SAN DIEGO MESA COLLEGE
PHYSICS 125 LAB REPORT

TITLE: **Waves on a String**

Name_________________________
Date __________**Time**___________
Partners ________________________
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Objective: To study the normal modes of oscillation of a stretched string.

Theory: Standing waves can be set up in a stretched string that is held fixed at both ends. These waves are also known as the normal modes.

The normal modes have well-defined frequencies and patterns of oscillation. Locations on the string that are not in motion other than the fixed ends are called nodes, while locations undergoing maximum oscillation are called antinodes. The patterns can be pictured as arising from fitting any number of half waves of a monochromatic wave within the length of the string. If the wavelength of the monochromatic wave is λ, the frequency of the mode can be obtained from the formula:

$$v = f\lambda \qquad (1)$$

where v is the velocity of waves on the string, and is given in terms of the tension T and mass per unit length μ of the string by the relation

$$v = \sqrt{\frac{T}{\mu}} \qquad (2)$$

The fundamental mode, also known as the first harmonic, has one antinode but no node. Thus one half wave is fitted into the string. Denoting by L the length of the string , we have

$$L = \frac{\lambda_1}{2} \qquad (3)$$

Similarly, the wavelengths of the second, third harmonics, etc. are given by

$$L = 2\frac{\lambda_2}{2}, \quad L = 3\frac{\lambda_3}{2}, \quad \cdots \qquad (4)$$

Solving Eqs.(3) and (4) for the wavelengths,

$$\lambda_1 = \frac{2L,}{1} \quad \lambda_2 = \frac{2L}{2}, \quad \lambda_3 = \frac{2L}{3}, \quad \cdots \qquad (7)$$

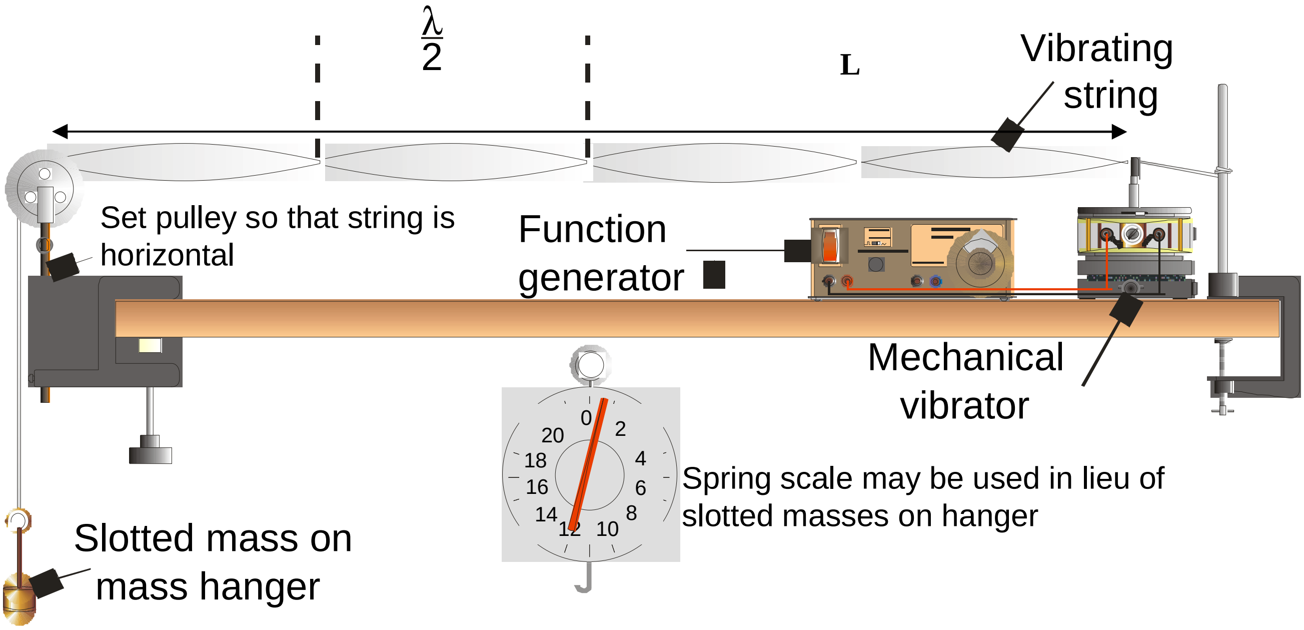
Using Eq.(1), the frequencies of these harmonics are therefore in the ratio

$$f_1 : f_{2:} : f_3 : \quad \cdots \quad = 1:2:3: \quad \cdots \qquad (8)$$

The purpose of the experiment is to verify Eqs. (2) and (8).

Equipment: Mechanical Vibrator, Pulley on table clamp, Table rod clamp, 20cm long threaded rod, Mass hanger, Slotted mass set, Function generator, digital multi-meter to read frequency to +/- 1Hz, two banana-to-banana leads (24"long), samples of different linear density strings (1.5m).

Procedure:



Procedure:

1. Weigh the string sample and measure its length $\mathcal{L}$ to calculate the mass per unit length.

2. Set up the apparatus as in the diagram above using the string sample. Load the mass hanger with a total mass of 1 kg, making sure the string is stretched out horizontally. This mass determines the tension on the string and will therefore affect the wave velocity and frequencies of the modes.

3. Turn on the frequency generator and slowly increase the frequency until the first harmonics is produced. Record the frequency as read on the digital meter.

4. Continue to increase the frequency to obtain a few more harmonics.

5. Calculate the speed of each standing wave using your measured value of λ and f.

6. Compare this calculated wave speed to the theoretical wave speed found from $v_{th} = \sqrt{\dfrac{T}{\mu}}$

Remember to use mks units and show all calculations.

Data: Mass of string sample M = __________

Entire Length of string sample $\mathcal{L}$ = ________________

Linear density of string μ = $\dfrac{mass\ of\ the\ entire\ piece\ of\ string}{length\ of\ the\ entire\ piece\ of\ string}$ =

Total Mass hanging on the string = ___________________

Tension in the string T =

Velocity of wave $v_{th} = \sqrt{\dfrac{T}{\mu}}$ =

Length of stretched string (**between pulley and fixed vibrating end**) $L =$ ______________

Harmonic Number	f (Hz)	λ (m) $\left(\lambda_n = \frac{2L}{n}\right)$	wave speed $v = f\lambda$ (m/s)	% difference: $\lvert(v - v_{th})/v_{th}\rvert \times 100$
1st				
2nd				
3rd				
4th				
5th				

Remember to use mks units and show all calculations.

The ratio of harmonic to fundamental frequencies are :

$\frac{f_2}{f_1} =$ $\frac{f_3}{f_1} =$ $\frac{f_4}{f_1} =$ $\frac{f_5}{f_1} =$

Conclusion and Summary of Results:

Write a brief conclusion, including a brief discussion of the physics involved in this experiment, including possible sources of error. State and summarize your numerical results and indicate whether these results give support or validate the purpose of the lab exercise.