Lab - Slinky Waves

In this experiment you will use a long slinky to investigate various properties of waves.

Part I: Transverse and Longitudinal Waves

Stretch the slinky to a length of approximately 10 – 15 feet on the lab bench or the floor. Have one partner hold one end of the slinky still while the other partner generates the waves.

1. Create a ***transverse pulse*** at one end of the slinky by quickly moving your hand back and forth once, in a direction perpendicular to the length of the slinky. In the space below, sketch a "snapshot" of the slinky as seen from overhead.

2. Now move your hand back and forth continuously to generate a ***continuous transverse wave***. Again, sketch what you see from an overhead view of the slinky. Underneath the slinky sketch, draw a single arrow indicating the direction of travel of the wave. On the slinky, draw a double arrow (two pointed ends) indicating the axis of motion of a point on the slinky as the wave passes through. Last, draw two line segments (no arrows) indicating on the diagram the distance that corresponds to the ***wavelength*** and the ***amplitude*** of the wave.

3. Generate a ***longitudinal pulse*** by moving your hand back and forth in a direction that is parallel to the length of the slinky. Again, sketch a "snapshot" of the slinky as seen from overhead. If you're having a hard time communicating through just pictures, you can supplement your drawing with words.

4. Generate a continuous longitudinal wave and sketch a snapshot of the slinky as seen from overhead. Underneath the slinky sketch, draw a single arrow indicating the direction of travel of the wave. On the slinky, draw a double arrow (two pointed ends) indicating the axis of motion of a single Slinkon molecule (you remember those from Chemistry, right?). Draw a line segment (no arrows) indicating on the diagram the distance that corresponds to the ***wavelength*** of the wave.

<u>Part II: Wave Velocity</u>

5. Generate two nearly identical pulses, one right after the other.

   a) Does the distance between them change as they move along the slinky?

   b) What does this tell you about wave speed along the slinky?

6. Generate two pulses close together, one with greater ***amplitude*** than the other.

   a) What do you observe?

   b) What does this show about the relationship between wave speed and ***amplitude***?

7. Generate two pulses close together, but one with a greater ***wavelength*** than the other

   a) How do you need to move your hand in order to generate a pulse with a greater wavelength (compared to one with a smaller wavelength)?

   b) Does the greater wavelength pulse travel faster, slower, or the same speed as the smaller wavelength pulse?

8. Stretch the slinky out to a greater length and/or take up a few of the links, so that the slinky is under greater ***tension*** than it was before. Doing this also changes the ***linear density*** (mass/length) of the slinky (makes it smaller). Try sending a few pulses along the slinky and see if you can observe whether the waves travel faster, slower, or the same speed compared with the less tight slinky. Describe your findings.

9. In summary, what factors <u>do</u> and <u>do not</u> appear to affect the velocity of waves along a slinky?

10. Now, put the slinky back the way it was and generate a continuous wave along the slinky. When you shake your hand back and forth faster, what happens to

    a) the frequency of the waves?

    b) the wavelength of the waves?

    c) the speed of the waves?

Part III: Wave Behavior

Reflection

11. Have one partner hold the end of the slinky still while the other partner generates a large amplitude pulse. Observe the ***reflection*** of this pulse from the ***fixed end***, and sketch what you see. (You will need to draw two pictures: "before" and "after.")

12. What properties of the pulse reflected off the fixed end are
    a) the same as the incident pulse?

    b) different than the incident pulse?

13. Have one partner climb up on the lab bench and dangle the slinky so that it comes close to but does not touch the floor. Generate a transverse pulse at the top of the slinky and try and observe the reflected pulse as it comes back up the slinky. Is the reflection inverted this time? Sketch "before" and "after" pictures.

Interference

14. Put the slinky back up on the lab bench (or back on the floor) and have each partner simultaneously generate identical transverse pulses (same amplitude, same direction) from their respective ends of the slinky. Observe the ***constructive interference*** that takes place when the two pulses meet and sketch what you see (now you need three pictures: "before," "during," and "after").

15. Repeat #14, but this time create pulses in opposite directions (crest meeting trough). ***Destructive interference*** is very hard to observe in real time, but give it a try, and sketch. If you can't really see what is happening because it is too fast, perhaps you can reason conceptually what <u>must</u> be happening. Sketch what you see and/or think is happening "before," "during," and "after" the oppositely directed pulses meet.

16. Return the slinky to your instructor. If there is time, try generating some "***standing waves***" using one of the long narrow springs (ask your instructor). MAKE SURE THAT YOU HAVE PLENTY OF SPACE! Both partners can try shaking their ends of the slinky at the same frequency, or one partner can do the shaking while the other partner holds their end still, serving as a fixed point for reflection.

In a ***standing wave***, the waves coming from each side of the slinky interfere in such a way that there are certain points along the slinky that stay virtually still and other points which move maximally. These are called ***nodes*** and ***antinodes***, respectively.

17. Sketch any ***standing wave*** patterns that you are able to produce, labeling the nodes and antinodes.

18. Can you generate a standing wave at any shaking frequency? Explain.

19. What type of interference is taking place at the ***nodes***? At the ***antinodes***?