Lab C4: *Standing Waves on a Helical Spring*

5/6/03

Goals:

- To determine the relationship between the frequency of standing waves on a helical spring and the number of antinodes in the standing wave pattern, and
- to determine the wavelength and speed of the waves

Pre-lab: Reading: Walker 14(1,2) 14(7 up through the 3rd paragraph under Interference), 14(8 up through the bottom of p. 445), and the Superposition Applet.
Format your lab report in advance. Include the following:

a) title, goals, table of contents entry
b) Data: Prepare a table like the one below, including enough rows for up to 4 antinodes. Also include labels for the constants (see the list of these below the data table) so you won't forget to measure them.
c) Theory: Draw large diagrams (half-page each) for each of the 4 standing wave patterns. Use your diagrams give the wavelength λ for each pattern in terms of the length L of the spring.

Method: You will generate standing wave patterns of 1, 2, 3, and 4 antinodes on a spring fixed at one end. For each wave pattern, measure the frequency for a large number of periods; EVERY person in the group (except the oscillator) must make period measurements. Then find the average. Develop a method of timing and oscillating that gives accurate results.

NOTE: Take data for n = 4 antinodes first since it is the most difficult to accomplish. A separation distance of 6 – 8 meters for the string ends is suggested. Based on your data for n = 2, 3, and 4, you'll make a prediction for n = 1 (see **Analysis** for instructions on making your prediction). You make take the data for n = 1 before you use your data to make a prediction for n = 1, but be sure not to include this data point in the data analysis for your prediction.

Number of Antinodes	**Number of periods measured**	**Total Time for no of periods you measured (s)**	**Your measured period**	**Ave. Frequency (Hz) for group**	**Wavelength (m)**	**wave speed (m/s)**
4						
3						
etc						

<u>Maintain the spring at constant stretch and length throughout the experiment</u>. Measure and record the length as the horizontal distance from the fixed hand to the oscillator's hand. You'll use this measurement later in wavelength calculations.

In addition to the table, include these constants:

- *number of oscillations used (i.e. full periods) for timing*
- *length of the spring*
- *letter of the spring (if any)*

Analysis:

1) Use YOUR calculator to obtain a graph of frequency vs. number of antinodes. (Which variable goes on the horizontal axis?) Do a linear least-squares fit to the data. Make a full-page diagram of the graph and label the axes properly.

2) On the page opposite your graph, present the usual matching table (see lab expectations).

3) Use the graphically determined fit equation to calculate the frequency for a standing wave with 1 antinode; compare it to the experimentally measured value. % difference?

4) Calculate the wavelength of each pattern using the formulas obtained in the pre-lab.

5) Calculate the speed of the wave for each standing wave pattern by using the average frequency that you measured and the wavelength that you calculated in #4. Present results for #4 and #5 in the data table made in the Prelab.

6) Without doing a calculation, about what would you expect the speed of the wave to be for $n = 1$? Why.

7) If you kept the distance from oscillator's hand to fixed hand the same but put more tension on the spring by stretching it more, how would the speed of the waves change? Why?

8) Conclusion, as always