1. A violinist bows the “E” string of her violin yielding a fundamental frequency of 660 Hz.

   a. Assuming that the length of the vibrating E string (between the bridge and end of the finger board) is 0.3 m, what is the wavespeed when the violinist plays the string (no fingers on the finger board), thus exciting mostly the first harmonic (fundamental)?

   \[
   \frac{\lambda}{2} = L = 0.3 \text{ m} \Rightarrow \lambda = 0.6 \text{ m} \\
   f = 660 \text{ Hz} \Rightarrow \lambda f = V = \\
   = \left( \frac{L}{12} \right) (660 \text{ Hz}) = 6(\text{66 m/s}) \\
   = 396 \text{ m/s}
   \]

   b. What is the distance between a node and antinode if the string vibrates instead in the second harmonic?

   \[
   \text{AN} / \text{IN} \Rightarrow \lambda / 4 \Rightarrow \lambda = L = 0.3 \text{ m} \\
   \Rightarrow \frac{0.3}{4} \text{ m} = 0.075 \text{ m}
   \]

   c. She notes that she after playing for a while, her violin slips out of tune by 4 beats/second. She increases the string tension (by adjusting the pegs) to get back into tune. What was the original frequency of the string when it was out of tune?

   \[
   660 + 4 = 664 \text{ Hz} \\
   660 - 4 = 656 \text{ Hz} \\
   T \uparrow \Rightarrow fT = 656 \text{ Hz}
   \]