Workshop module 13 - Physics 113, Fall 2012
waves

1. Why do you see lightning before you hear the thunder? Would you see a rocket lift off from the moon before you heard it? You see a baseball player swing at a ball 1.0 seconds before you hear the crack of the bat on the ball. How far away from home plate are you sitting?

2. Erving Von Humbolt, famed Professor of Pre-Columbian Artifacts has discovered a musical instrument he believes was once used by native peoples in what is now southeast Paraguay for "some serious jammin', rockin', and gettin' down" during adolescent mating rituals. Unfortunately, the instrument he has discovered is broken. He comes to you for help in understanding what sounds the instrument might have made. Please help him out!

The instrument has one string. That string is tied at one end and constrained to move freely up and down a thin rod on the other end. Break up into small groups and determine the correct expression for the frequency of the n^{th} harmonic of the string in terms of the length (L), tension (T), and the mass/length (μ) of the string. Try to convince the other groups of your answer. Below are are a few possibilities, one of which is the correct answer.

(a)

$$\nu_n = \frac{n}{2L}\sqrt{\frac{T}{\mu}}$$

where n=1,3,5 …

(b)

$$\nu_n = \frac{n}{2L}\sqrt{\frac{T}{\mu}}$$

where n=1,2,3, …

(c)

$$\nu_n = \frac{n}{2L}\sqrt{\frac{gT}{\mu}}$$

where n=1,2,3, …

(d)

$$\nu_n = \frac{n}{4L}\sqrt{\frac{T}{\mu}}$$

where n = 1,3,5, …

(e)

$$\nu_n = \frac{n}{4L}\sqrt{\frac{T}{\mu}}$$

where n=1,2,3, …

3. Mick Jaguar, famous rock musician, sits in the stadium during a sound check before his concert. He sits in front of the stage 20 meters from one speaker and 23 meters from another. These are the only two speakers on the stage. As part of the sound check, the frequency emitted by the speakers is swept slowly through the entire audible range from 20 to 20,000 Hz. Mick notices that the intensity of the sound he hears depends on the frequency.

(Intensity is a measure of the energy/area flowing through a point due to the wave passing by. It is the time average of the square of the total wave amplitude at a point. A total wave amplitude that is large gives a large intensity.)

Should he be worried that there is something wrong with his hearing? Suppose Mick's ears have a perfectly flat frequency response. What else could cause a variation in the intensity of the sound Mick hears? At what frequencies should Mick hear a minimum intensity? At what frequencies will he hear a maximum intensity?

4. A violinist is tuning the A string on her violin by listening for beats when this note is played simultaneously with a tuning fork of frequency 440 Hz. She hears a beat frequency of 4 Hz. She notices that, when she increases the tension in the string slightly, the beat frequency decreases. What was the frequency of the mistuned A string?