**WAVES ON A SLINKY**

*Key Goal:* Students will gain a greater understanding of wave motion and what determines the speed of a wave.

**Objectives**: Students will complete a laboratory report on wave motion and what determines the speed of a wave with 80% accuracy.

**Alabama Course of Study:**

 9. Compare methods of energy transfer by mechanical and electromagnetic waves.

* Distinguishing between transverse and longitudinal mechanical waves
* Relating physical properties of sound and light to wave characteristics

Examples: loudness to amplitude, pitch to frequency, color to wavelength and frequency

Besides being a fun toy, a slinky can be used to study many aspects of wave motion. In this activity, you and a partner will hold a slinky at each end, stretched out some but not too much. Observe how a wave moves down the slinky when you shake one end of it. Notice also that if your partner holds her end tightly, the wave will reflect back to you.

**Exploration**

The first thing for you to do is measure the speed of a wave on a slinky, and investigate how you can change that speed. Before we start, we ask you to think about what determines the speed of a wave.

**Exploration – Phase 1 Engage and Explore**

**Engage**

1. Predict how you might increase the speed of a wave by changing the tension (tightness of stretch) of your slinky.

 2. Predict what might happen to the speed of the wave if you shake your end back and forth more rapidly (at a higher frequency).

3. Finally, predict how the speed might change if you had a slinky made out of lighter material.

**Explore**

Now you are going to actually measure the speed. You’ll need the third member of your team to be the timer. Your GLX has a stopwatch feature that you can use. Measure the time it takes for a pulse to go from you to your partner and back. Try this for high frequency waves and for low frequency waves.

The speed is the total distance gone divided by the time. Do you find a difference between the two wave speeds?

Now test your prediction of how the speed might change when the slinky tension changes. Were you right?

Now try making some standing waves. Here are some pictures of standing waves on a rope. The standing wave on the left has one “loop,”, and the others have 2 loops, 3 loops, and 4 loops. Two loops make a distance called the wavelength. See if you can produce these 4 standing waves with your slinky.



**Invention**

**Invention – Phase 2 Explain**

**Explain**

Since two loops equal one wavelength, one loop is only half a wavelength, 3 loops is 1 ½ wavelengths, and 4 loops are 2 wavelengths. So if the length of the rope in the picture is L, what are the wavelengths of the 4 standing waves? We’ll fill in one of the blanks for you.

1 loop: wavelength = \_\_\_\_

2 loops: wavelength = L

3 loops: wavelength = \_\_\_\_

4 loops: wavelength = \_\_\_\_

Investigation: measure the speed of waves on the slinky by timing the period T. This is the time it takes for a part of the slinky to go from its highest point to the lowest point and back to the highest. Since you will be generating these waves by shaking your hand up and down, the period will be the time for your hand to go from top to bottom and back to top again. Have team member 3 use the stopwatch to measure the period of each standing wave that you make…from 1 loop to 4 loops. Calculate the speed of the waves using:

speed = wavelength/period.

Do you find that all 4 waves have the same speed? How does this speed compare to what you measured in the exploration?

**Expansion**

**Expansion Phase 3 – Elaborate and Evaluate**

**Elaborate**

Here’s another way to measure the wavelength: take a snapshot. Make a scale on the chalkboard (or whiteboard) and create a standing wave in front of it. Take a picture with a cell phone or other camera, and use the scale to estimate the length of one loop. Remember that one loop is only half a wavelength, so multiply by two to get the actual wavelength.

**Evaluate:** Students will prepare a laboratory report for all experiments in the 5E lesson. Use the *Experimental Design and Report Requirements* to evaluate student laboratory reports.

**Experimental Design and Report Requirements**

4 – Excellent, all items included, clear, concise, accurate

3 – Good, most items included, generally clear, concise, accurate

2 – Average, half items included, some points not clear, concise, accurate

1 – Poor, less than half required items included, most points are not clear, concise or accurate

0 – Required items not included, most points are incoherent and do not represent currently accepted scientific thought

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Score** |  |  | **Score** |
| **Title** | Adequately represents experiment, succinct |  | **Results** | Data is organized in charts, graphs, or other appropriate forms |  |
| **Problem or Question** | Clearly Stated |  | Data collected is appropriate for the problem and hypotheses |  |
| Complete and appropriate |  | Number of trials is adequate |  |
| Creative, unique or appropriate |  | Appropriate sampling |  |
| **Hypotheses** | Stated in such a way that it is testable |  | **Tables (part of results section)** | Includes title |  |
| Multiple hypotheses identified |  | Label columns and rows |  |
| Appropriate and clear |  | **Graphs (part of results section)** | Includes title, label axes, accurately space numbers |  |
| **Variables** | Correctly identified |  | Use separate graph paper, computer or hand-held generated graph |  |
| Independent – well written, appropriate |  | Place independent and dependent variables on correct axes |  |
| Dependent – well written, appropriate |  | **Diagrams (part of results section)** | Adequately represents results, clear, concise |  |
| Controls – well written, appropriate |  | **Conclusions** | Clear statement of acceptance/rejection of hypotheses |  |
| **Procedures** | Stated clearly, succinctly and in appropriate sequence |  | No extraneous statements or information included. Clean, succinct explanations. |  |
| Show a depth and rational of strategies needed to conduct a fair test |  | Explanations and interpretations are accurate and complete |  |
| Shows creative or unique strategies |  | Explanations make exceptional connections to current scientific thought |  |
| Can be followed and repeated |  | Provides suggestions for improvement in the design and further experimentation |  |
| Appropriate for the question and hypotheses |  | Discusses critical flaws in the design (operational definitions, or procedures etc,) |  |
| Repeated trials included |  | **Grammar, structural, spelling** | Report in general is well written with few grammar, structural or spelling errors |  |
| Flow chart included, appropriately outlines procedures, diagrams included as appropriate |  | Standard English |  |
| **Background** | Background information clear, concise, accurate |  | Avoids first-person personal pronouns |  |