Lab C3: ***Investigating Pulses on a Long Spring*** ***may 1 2003***

Goals:

- To investigate how pulses are transmitted along a long spring.
- To measure the speed of wave propagation down the spring.
- To investigate how pulses interact with one another.

Equipment: Long skinny spring ; slinkly spring; Meter Stick ; Stopwatch ; 20 Newton Spring Scale

Note: The springs can easily be stretched beyond their elastic limit. They can also hurt someone if they fly loose while you're shaking them rapidly. Be gentle! Be careful!

PART A: Transverse pulse creation and behavior.

Method A: Two people will stretch and hold a slinky spring on the floor (about 4 meters apart between ends for the extra long slinky; about 2 meters apart for the shorter slinky). To produce a transverse pulse, the student "whips" his end of the spring perpendicular to the length of the spring to send a transverse pulse down the spring. This should produce an easy to observe "bump" that travels along the spring. Perhaps your instructor will demonstrate this technique.

1. Does the size of a pulse change as it travels along the spring? Why does it change size?

2. What happens to a pulse as it reflects from the stationary end of the spring? (In this and the remaining parts, make the amplitude of the pulses fairly large, so that the pulses travel all the way down the spring (and back) without being destroyed by friction with the floor.) Picture sequence required in addition to word explanation.

3. If two pulses of equal size meet while traveling in opposite directions but starting on the same side of the spring, what happens? Do they reflect off of each other or do they pass through each other? What do they look like when they overlap one another? Picture sequence required in addition to word explanation.

4. If two pulses of equal size collide meet traveling in opposite directions and starting on opposite sides of the spring, what happens? What do they look like when they overlap one another? Picture sequence required in addition to word explanation.

5. Does the speed of a pulse depend on the size of the pulse? How would you decide?—describe your technique, record any data, draw conclusions.

PART B: This part is an investigation of how speed and tension are related.

Method B: Two people will stretch and hold a long skinny spring on the floor about 4 meters apart between ends. You can tighten the spring by pulling coils towards you, but DO NOT change the distance between ends—keep it at 4 meters.

We will now determine if the speed of a pulse depends on the spring tension. Using your spring scale to hold the stationary end, measure both the pulse speed and the tension. Vary the tension by letting more or fewer coils into the spring, again WITHOUT changing the length of the spring between partners; try at least 5 different spring tensions—but not so loose that the pulses die immediately. Be sure to time each pulse for as long as possible—that is for as many trips between the ends as you can see the pulse.

Using your calculator, make a data table and plot Pulse Speed vs. Tension. Is the graph linear? Is it increasing? Do a power fit? Report your graph and fit. What mathematical shape does the book say this graph should have ? What specific things might cause your data to give the wrong result?

(Note: by keeping the length of the spring constant, the linear density of the spring should stay nearly constant as long as we do not greatly change the number of coils of the spring)

PART C: This part is an investigation of how speed, frequency, and wavelength are related.

Method C: Again, two people will stretch and hold the long skinny spring (same spring as in part B) on the floor about 4 meters apart between ends. You can tighten the spring by pulling coils towards you, but DO NOT change the distance between ends—keep it at 4 meters.

A person at one end should now make *periodic* transverse pulses. The pulses created by this person will travel down the spring, reflect off the tightly held other end, and then these reflected pulses will interact with pulses coming directly from the wiggling end. Adjust the *frequency* of the pulses until a stable pattern is created with the *wavelength* of the created pattern at about 4 meters—in other words, you will get a stable repeating wave pattern where you can see one full waveform between the ends in every "snapshot" of the spring motion.

1. When you have mastered creating this waveform, measure the frequency of the pulses that are creating the wave which is also the frequency of the wave itself. How will you best measure this frequency?—describe your technique and record all data clearly.

2. Using your observed frequency and wavelength, calculate the speed of the periodic pulses. How does your calculated speed compare (% diff.) with the speed determined by the graph you made in part B?

CONCLUSIONS/SUMMARY