**Spring Wave Lab DAL 01/13/2014** Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Period\_\_\_\_\_ Date\_\_\_\_\_\_\_\_\_

**Objectives**:

* Measure wave frequency, wavelength, and velocity
* Determine the relationship between wavelength, frequency, period, and speed

**Materials**: Long coil spring, masking tape, stopwatch, meter stick or tape measure

**Pre-Lab Questions:**

1. What is the total length from endpoint to endpoint in the wave to the right? \_\_\_\_\_\_\_
2. How many wavelengths are shown in the wave? \_\_\_\_\_
3. Use algebra to calculate the wavelength, to the nearest millimeter: \_\_\_\_\_
4. Label every node and antinode on the wave. There are \_\_\_\_ nodes and \_\_\_\_ antinodes.
5. Standing waves result from the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of two waves traveling in opposite directions. At every node, there is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ interference, and at every antinode, there is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ interference.
6. If the wave above vibrates 25 times in 9.52 seconds, then what is the frequency?
7. Using the frequency you just calculated, and the wavelength you measured, what would be the speed of the wave?
8. What is the speed of a wave which has a frequency of 1.6 Hz and a wavelength of 2.80 meters?
9. If a wave travels at 16.2 m/s, what shaking frequency should produce a wavelength of 1.40 meters?



1. Measure the waves to the right, and calculate and label the wavelength for each one.

λ2 = \_\_\_

λ1 = \_\_\_

λ3 = \_\_\_

**Procedure:**

**SETUP:**

1. **Choose one spring to use for the entire lab. Do not switch between springs!** One person should hold the end of a spring at stomach height, above a piece of masking tape on the floor, or some other mark. Using the rope handle attached to the end of the spring will protect both the spring and your fingers.
2. Another person should take the other end of the spring, and move back only as far as necessary to get the spring about a foot (30cm) off of the floor. The springs we commonly use should end up between 4 and 7 meters long. Try to select a length which is an integer number of meters.
3. Place a piece of masking tape on the floor below each end of the spring, to mark the spring length. Measure the distance between the pieces of tape, and record the spring length. Keep the end of the spring at this length for the whole lab!!

**PART 1**: ***Speed of a Single Pulse***

1. Measure the time it takes a wave pulse to make two round trips on the spring (out and back, out and back again.) The wave maker should send one single wave pulse down the spring. Strike the spring quickly, but gently, with the edge of one hand. (Announcing “ready, set, Go” will help the timer.) Record the length of the spring, the total number of lengths traveled (four), and the time taken.
2. Repeat step 4 two times, to collect more data and improve accuracy.

**PART 2: *Speed Calculated from Standing Wave Data***

1. The wave maker should now vibrate the spring horizontally at its *fundamental frequency*, or *first harmonic*. This is the lowest frequency that will make a steady standing wave.

DO NOT MAKE THE AMPLITUDE OF THE WAVE EXCEED A HALF METER (1.5 FEET). THIS WOULD BOTH DAMAGE THE SPRING AND MESS UP YOUR DATA.

1. Time 12 cycles of this wave. Have the timer stand next to an antinode, and count “Ready, Set, Go”, timing their counts to match the spring almost hitting them. Start timing at “Go” and then stop timing when you have reached 12 cycles. One cycle is one full “back and forth”.
2. Record the number of cycles you timed, and the time to the hundredth of a second.
3. Now make the spring vibrate at its *second harmonic*, with one full wavelength.
4. Repeat the procedure you used for the first harmonic to measure the frequency for the second harmonic.
5. Now measure the frequencies for the third and fourth harmonics. For these, however, you should time 20 cycles. (Why?)
6. Extra Credit: You may measure the fifth and sixth harmonic frequencies, now timing 30 cycles.

**Calculations and Results:**

You should have all the white data boxes filled in (for at least the single pulse and the first four harmonics. Now calculate your results in the gray boxes. **If you have done the lab correctly, you should find that the wave speed is approximately the same for all the waves.** (They are all traveling on the same spring.)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Length of Spring (m) | # of lengths traveled by pulse | Total length traveled (m) | Time1 (s) | Time2 (s) | Time 3 (s) | Average Time (s) | Wave Pulse Speed (m/s) |
| **Single Pulse Data:** |  |  |  |  |  |  |  |  |

Waves on a Spring Lab:

Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date\_\_\_\_\_\_\_\_ Period\_\_\_\_\_

Data and Results Table White boxes: Data collected during lab. Gray boxes: Results calculated after data collection

**Average Speed of Wave Calculated from Standing Wave Data**

**λ = 2 ∙ Length of Spring**

 **# of Antinodes**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Standing Wave Data:** | Length of Spring (m) | # of Antinodes (number of “loops”) | # of Wavelengths | λ: Wavelength (meters) | # of Cycles measured | Time (sec) | Frequency in Cycles/Second (Hertz) | Period (seconds per cycle) | Speed (m/s) |
| 1st Harmonic |  |  |  |  |  |  |  |  |  |
| 2nd Harmonic |  |  |  |  |  |  |  |  |  |
| 3rd Harmonic |  |  |  |  |  |  |  |  |  |
| 4th Harmonic |  |  |  |  |  |  |  |  |  |
| 5th Harmonic \* |  |  |  |  |  |  |  |  |  |
| 6th Harmonic \* |  |  |  |  |  |  |  |  |  |

**Speed = Wavelength ∙ Frequency**

***Spring Lab Conclusion Questions and Summary:***

**No, you do not need to retype the procedure. However, if you have not bothered to read this sentence, and you ask me if you have to type it out, I will tell you that you do have to retype it.**

**Hand in your typed conclusion and summary on a separate sheet of paper, stapled to the rest of the lab.**

Conclusion Questions:

1. What was the relationship between the harmonic number, the wavelength, and the frequency, for the standing waves? (“As the harmonic number increased, the wavelength …)
2. What was the relationship between wavelength and number of wavelengths on the spring?
3. Did the speeds of all the standing waves come out approximately the same? If not, did you see a pattern?
4. What was the percent difference between the speed of the pulse (from part 1) and the average speed calculated from the standing wave data (from part 2)? Use the pulse speed as the “accepted” value.
5. As the frequency of the standing waves increased, did you use more power, less power, or the same? (How much more or less energy did you expend?)
6. What was the benefit of timing the pulse as it traveled four lengths of the spring? Why not just time it for one length? Why not time it for ten lengths?
7. A lab similar to this one can be done with sound waves. It is not possible to see sound waves, but it is relatively easy to measure their frequency and wavelength. A student doing a sound lab measures a 440-Hz note (“A” on a piano) to have a wavelength of 77.8 cm. What would she calculate as the speed of sound that day? Be sure to convert the wavelength to meters.

Summary: In a few paragraphs, summarize what you have learned about waves from this lab. Use the proper scientific terms, and read over your sentences to check for proper spelling and grammar.