Experiment No. 6 **Date:**

DETERMINATION OF THE FREQUENCY OF A.C. MAINS AND COMPARE THE MASS PER UNIT LENGTH OF THE TWO GIVEN WIRES.

APPARATUS REQUIRED:

a) Sonometer box b) Horse-Shoe magnet, c) Micrometer screw gauge,

d) Slotted weights with hanger e) Step down transformer (220V-6V),

f) Steel and Copper wires

THEORY :

A sonometer is a hollow sounding box,whose one end of which is fixed at one end and the other end passes through a pulley fixed at the other end of box. The vibrating length of the wire can be adjusted by means of two sharp knife edges, over which the wirepasses. The horse-shoe magnet is placed at the middle of the wire. An alternating current of low voltage is passed through the wire when a current carrying conductor is placed in an uniform magnetic field, it will experience a magnetic force and is deflected. According to Fleming's left hand rule, if the current flows from left to right and magnetic field is directed in the direction opposite to our face, the wire experiences upward force and is deflected upward. After next half cycle of a.c., the current flows from right to left and the wire is deflected downward and so on. In this way, the wire moves up and down and its vibrations are maintained.

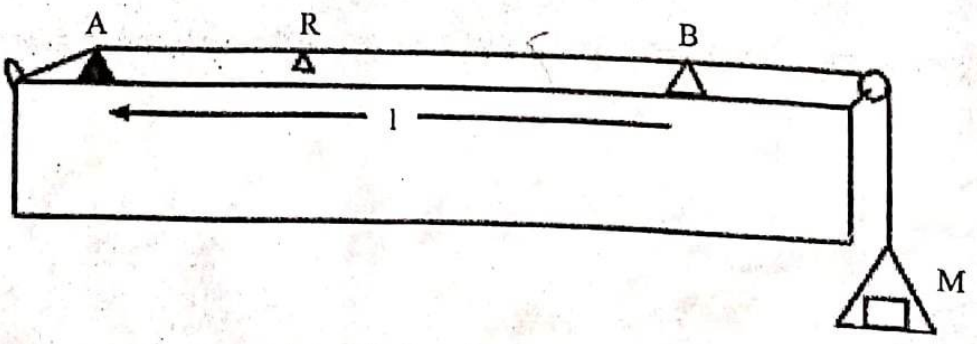


Fig.Sonometer

When the wire resonates, the frequency ofa.c. mains is equal to the frequency of vibration of the string.

According to laws of transverse vibration of string, the frequency of fundamental mode is,

$$f = \frac{1}{2l}\sqrt{\frac{T}{\mu}} \quad \ldots\ldots (i)$$

Where, l is length of the vibrating segment of the wire.

T= mg, is the tension in the wire, m is mass placed in the pan and μ is mass per unit length of wire.

If d be the diameter of the wire, then area of cross-section of wire $= \frac{\pi d^2}{4}$

Volume of wire = Area of cross-section × Length

∴ Mass of wire = Volume × Density

$$= \frac{\pi d^2}{4} \times l \times p$$

∴ Mass per unit length of wire $(\mu) = \frac{\pi d^2}{4} \times \rho$

Here, ρ = density of material of wire.

PROCEDURE:

1. The sonometer is placed on the table and the wire is stretched with a hanger of 0.5 kg.
2. A horse-shoe magnet is placed on the box in exactly mid-way between the bridges so that its poles N and S lie in the wire with one on each side of it.
3. The secondary of the step-down transformer is connected across the wire through the rheostat and a key. The secondary voltage is about 6V.
4. The positions of the bridges are adjusted with the magnet exactly mid-way between them until the wire vibrate with maximum amplitude.
5. The distance between the bridges is noted
6. Procedures (4) and (5) are repeated with different tensions by increasing the weights in equal steps of 500 gm.
7. Measure the diameter of wire at least in three places and find the mean. Hence, the mass per unit length is determined using above formula.

8. Repeat the same observation for another type of wire.

OBSERVATIONS :

1. For Steel wire

Diameter of wire (d) =

Density of material of wire (ρ)=

Mass per unit length of wire (μ)= $\frac{\pi d^2}{4} \times \rho =$

S.N.	Total load 'm' (kg)	Resonating length l(m)	Tension (T) = mg	f(Hz)	mean (f_1)
1.	0.5				
2.	1.0				
3.	1.5				
4.					
5.					

2. For Copper wire

Diameter of wire (d) =

Density of material of wire (ρ)= $8.93\ g/cm^3$

Mass per unit length of wire (μ)= $\frac{\pi d^2}{4} \times \rho =$

S.N.	Total load 'm' (kg)	Resonating length l(m)	Tension (T) =mg	f(Hz)	mean (f_2)
1.					
2.					
3.					
4.					
5.					

RESULTS:

The frequency of A.C. mains $(\tilde{f}) = \frac{f_1+f_2}{2} =$

Standard value of f =

%error =

Frequency from graph of T and l^2 =

CONCLUSIONS:

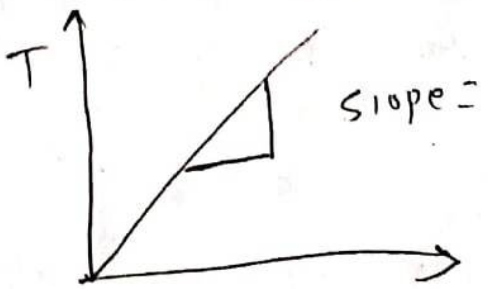
PRECAUTIONS:

For graph

$$f = \frac{1}{2l}\sqrt{\frac{T}{\mu}}$$

$$f^2 = \frac{1}{4l^2}\frac{T}{\mu}$$

$$T = (4\mu f^2)\, l^2$$



$$\text{slope} = \frac{\Delta T}{\Delta l^2} = 4\mu f^2$$

$$\Rightarrow f^2 = \frac{\text{slope}}{4\mu}$$

$$f = \sqrt{\frac{\text{slope}}{4\mu}}$$