Laboratory 13-2

Waves on a String (Inquiry Based)

The local string and pulley company has recently contacted our science department with a problem. They claim that when their strings are placed over their pulleys and then weighted down, certain vibrations on the string start to oscillate with greater amplitude. They have named these oscillations standing waves in the string appear to stand still. Because the strings start to oscillate at greater frequencies, the company is concerned that nearby strings oscillating may collide and become knotted. Therefore the company has asked us to identify an equation to determine the frequencies in which their 2 main string types oscillated with 4.9N and 9.8N of tension on the string.

The company has also asked that we come up with an equation to predict future waves for the string. Through many interviews with workers at the string and pulley company we have been able to identify a few factors that might come into play with these phenomena. These factors are the strings length, the frequency the string is oscillating at, the amplitude of the wave, the strings mass density, the tension on the string, the amount of light in the room, and the angle at which the wave is moving in reference to the desk.

Using the following equipment, plus additional equipment you request from your laboratory instructor determine an equation to predict the frequencies at which standing waves will occur for both string provided with a tension of 4.9N and 9.8N

Then determine which factor above effect the standing waves at the frequencies you have predicted. (This means an equation that solves for frequency)

Finally find a universal equation that combines the factors above. You may need to graph with excel the relationship of these factors versus frequency to determine whether the factors are linear, inverse, direct squared, direct square root, or any of the other functions found at http://www.croomphysics.com/assignment/phys/chapter1/Types_of_Equations.pdf. Remember these graphs show you the relationship the factor has to the frequency. When you are done be prepared to defend your results. Other teams are also competing for the recognition of being the first to find this answer.

To make your life easier, the company has forwarded all of their research about this topic which can be found below.

Good Luck.

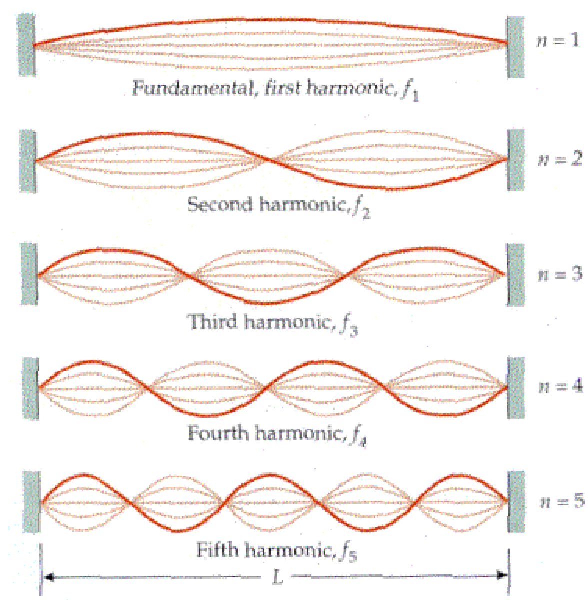
Name:____________________________ Date:_____________________________

Equipment List:

- *Science Workshop™ Interface*
- Power Amplifier
- Balance (for measuring mass)
- graphing program (such as Excel)
- Mass and Hanger Set
- meter stick
- (2) Patch Cords, banana plug
- Heavy String or twine, 20 meters
- Super Pulley
- Support Rod
- Table edge Clamp with smart pulley
- Wave Driver

Research

When a stretched string is plucked it will vibrate in its fundamental mode in a single segment with nodes on each end. If the string is driven at this fundamental frequency, a standing wave is formed. Standing waves also form if the string is driven at certain higher frequencies. These higher frequencies are called the harmonics.

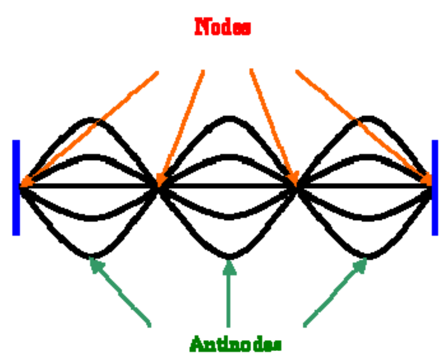


Each segment is equal to half a wavelength. In general for a given harmonic, the wavelength is shown by $\boxed{\lambda = 2L/n}$ where **L** is the length of the stretched string and **n** is the number of segments in the string.

The linear mass density of the string can be directly measured by weighing a known length of the string: $\mu = \text{mass}/\text{length}$

The velocity of any wave is given by where *f* is the frequency of the wave. For a stretched string:

$$v = \lambda f$$



The velocity of a wave traveling in a string is also dependent on the tension, **T**, in the string and the linear mass density, **μ**, of the string:

$$v = \sqrt{\frac{T}{\mu}}$$