A string is clamped between two supports 1.75 m apart. The total mass of the string free to oscillate between the supports is 0.0625 kg. The string is driven by a fixed frequency oscillator at 120 Hz, as shown in class.

(a) Calculate the values of the tension needed to produce the first four harmonics (the fundamental and the first three overtones) of the driving frequency.

(b) A new string is clamped in the same apparatus. It is found by experiment that the tension to produce the fundamental is 82.0% of that in (a). Find the total mass of the new string.

\[ v = \lambda f = \left( \frac{T}{\mu} \right)^{1/2} \]
\[ \mu = \frac{m}{l} \]
\[ l = n \left( \frac{\lambda}{2} \right) \quad n = 1, 2, 3, \ldots \]
\[ \lambda = \frac{2\pi}{n} \]
\[ T_n = \left( \frac{m}{l} \right) \left( \frac{2\pi}{n} \right)^2 f^2 \]
\[ T_n = \left( \frac{4m \lambda^2}{n^2} \right) \]
\[ T_n = \frac{6300 N}{n^2} \]

\[ T_1 = 6300 N \]
\[ T_2 = 1580 N \]
\[ T_3 = 700 N \]
\[ T_4 = 394 N \]

\[ T \propto m \quad \Rightarrow \quad \frac{T}{T_0} = \frac{m}{m_0} \]

\[ m = m_0 \left( \frac{T}{T_0} \right) = m_0 (0.82) \]

\[ m = 5.13 \times 10^{-2} \text{ kg} \]