

LAB 23, PULSES ON SPRINGS

Name _____ Period _____

The Slinky is a large "soft" spring, edge wound of flat wire, that transmits a pulse slowly enough to be observed with relative ease. When a heavy metal spring is attached to the end of the Slinky, the energy of a traveling pulse is partly reflected at the junction and partly transmitted across the junction. The inertia of the heavy spring is greater than that of the Slinky. Thus, at the junction of the two springs, the Slinky has a relatively fixed-end termination while the heavy spring has a relatively free-end termination.

OBJECTIVE: After completing this experiment, in which the behavior of transverse and longitudinal pulses on a stretched coil spring are observed, you should have gained an understanding of the effects that free end and fixed-end terminations of the transmission medium have on the traveling pulse.

PROCEDURE: *There are 35 questions to be answered as the lab is performed.*

A. Transverse pulse:

Place a large, light spring (a Slinky) on a smooth floor and stretch it to a length of approximately 8 m. (Suggestion: Mark one end position on the floor with chalk and mark other positions 6 m, 8 m, 10 m, and 12 m away.

Determine the best stretch distance for your coil by experiment **being careful not to exceed the stretch limit of the spring being used.** Station group partners at each end of the Slinky to hold it securely in position while it is stretched.

CAUTION: *Avoid releasing an end of the stretched spring! The untangling process can be very difficult !!*

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 displacing it to one side by a quick back-and-forth motion of the hand. Practice this motion until a pulse can be formed that travels down only one side of the spring.

1. Why is the pulse called a transverse pulse?

2. Make a statement about a transverse pulse, relating the motion of the separate coils of the spring to the path traversed by the pulse.

3. Observation.

The coil spring is the medium through which the pulse travels. Send a short pulse down the spring.

4. Observe the shape of the pulse as it moves along the spring.

5. How does the shape change?

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6. Can you suggest a reason?

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7. Upon what does the initial amplitude of the pulse depend?

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8. Does the speed of the pulse appear to change with its shape?

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Generate single pulses of different amplitudes.

9. Does the pulse speed appear to depend on the size of the pulse?

10. Observation.

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Measure the length of the stretched Slinky and the travel time of a pulse generated at one end. Assuming that the pulse speed remains unchanged after reflection, the time required for the pulse to make a few excursions back and forth along the spring could be measured.

11. Can you devise a way to check this assumption?

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12. Compute the speed of the traveling pulse.

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Change the tension in the Slinky and determine the pulse speed as before.

13. Is the speed of propagation through the spring affected by the tension?

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14. Does the stretched Slinky, under different tensions, represent the same or different transmitting media?

15. Observation.

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Generate single pulses simultaneously from opposite ends of the stretched Slinky.

16. Observe the way they meet and pass through each other.

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The superposing of the two pulses is called *interference*.

Send two pulses of approximately equal amplitudes toward each other on the same side of the spring.

17. Describe the interference as they pass through each other.

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18. How does the pulse amplitude during interference compare with the individual amplitudes before and after superposition?

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Repeat the experiment, but with the two pulses traveling on opposite sides of the spring.

19. Compare the interference with that of the previous trial.

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20. Observe the region of interference closely to see if there is a point on the spring that does not move appreciably during interference.

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21. What conclusions can you draw about the displacement of the medium at a point where two pulses interfere?

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22. Observation.

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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.

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23. Compare its amplitude with that of the transmitted pulse just before reflection.

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24. What is its phase relative to the transmitted pulse?

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Attach a light string about 2 m long 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.

25. Observation.

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26. Compare reflection from the "free" end of the spring with reflection from the fixed end. Observation.

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Investigate the transfer of a pulse from one medium to another by attaching a heavy metal spring of about 2 cm diameter to the end of the Slinky.

27. Would you expect the pulse speed to remain the same in both sections of the stretched combination?

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To the extent that the second spring produces an impedance mismatch at its junction with the Slinky, the pulse energy arriving at the junction will be partly reflected and partly transmitted.

Send a single pulse down the stretched combination, first from one end and then the other.

28. Observe what happens when each pulse reaches the junction of the two springs.

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29. How does the speed of propagation in the heavy spring compare with that in the Slinky?

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Send a pulse down one side of the Slinky toward the junction and observe the relative phase of the pulse reflected at the junction.

30. Observation.

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Similarly determine the relative phase of the pulse transferred across the junction to the heavy spring. Repeat these phase observations for a pulse sent down the heavy spring toward the junction.

31. If the difference in pulse speeds in the two springs was greater, how would you expect the relative portions of the pulses energy reflected and transmitted at the junction to be affected?

32. Summarize your observations of the reflection of pulses from the junction of two media in which they have different speeds.

B.. Longitudinal pulse:

With the heavy metal spring removed, stretch the Slinky as before and ensure that the far end is held firmly against the floor by a partner. While holding your end of the spring securely, pull about 0.5 m of stretched spring together toward the end with your free hand and release it. *CAUTION: Do not let go of the end of the Slinky!!*

33. Observe the pulse that travels back and forth through the spring.

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34. Why is it called a longitudinal pulse?

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35. Make a statement about a longitudinal pulse, relating the motion of the separate coils of the spring to the path traversed by the pulse. Observation.

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CRITIQUE: