**Slinky Waves Lab**

**Purpose/Question:**

The purpose of this lab is to observe properties of mechanical waves on a Slinky:

1) **types** of mechanical waves – what is the difference between them?

2) **wave speed** - what does it depend upon?

3) **wavelength and frequency** - how are they related?

4) **interference** - how will two wave pulses interact?

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**Experimental:**

**WARNING:**

THESE ARE NOT TRADITIONAL SLINKIES AND CAN BE DAMAGED EASILY.

NEVER HOLD THE SLINKEY UP IN THE AIR. SLINKLIES MUST ALWAYS STAY IN A STRAIGHT LINE AND FAR AWAY FROM OTHER SLINKLIES.

**Materials:**

● Slinky

● Stopwatch

● Meter-stick

● Tape

● String

**Procedure:**

**For the following steps, you should both EXPLAIN and DRAW what you see. Remember to make your drawings as detailed as possible, and label clearly. ALL YOUR OBSERVATIONS SHOULD BE WRITTEN IN COMPLETE SENTENCES.**

**Particle Motion in Different Types of waves:**

**A) Transverse:**

**1.** Have your partner hold one end of the slinky and stretch it along a smooth floor until it is about 2.5 m long.

**2.** One person should send **a pulse** down the spring by jerking the spring to the **right and back to center**. Do this very fast, to make the pulse as short as possible, but try not to overshoot when you bring your hand back to the center. The pulse should be only on one side:

**3.** **Sketch** a pulse moving along the slinky. Use an arrow to indicate the **direction of pulse** – energy motion. Also note the **direction of the particle** (the actual springs) motion on your drawing. **Describe** the motion of the pulse and the particle.

**B) Longitudinal:**

**4.** Hold one end of the slinky and push your arm forward and back, like a piston. Do this as quickly as possible; try **not** to get any side-to-side motion.

**5.** **Draw** and **describe** the motion of the pulse and the particle.

**a) Transverse (S-wave):**

Diagram of wave: Description:

**b) Longitudinal (P-wave):**

Diagram of wave: Description:

How is this longitudinal wave different from a transverse wave?

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**2) wave speed:** **What type of wave travels faster?**

**1.** Stretch out the spring under moderate tension (5 m long).

**2.** Measure the time it takes for a small amplitude (about 30 cm) **transverse** wave pulse to travel from end of the spring and back. Perform 3 trials.

**3.** Calculate the speed of the wave pulse in each trial and record in the table. **[speed = distance/time]**

**4.** Repeat the above steps 2 and 3 with a large amplitude (twice the small amplitude ~ 60 cm) wave pulse.

**5.** Make a **longitudinal** wave pulse and measure the time it takes to the end of the spring and back. Perform 3 trials.

**6.** Calculate the speed of the wave pulse in each trial and record in the table.

**a) Transverse:**

**Table 1**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Amplitude**  **(m)** | | **Length of slinky**  **(m)** | **Time**  **(forward-and-back)**  **(s)** | **Speed**  **(m/s)** | **Average Speed**  **(m/s)** |
| Small  **30cm** | Trial 1 | **5 m** |  |  |  |
| Trial 2 |  |  |
| Trial 3 |  |  |
| Large  **60cm** | Trial 1 | **5 m** |  |  |  |
| Trial 2 |  |  |
| Trial 3 |  |  |

Compare the pulse (wave) speeds of different amplitudes. Is there a significant difference in the speed of the pulse? Discuss your observations and calculations.

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**b) Longitudinal:**

**Table 3**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Length of slinky**  **(m)** | **Trial #** | **Time**  **(forward-and-back)**  **(s)** | **Speed**  **(m/s)** | **Average Speed**  **(m/s)** |
| **5.0 m** | Trial 1 |  |  |  |
| Trial 2 |  |  |
| Trial 3 |  |  |

Which wave is faster? Why do you think this type of wave should be faster? Discuss your observations and calculations.

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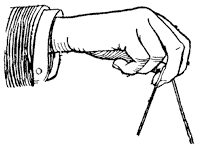
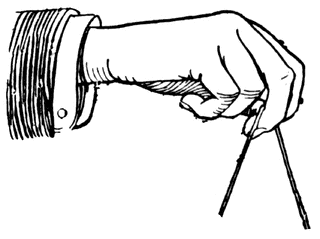
**wavelength and frequency: How are they related?**

**2.** Shake the spring repetitively up and down on the ground to generate transverse wave trains in the spring.

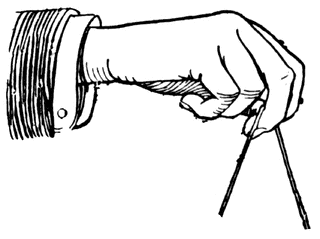
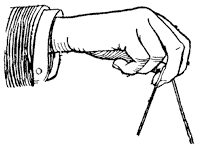
**3.** Move your hand slowly, then faster, and **observe** the wavelengths of the waves. (The wavelength of a wave in the spring is the distance from a crest on one side of the spring to the next crest on the same side. The frequency of the wave is the same as the frequency at which you shake the spring.)

**4.** **Draw and label λ and *f*.**

*Lower frequency:*



*Higher frequency:*



When you increase the frequency, what happens to the wavelength?

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Two physics students are sitting on the side of a pool. Bill taps his foot once every two seconds. Jane taps her foot into the water once each second. Water waves travel through the water away from their feet. Show work!

a) Find the wave frequency produced by Bill. Find the wave frequency produced by Jane.

b) What is the period of each wave produced by Bill? By Jane?

c) How will the two wavelengths compare? Explain and **draw** for Bill and Jane.

d) How will the speeds of the two waves compare? Try to Solve for real numbers!

**Interference of waves: How will two wave pulses interact?**

**1.** Have your partner grasp one end of the spring while you grasp the other end. **Practice** sending pulses toward each other **at the same time** - hold on tight to the slinky!

**2.** Observe the pulses when they come together and also after they pass through each other. Try pulses both on one side of the spring ("in phase") and then one on one side and one on the other ("opposite phase").   
  
**3. Draw** and **describe** what happens to the amplitude when two pulses in phase meet.

**4.** **Draw** and **describe** what happens to the amplitude when two pulses in opposite phase meet.

**a) Two pulses in phase meet:**

|  |  |  |
| --- | --- | --- |
| Before | Waves meet | After |

**b) Two pulses in opposite phase meet:**

|  |  |  |
| --- | --- | --- |
| Before | Waves meet | After |