**Standing Waves in Strings**

1. Draw diagrams showing the shapes of the standing waves below. Label the nodes and antinodes. Write the wavelength (in terms of *ℓ*) in the space to the right of each wave.

Fundamental frequency

(First harmonic)

Second harmonic

Third harmonic

1. The speed of waves in a particular guitar string is 425 m s-1. Determine the fundamental frequency of the string if its length is 76.5 cm.
2. A guitar string is 0.700 m long and is played so that it vibrates in its fundamental frequency. What would be its wavelength if it were played so as to vibrate in its 5th harmonic?
3. Someone is singing in a shower that measures 2.40 m from floor to ceiling, and notices their voice causes the shower to resonate with a fundamental frequency of 73 Hz.
   1. Sketch a standing wave and calculate the speed of sound in the shower.
   2. Sketch the standing wave for the second harmonic and calculate the frequency.
4. A guitar string is 0.70 m long and is tuned to play E above middle C (330Hz, that is the first harmonic)
   1. What is the speed of the wave on the string?
   2. How far from the end of this string must the finger be placed to play A above middle C (440 Hz) ?
5. While driving to work, Jill notices that workers have strung plastic ribbon around their worksite to prevent people from walking into a large hole. Jill notes that between two support poles the ribbon in 1.5 m long and is vibrating in a standing wave pattern with 5 loops. The vibrating ribbon is creating a sound that corresponds to the note A (f = 420 Hz).
   1. What is the wavelength of the standing wave?
   2. What is the speed of vibrations in the ribbon?