Physics Exploration Homework Supplement **P111-2.pdf**

Standing Waves on a String and in an Air Column

Go to the Physics Exploration Center. Enter through the resource room 311/312 Thaw Hall.

This exploration involves calculating: (a) the resonance frequency of standing waves on a string and its relation to the tension in the string, and (b) standing waves set up in an air column.
Before you start the exploration, answer the following questions.

(I) Which one of the following will result in standing waves?
(a) the superposition of waves that travel with different speeds.
(b) the superposition of identical waves that travel in the same direction.
(c) the superposition of identical waves that travel in opposite directions.
(d) the superposition of nearly identical waves of slightly different amplitudes.
(e) the superposition of nearly identical waves of slightly different frequencies.

(II) A feature of the standing wave is that
(a) the locations of maxima and minima do not change.
(b) the location of the maxima changes but not minima.
(c) they are two waves traveling in the same direction with the same wavelength and amplitude.
(d) its phase differences is always $\pi/2$.
(e) it is a special case of a traveling wave.

(III) The resonant frequencies for a pipe of length L with 2 open ends requires that the wave-lengths be equal to (n is an integer)
(a) 2L/n
(b) 4L/n
(c) L/2n
(d) L/n
(e) L/4n

(IV) Which of the following is true concerning the points on a string that sustain a standing wave pattern?
(a) All points vibrate with the same energy
(b) All points undergo the same displacements
(c) All points vibrate with the same frequency
(d) All points vibrate with the same amplitude
(e) All points undergo motion that is purely longitudinal

Now go to the station with a horizontal string which can be made to vibrate at different frequencies (Set-up P111-2A.pdf). The tension in the string can also be changed by changing the mass hanging from the string.

(1) Play with the exploration setup by changing the frequency. Find the lowest resonance frequency for a 300 gram mass hanging from the string. Repeat the above exploration for a higher harmonic.

(2) Change the mass hanging from the string to 1200 gram and repeat part (1). Does the lowest resonance frequency of standing wave increase or decrease? Explain why this makes sense based upon what you learned in the lecture?

(3) If a musician who plays a string instrument wants to increase the frequency of the lowest harmonic standing wave for the full length of the string, should he increase or decrease the tension in the string by tuning the instrument? Explain.

Next go to the exploration setup with a tuning fork (which produces sound of one fixed frequency) and an air column (Set-up P111-2B.pdf).

(4) Strike the tuning fork on the "striker block" and then hold the timing fork above the air column. Slowly adjust the column so that you hear an amplification of sound. That length of the column corresponds to resonant standing waves in the column. Note down the length of the air column and find the frequency of the tuning fork using the fact that speed of sound in air is 343 m/s.

(5) Can you increase the length of the air column to obtain a higher harmonic resonant standing wave? Predict the approximate length of the air column at which it should happen. Then, do the experiment and verify that you do get an amplification of the sound for that length of the column.

(6) Describe one aspect of the above explorations (any one of the two explorations) that you find most fascinating?