

45. Each wire is vibrating in its fundamental mode so the wavelength is twice the length of the wire ($\lambda = 2L$) and the frequency is $f = v/\lambda = (1/2L)\sqrt{\tau/\mu}$, where v ($= \sqrt{\tau/\mu}$) is the wave speed for the wire, τ is the tension in the wire, and μ is the linear mass density of the wire. Suppose the tension in one wire is τ and the oscillation frequency of that wire is f_1 . The tension in the other wire is $\tau + \Delta\tau$ and its frequency is f_2 . You want to calculate $\Delta\tau/\tau$ for $f_1 = 600$ Hz and $f_2 = 606$ Hz. Now, $f_1 = (1/2L)\sqrt{\tau/\mu}$ and $f_2 = (1/2L)\sqrt{(\tau + \Delta\tau)/\mu}$, so

$$f_2/f_1 = \sqrt{(\tau + \Delta\tau)/\tau} = \sqrt{1 + (\Delta\tau/\tau)} .$$

This leads to

$$\Delta\tau/\tau = (f_2/f_1)^2 - 1 = [(606 \text{ Hz})/(600 \text{ Hz})]^2 - 1 = 0.020 .$$