are traveling down the string?

$\lambda = 2L = 2(68\text{cm}) = 136\text{cm}$

c. What is the relationship between string length and the wavelength of the string's fundamental standing wave?

c. What is the speed of those waves? Note: This speed is constant for a given string as long as the string's tension remains constant.

$v = f\lambda = 220\text{Hz}(136\text{cm}) = 29{,}920\ \frac{\text{cm}}{\text{s}}$

d. The first fret (closest to the nut) on a finger board needs to correspond to a note that is one half-step higher than the open string. What is the frequency of a note one half step higher than the 400hz open string?

$f = f_0\left(2^{1/12}\right) = 220\text{Hz}(1.059) = 233\text{Hz}$

e. In order to produce that note, what wavelength must the string have? [hint: you know the string's wave speed]

$v = f\lambda \Rightarrow 29{,}920\ \frac{\text{cm}}{\text{s}} = 233\text{Hz}(\lambda)$

$\lambda = 128.4\text{cm}$

f. How long must the vibrating portion of the string be in order to produce that wavelength?

$\lambda = 2L \Rightarrow 128.4\text{cm} = 2L \Rightarrow L = 64.18\text{cm}$

g. How far from the nut should the first fret be located? In other words, by what distance must you shorten your string in order to raise your instrument's pitch by one half step?