Experiment 9: To determine the frequency of an electrically maintained tuning fork by Meldes experiment.

Equipment Required: Electrically maintained tuning fork, Clamp stand, pan, weight box, rheostat, key, connecting wire, meter rod.

Material Required: Thread

Learning Objectives: To understand the formation of standing waves in transverse and longitudinal waves and also study laws of string.

Formulae:-
Frequency of the tuning fork in the transverse mode of vibration

$$\eta = \frac{1}{2l}\sqrt{\frac{T}{m}}$$

Where ' l ' is the length of each loop. 'T' is the Tension applied as $T = (m_1+m_2)\, g$
where 'm_1' is the mass of the pan and 'm_2' is the load added to the pan and 'g' is acceleration due to gravity in cm/sec^2 . 'm' is the linear density of the thread.
where 'M' is mass of the thread and 'L' is the total length of the thread.

Frequency of the tuning fork in the longitudinal mode of vibration

$$\eta = \frac{1}{2l}\sqrt{\frac{T}{m}}$$

Where ' l ' is the length of each loop. 'T' is the Tension applied as $T = (m_1+m_2)g$
where 'm_1' is the mass of the pan and 'm_2' is the load added to the pan and 'g' is acceleration due to gravity in cm/sec^2,'m' is the linear density of the thread and 'M' is mass of the thread and 'L' is the total length of the thread.

Theory

Speed of waves in a stretched string: A string means a wire or a fiber which has a uniform diameter and is perfectly flexible. The speed of a wave in a flexible stretched string depends upon the tension in the string and mass per unit length of the string.

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

Where m= M/L as M is the mass of the string and L is the total length of the string.

Vibrations of a stretched string: When the wire is clamped to a rigid support, the transverse progressive waves travel towards each end of the wire. By the superposition of incident and reflected waves, transverse stationary waves are set up in the wire. Since ends of the wire are clamped, there is node N at each end and anti-node A in the middle as shown in Fig: 1.

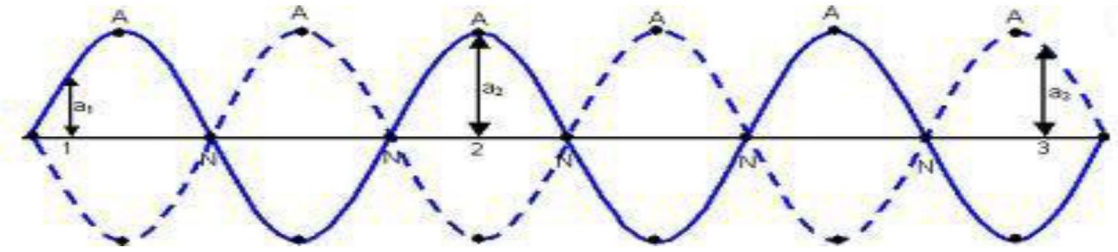


Fig:8. Pattern of nodes and antinodes in vibrating string.

The points of the medium which have no displacements called ***nodes*** and there are some points which vibrate with maximum amplitude called ***antinodes.***

The distance between two consecutive nodes is λ/2, (λ - wavelength). Because *l* is half a wavelength in the equations, *l* =λ/2, η is frequency of vibration of wire

$$\eta = \frac{v}{2l}$$

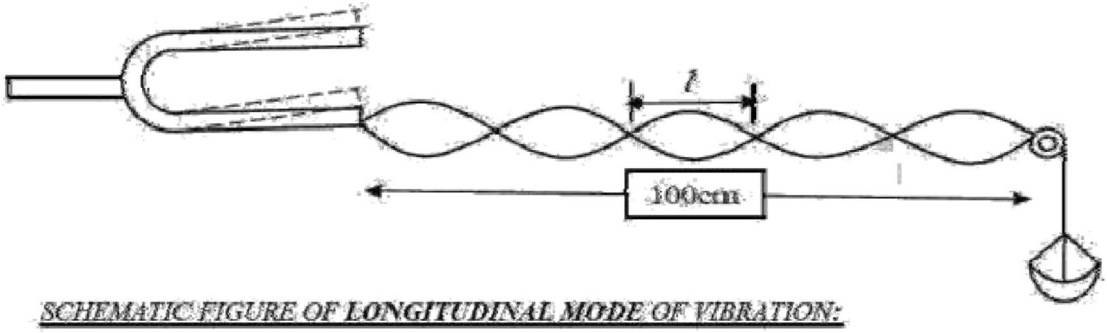
Substituting the value of ' *v* ' in equation

$$\eta = \frac{1}{2l}\sqrt{\frac{T}{m}}$$

Outline of the Procedure:

- A string can be set into vibrations by means of an electrically maintained tuning fork, thereby producing stationary waves due to reflection of waves at the pulley. The standing wave is formed between the pulley and the end of the string.

SCHEMATIC FIGURE OF TRANSVERSE MODE OF VIBRATION:



SCHEMATIC FIGURE OF LONGITUDINAL MODE OF VIBRATION:

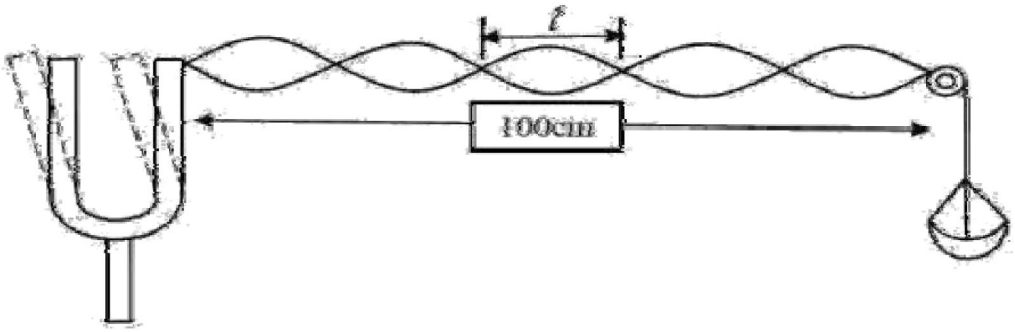


Fig.10. Different modes of vibration

- Find the weight of pan P and arrange the apparatus as shown in figure. Place a load of 4 To 5 gm in the pan attached to the end of the string passing over the pulley. Excite the tuning fork by switching on the power supply. Adjust the position of the pulley so that the string is set into resonant vibrations and well defined loops are obtained. If necessary, adjust the tensions by adding weights in the pan slowly and gradually. For finer adjustment, add milligram weight so that nodes are reduced to points.
- Measure the length of n loops formed in the middle part of the string. If 'L' is the distance in which n loops are formed, then distance between two consecutive nodes is L/n. Note down the weight placed in the pan and calculate the tension T.

  T= (wt. in the pan + wt. of pan) g.

- Repeat the experiment twine by changing the weight in the pan in steps of one gram and altering the position of the pulley each time to get well defined loops. Measure one meter length of the thread and find its mass to find the value of m, the mass per unit length.

Required Results: Find the frequency of tuning fork in transverse mode and also in longitudinal mode. Observe and discuss the difference between these arrangements.

Cautions:

The thread should be uniform and inextensible. Well defined loops should be obtained by adjusting the tension with milligram weights. The loops in the central part of the thread should be counted for measurement. The nodes at the tip of the prong and at the pulley should be neglected. Frictions in the pulley should be least possible.

Book suggested

1. B.Sc Practical Physics by C.L. Arora S.Chand Publication,19th edition(2010)

2. B.Sc Practical Physics by Harman Singh and Dr. P.S. Hemne, S.Chand Publication,1st edition(2011)

Websites: http://vlab.amrita.edu/?sub=1&brch=201&sim=882&cnt=1

Worksheet of the student

Date of Performance Registration Number:

Aim: : To determine the frequency of an electrically maintained tuning fork by Meldes experiment.

Observations:

Mass of Pan =

Mass of Thread =

Length of Thread =

Mass per unit Length of Thread (m) =

Mode of vibration	Sr. No.	No. Of loops (p)	Distance between extreme nodes (L)	Length of each loop L/p=l	Mass in the pan W	Tension T= (W+w)g	Frequency n
Transverse mode (A)	1						
	2						
	3						
	4						
Longitudinal mode (B)	1						
	2						
	3						
	4						

Calculations:

Result and Discussion:

Error Analysis

Learning Outcomes (what I have learnt):

To be filled in by Faculty

S. No.	Parameter	Marks obtained	Max. Marks
1	Understanding of the student about the procedure/apparatus.		20
2	Observations and analysis including learning outcomes		20
3	Completion of experiment, Discipline and Cleanliness		10
	Signature of Faculty	**Total marks obtained**	