VIBRATING STRING Remote Lab Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Watch the video of a vibrating string: <https://www.youtube.com/watch?v=cnH2ltfW48U>

Purpose: To investigate waves in a stretched string and determine the wave speed.

Theory: Stringed musical instruments are played by plucking or bowing a stretched string. In the first investigation a string vibrator will make the string to vibrate at a frequency of 6.0 Hz. The tension will be provided by a hanging mass. The vibrations will travel along the string and get reflected at the other end. The reflected waves and the incoming waves will interfere and form standing waves. By varying the tension, *T* standing waves with different number of loops can be obtained. The standing waves for two and three loops are shown below. Loop length is obtained by dividing the length of the vibrating string by the number of loops. Wavelength is twice the loop length.



A string, stretched between two clamps, is made to oscillate in standing wave patterns as shown below. Determine the loop length and wavelength for each of the oscillations in terms of *L*, the length of the vibrating string.

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  |  |
| Loop Length |  |  |  |
| Wavelength |  |  |  |

In terms of frequency, f and wavelength, λ the wave speed, *v* is given by:
 
In terms of tension, *T* and strings linear density, *μ* the wave speed, *v* is given by:
 
Linear Density: Linear density, *μ* is a property of the string which tells us whether the string is "heavy" or "light". You may know that the four violin strings are not the same. Some are thick and others are thin. The heavy strings are used for low frequency tones and the light ones are for high frequency tones.

Procedure: Open the simulator, and click begin
<http://www.thephysicsaviary.com/Physics/Programs/Labs/StandingWaves/index.html>

1. In the first part of the experiment, you will keep the frequency and tension constant, and change the linear density of the string.

Set the frequency to 6.0 Hz, by clicking on the circle below the frequency, and the string tension to 3 N, and click on the power. You can change the string linear density, and string tension by clicking on the vertical arrows. You can click on the power again to reset the simulation.

You can pause the oscillations, to measure the wavelength. You can also increase the amplitude of the signal by using the horizontal arrows. Measure the loop length (distance between two nodes) and wavelength (twice the loop length or distance between two crests) on the string by activating the grid, and fill the table below.
If you prefer, use Excel to construct this data table.

 $ \%Difference=\frac{\left|Difference\right|}{Average}x100$

Table I:

Frequency = 6 Hz, Tension = 3 N

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Linear density *μ (kg/m)* | Loop Length (m) | Wavelength, *λ (m)* | Wave Speed, *v* (m/s) | % Difference |
| Using *f* & λ | Using *T* & *μ*  |
| 0.1 |  |  |  |  |  |
| 0.2 |  |  |  |  |  |
| 0.3 |  |  |  |  |  |
| 0.4 |  |  |  |  |  |
| 0.5 |  |  |  |  |  |
| 0.6 |  |  |  |  |  |
| 0.7 |  |  |  |  |  |
| 0.8 |  |  |  |  |  |
| 0.9 |  |  |  |  |  |

1. In the second part of the experiment you will keep the linear density and the frequency constant, and change the tension of the string to obtain different modes of vibrations.

Procedure:

1. Go to the simulation: <https://ophysics.com/w8.html>

2. What you see is the resonance mode with maximum amplitude for 8 loops or 4 wavelengths.

Record these values in the third row of the data table below and complete the calculations for that row.

3. Change the tension (increasing the tension will reduce the number of loops) and obtain other resonance modes with maximum amplitude, just like you show when you opened the simulation.

For example, a tension of 89 N will give 6 loops or 3 wavelengths.

4. Record the values for all other modes and complete the data table.

DATA: Frequency = f = 125 Hz Linear Density = *μ* = 3.2 x 10-3 kg/m
 Length of the vibrating string = L = 4.0 m

Table II: For a particular # of loops, obtain resonance with the highest amplitude by changing the tension. If you prefer, use Excel to construct this data table.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| # of Loops | Loop length (m) | Wavelength, *λ* (m)  | Tension (N) | Wave Speed, *V* (m/s) | % Difference |
| Using *f* & λ | Using *T* & *μ*  |
| 6 |   |   |   |   |   |   |
| 7 |   |   |   |   |   |   |
| 8 |   |   |   |   |   |   |
| 9 |   |   |   |   |   |   |
| 10 |   |   |   |   |   |   |
| 11 |  |  |  |  |  |  |
| 12 |  |  |  |  |  |  |
| 13 |  |  |  |  |  |  |
| 14 |  |  |  |  |  |  |

Write an overall conclusion for the entire lab.