VIBRATING STRING Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Partners:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Course:\_\_\_\_\_\_\_\_\_\_\_\_\_ Time:\_\_\_\_\_\_\_\_\_\_\_

Read sections 16-6(p420) and 16-13(p433) in your text (HRW-9) and answer the following questions.

1. Express the speed of a wave, *v* in terms of frequency, *f* and wavelength, *λ*.

2. You cannot send a wave along a string unless the string is under \_\_\_\_\_\_\_\_\_\_\_.

3. In terms of tension, *T* and string’s linear density, *μ* the wave speed, *v* is given by:
 
Show that the above equation is correct, unit wise.

4. 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 |
|  |  |  |
|  |  |  |
|  |  |  |

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

Apparatus: String vibrator, clamp for string vibrator, string, mass set, mass hangers (50-g and 5-g), electronic balance (accuracy 0.01-g), meter stick, and pulley w/clamp.

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 60 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.



In terms of hanging mass, *m* and acceleration due to gravity, *g* tension, *T* is given by:
 

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 tones and the light ones are for high tones. In this investigation you will determine *μ*, by measuring the length and mass of the string before attaching it to the string vibrator, to 3 significant figures.

DATA: Use SI units

Total length of string = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Total mass of string = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Linear Density = *μ* = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Acceleration due to gravity = *g* = 9.8 m/s2

Length of the vibrating string = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Table I: For a particular # of loops, obtain resonance with the highest amplitude by changing the hanging mass.  Frequency = *f* = 60 Hz. If you prefer, use Excel to construct this data table.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| # of Loops | Loop length | Wavelength, *λ*  | Hanging mass, *m* | Tension,  | Wave Speed, *V* | % Difference |
| Using *f* & λ | Using *T* & *μ*  |
| 2 |   |   |   |   |   |   |   |
| 3 |   |   |   |   |   |   |   |
| 4 |   |   |   |   |   |   |   |
| 5 |   |   |   |   |   |   |   |
| 6 |   |   |   |   |   |   |   |

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

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Hanging Mass (kg) | Loop length | Wavelength, *λ*  | Frequency,f  | Tension,  | Wave Speed, *V* | % Difference |
| Using *f* & λ | Using *T* & *μ*  |
| 0.1 |   |   |   |   |   |   |   |
| 0.2 |   |   |   |   |   |   |   |
| 0.3 |   |   |   |   |   |   |   |
| 0.4 |   |   |   |   |   |   |   |
| 0.5 |   |   |   |   |   |   |   |
| 0.6 |   |   |   |   |   |   |   |

Questions/Problem:



Questions 1-3 deals with the wave shown below:

1. The amplitude of the wave in the figure is\_\_\_\_\_\_\_\_\_\_\_

2. The period is\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

3. The frequency of the wave is\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Problem 49, HRW Page 441:
A nylon guitar string has a linear density of 7.20 g/m and is under a tension of 150 N. The fixed supports are distance  apart. The string is oscillating in the standing wave pattern shown below. Calculate the (a) speed, (b) wavelength, and (c) frequency of the traveling waves whose superposition gives this standing wave.

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Conclusion: