Slinky Lab

Introduction:

A slinky is just a large spring. It can be used to study the properties of waves. In this lab, a slinky will be the medium of travel for both transverse and longitudinal waves.

Science Vocab:

wave: disturbance that carries energy without transferring matter (sound, light, water waves)
medium: material a wave travels through (air, water, spring)
pulse: a single disturbance
reflect: to bounce back (echo)
wavelength: width of a pulse
free-end termination: when a wave hits a barrier that allows the medium to move
fixed-end termination: when a wave hits a barrier that prevents the medium from moving
amplitude: size (height) of a pulse
interference: addition of two waves

Objectives

-Learn about the behavior of transverse and longitudinal pulses
-Determine how waves interfere with each other
-Discover the affects of free-end and fixed end termination

Procedure:

1. Transverse pulse

Place a slinky on a smooth floor and stretch it between two people. Do not stretch it too far. Station group partners at each end of the slinky to hold it securely in position while stretched. Station one group member to observe the pulses from above the slikly.
CAUTION: *Avoid releasing an end of the stretches spring; the untangling process can be very difficult. Do not strech the slinky to a point where it could potentially be bent out of shape.*
With the ends of the stretched slinky held rigidly in place, form a pulse by grasping a loop near one end of the spring and move it quickly (within a fraction of a second) out and then back to the position it started. Use only one back and forth (out and back) motion. The pulse should travel down only one side of the spring and its wavelength needs to be relatively short. Make a statement about the transverse pulse, relating the motion of the separate coils of the spring to the motion of the pulse. (1a)

Figure 1:
Sending a
transverse pulse

The coil spring is the medium through which the pulse travels. Send a short pulse down the spring. Observe the shape of the pulse as it moves along the spring. Why would the pulse decrease in amplitude? Upon what does the initial amplitude of the pulse depend? Does the speed of the pulse appear to change as it's amplitude decreases? You can change the pulse speed by making the slinky more or less stretched (1b)

Generate single pulses of different amplitudes. Does the pulse speed appear to depend on the size of the pulse? (1c)

Stretch the slinky further and send more pulses. Is the speed affected by the tension? How? (1d)

What about the physical motion of your hand causes a change in the wavelength of the pulse? (1e

Generate single pulses from opposite ends of the stretched slinky at the same time. Observe the way they meet and pass through each other. Send two pulses of approximately equal amplitudes toward each other with displacements on the same side of the spring. Have a third member of your group locate the place the two pulses meet. (They must meet each other before either one reaches the other side. This will require group members to coordinate and send identical pulses at exactly the same time. Remember to make very fast motion out and back with your hand.) Describe the interference as they pass through each other. How does the pulse amplitude during interference compare with the individual amplitudes before and after superposition? (1f)

Figure 2:
Same side
interference

Repeat the last step, but with the two pulses traveling on opposite sides of the spring. Compare the interference with that of the previous trial. Observe the region of interference closely to see if there is a point on the spring that does not move very much during interference. What conclusions can you draw about the displacement of the medium at a point where two pulses interfere? (1g)

Figure 3: Opposite side interference

With the far end of the slinky held firmly in place (fixed-end termination), send a single pulse down one side of the spring. Observe the reflected pulse. Compare its amplitude with that of the original pulse. How is it different? (1h)

Figure 4: Fixed-end termination

Attach a light string to the far end of the slinky and maintain the tension on the spring by holding the end of the string. This approximates a free-end termination for the slinky. Send a pulse down one side of the spring as before and observe the pulse reflected from the “free” end. Compare reflection from the “free” end of the spring with reflection from the fixed end. (1i)

Figure 5: Free-end termination

2. Longitudinal pulse

Stretch the slinky and ensure that the far end is held firmly against the floor by a partner. While holding your end of the spring securely, release one coil from your hand allowing it to "push" the other un-held coils. **CAUTION:** ***Do not let go of the end of the slinky***. Observe the pulse that travels back and forth through the spring. Why is it called a longitudinal pulse? Make a statement about a longitudinal pulse, relating the motion of the separate coils of the spring to the motion of the pulse. (2)

Figure 6: Longitudinal Pulse

3. Periodic and Standing Waves

While still holding one end fixed, send transverse waves from the other end in a periodic fashion, so the slinky looks like a few oscillations of a sinusoidal curve. Move your hand back and forth repeatedly a two times. Stop before they get to the other side. What happens when these waves hit the fixed end boundary? (3a)

Figure 7: Periodic Wave

If you send waves so that the reflected waves are in phase with your original waves, you will achieve a standing wave. This will happen if the length of the slinky is some multiple of the wavelength of individual waves. Send a continuous periodic wave at a constant frequency. Try to create a standing wave. Why is it called a standing wave? Is the wave actually "standing" or moving?(3b)

Write up: On your own piece of paper, write answers IN COMPLETE SENTENCES for 1a-i 2 and 3a-b.