**And then Lab 13: Standing Waves on a String**

In the study of sound waves, one’s attention is immediately directed to the musical instruments that produce the different pitches that are the familiar notes of the musical scale. Regardless of the type of instrument, the production of a pitch is based on the resonance that is created when a sound travels back and forth between two boundaries set up by the instrument. In this experiment, these boundaries will be solid, much like the bridges found at opposite ends of the finger board on a guitar. In this case, when a string is plucked, the energy travels down the string in both directions. When the pulse hits the ends, where the bridges are located, the pulse flips over and returns. This is on account of Newton’s 3rd law. The pulse pulls up on the bridge and the bridge pulls down on the pulse. Being much less massive than the body upon which the string is attached, one notices the pulse flip over and travel in the opposite direction (has a large acceleration), while the massive structure appears motionless (not actually true but the acceleration is so small, you cannot see the effect unless you isolate it. With the two waves traveling in the opposite direction, a standing wave will be produced if the movement of the waves are synchronized and is called resonance. This synchronization will be studied in this lab.

In preparation for class, consider this question: What kind of measurements can be made that would explore the nature of a wave moving back and forth between two rigid barriers (see the Procedure section for an illustration of the experimental setup)?

**Read through this document. There is a pre-lab Discussion Question on LoudCloud pertaining to your reading. It is due by midnight, the night before the lab is conducted.**

**Review section 16.10 prior to class.**

**Learning Objectives:**

* Examine how tension, mass density, and resonance affect the production of a standing wave.
* Analyze the results in the context of the superposition of waves and the condition that nodes occur at the boundaries of the medium.

1. **Testable Questions:**

Brainstorm to develop an experiment that will test possible variables that will create a standing wave. You will be collecting and analyzing data for two questions.

1. **Hypothesis:**

Prepare on your own.

1. **Variables:**
2. **Controls:**

**Independent:**

**Dependent:**

1. **Controls:**

**Independent:**

**Dependent:**

1. **Table Design:**

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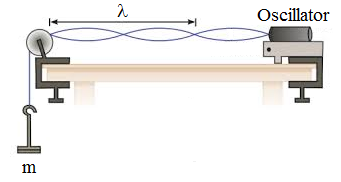
1. **Materials:**

Bullet list the materials used, but do not include paper and pencil.

1. **Procedures:**

Clearly describe the steps so an absent classmate can follow them.

**Set up:**

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* Be sure to record the tension in the string (g = 9.81m/s2) and the mass density of the string you will be using. A cent-o-gram balance will produce the largest number of significant figures (Make sure it is zeroed). If you work with another team or as an entire class, the string can be weighed together to gain more precision. This will also create more significant figures (Why is this?)
* The second experiment will require a calculation to get the speed of the wave. Examine the results of the first experiment to determine the equation or look on your equation sheet.
* The generator may not produce waves with a sizeable amplitude. If this is the case, you can put paper alongside the string, which will produce more contrast and an easier measurement.




2. **Data:**
3. **Analysis:**

Make graph(s) as usual. If the initial graph does not yield a straight line, then use the *Graphical Analysis* reference file to determine how to manipulate the x-axis for a second graph.

1. **Conclusion:**

Use the *Graphical Analysis* reference file to identify the relationships found in each experiment, and write two separate statements, and be sure to include the equations from each graph.

1. **Evaluation:**

Be sure to include each of the following. No need for bullet points – a single paragraph is expected (see the *Lab Report Format* document for guidance).

* First, you must address if your hypothesis is supported or not. Be specific when describing how the dependent variable is affected when the independent variable is increased, now that there is an equation describing the relationship.
* Describe the level of accuracy (% error less than 5% is excellent) and then provide a possible and reasonable source of systematic error to explain an inaccuracy in the experiment. It should be a reason why the measured value is less than or greater than the theoretical value.
* Describe the level of precision (R2 value greater than 0.985 is good to excellent) and then provide a possible and reasonable source of random error to explain an imprecision in the experiment. It should be a reason why there are fluctuations in the data set that cause the values to be unpredictably high or low.
* Keep each evaluation separate and discuss accuracy/systematic error first. Also, outliers are not experimental errors. They are mistakes that should be corrected as they arise.

The report should be submitted in the “Lab 13: *“Standing Waves on a String*” drop box in LoudCloud as directed by your instructor.