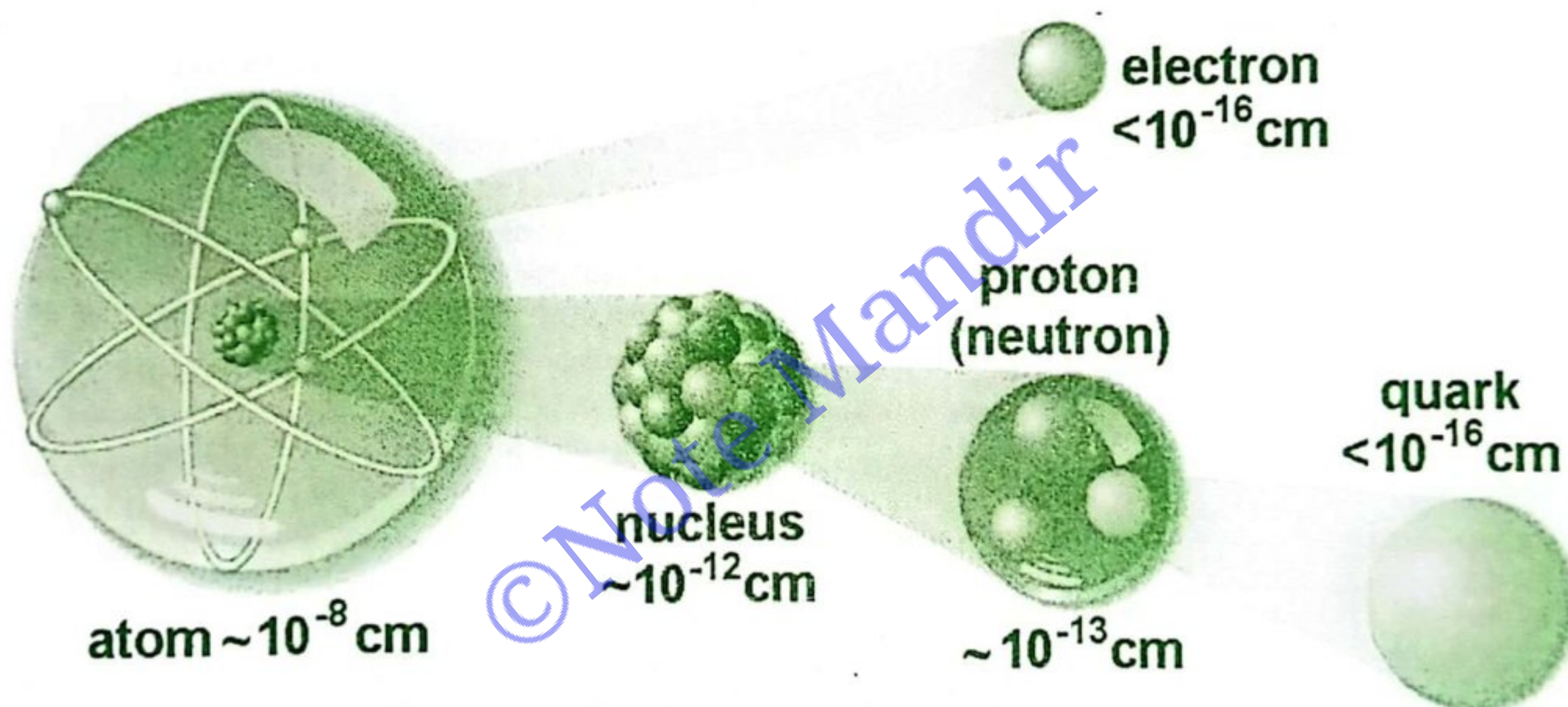




PHYSICS

Practical Note Book



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Class: <u>12</u>	Sec: <u>'C'</u>
Subject: Roll No.:	
House:	
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EXPERIMENT NO:- 1

NAME OF EXPERIMENT:- USE OF SIMPLE PENDULUM FOR THE DETERMINATION OF THE VALUE OF 'g' IN THE LABORATORY BY GRAPHICALLY ANALYSING THE VARIATION OF PERIOD OF OSCILLATIONS WITH LENGTH OF THE PENDULUM

APPARATUS REQUIRED

- i A metallic bob
- ii A thread (about 2m long)
- iii Clamp and Stand
- iv A Vernier Calliper
- v A meter scale
- vi A cork and Needle
- vii Stop Watch

THEORY

A simple pendulum is a heavy metallic bob suspended from a rigid support by means of a light, flexible and inextensible string under effect of gravity alone so that, it can vibrate freely on the basis of simple harmonic motion about its mean position.

Simple harmonic motion (SHM)

→ It is a periodic motion in which a body executes to and fro motion such that acceleration of a vibrating particle is directly proportional to its-

displacement from mean position and its direction directed towards the mean position.

That is, acceleration (a) $\propto$ displacement (y): For SHM or, $a = -\omega^2 y$. Where ω is + angular speed. Here, the negative sign indicates that acceleration is directed opposite to the displacement.

A second pendulum is the simple pendulum whose time period is 2 seconds.

~~Time period of simple pendulum whose time period is 2 seconds.~~

Time period of simple pendulum is the time taken by the pendulum in one complete oscillation. It is given by the formula $T = 2\pi \sqrt{\frac{L}{g}}$

Where, L = effective length of pendulum
 g = acceleration due to gravity

Now, value of g :-

Since $T = 2\pi \sqrt{\frac{L}{g}}$ for simple pendulum

Squaring: $T^2 = 4\pi^2 \frac{L}{g}$ $\therefore \boxed{g = 4\pi^2 \frac{L}{T^2}}$

Length of second pendulum :- It is obtained by taking: $T=2\text{sec}$

Then, we have: $T = 2\pi \sqrt{\frac{L}{g}}$

or, $2 = 2\pi \sqrt{\frac{L}{g}}$: for second's pendulum

or, $L = \frac{g}{\pi^2} \approx 100\text{cm}$ (Calculated Value)

This relation gives length of second's pendulum and is found to be approximately 100cm. Graphically, the length of the second's pendulum can be calculated determined in the lab by the method of extrapolation. The value of L corresponding to $T^2 = 4$ from the L vs T^2 graph & corresponding to $T=2$ from the L vs T graph.

Law of length & value of g from graph.

At a given place ' g ' is constant, time period of simple pendulum is directly proportional to square root of its effective length.

i.e. $T \propto \sqrt{L}$

so, $\frac{L}{T^2} = \frac{g}{4\pi^2} = \text{constant}$. This implies graph

between L & T^2 is a straight line as in fig. (b).

So, Slope of the line gives;

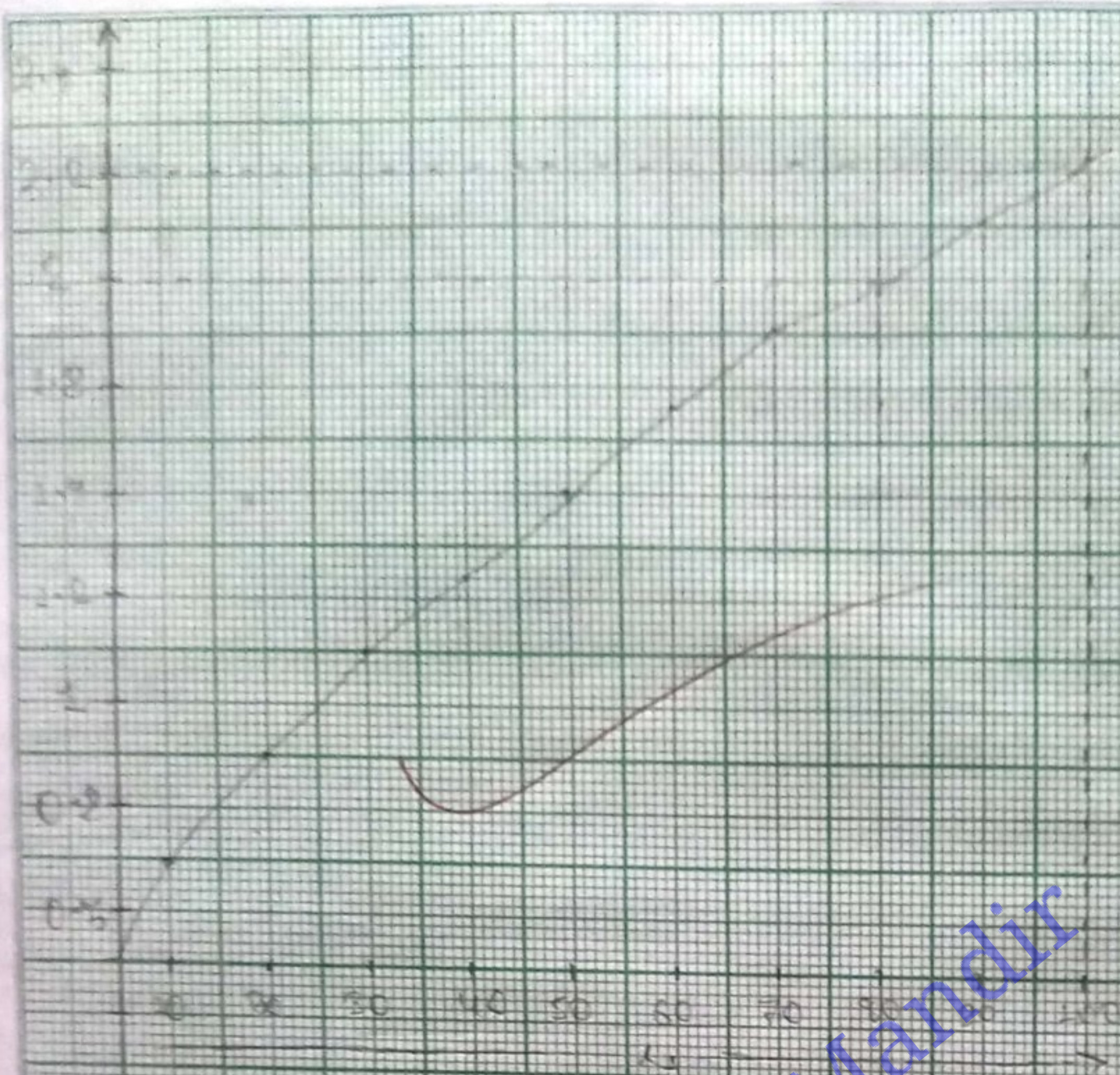
$$\text{Slope} = \frac{\Delta T^2}{\Delta L} = \frac{4\pi^2}{g}$$

$$\therefore g = \frac{4\pi^2}{\text{slope}} \quad \text{--- (ii)}$$

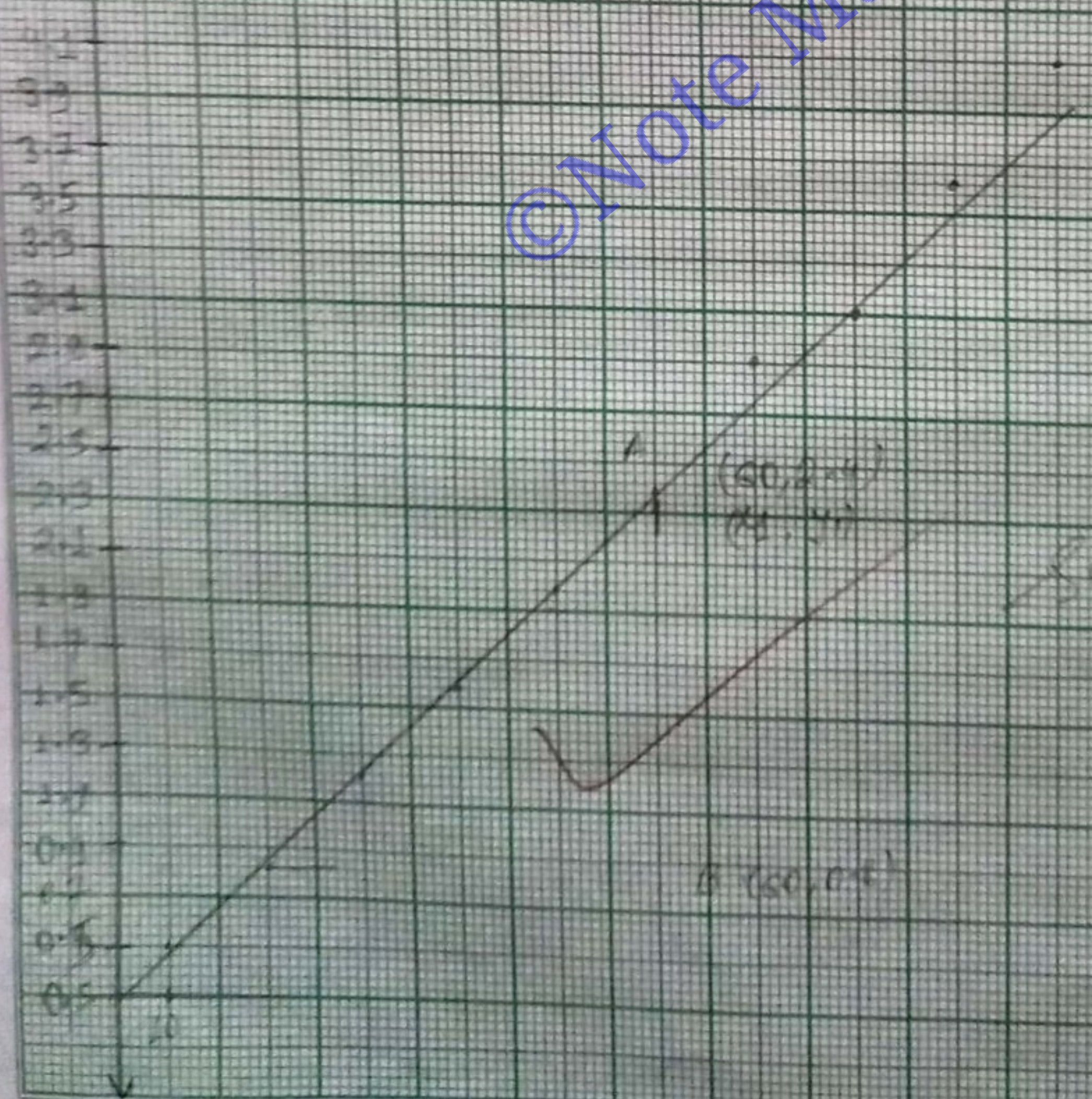
So, Value of g can be obtained from $L-T^2$ graph.

Graph .

©Note Mandir



Graph of
L.A.T



$$\text{Slope} = \frac{y_2 - y_1}{x_2 - x_1}$$

$$= \frac{2.4 - 0.5}{100 - 0}$$

$$= \frac{1.9}{100}$$

$$= 0.019$$

Here, the graph between L and T^2 is straight line (shown in fig. (a)) and $T \propto \sqrt{L}$ so, graph between L and T is parabolic (shown in fig. (b)).

PROCEDURE

1. At first LC. of meter scale & V.C of Vernier Caliper are determined.
2. Find the diameter d and radius of the bob using Vernier Caliper.
3. Length of thread plus the hook (L) is measured by keeping the upper edge of the bob at the zero of meter scale & mark on the thread at required position. Then, radius (r) of the bob added to this length, which gives effective length $l (= L + r)$ of pendulum. Here, the effective length of pendulum is mark on thread such that: $AC = 20\text{ cm}, 40\text{ cm}, 60\text{ cm}, 80\text{ cm}, 100\text{ cm}$ & so on respectively.
4. Clamp the two wooden pieces such that the thread passes between the two wooden pieces & then bob of pendulum hangs freely on the thread.
5. Displace the bob from the mean position through a small vertical angle 4 to 6 degree and release it.
6. Measure the time for 20 oscillations with the help of stop watch for 1st effective length mark by ink on thread.

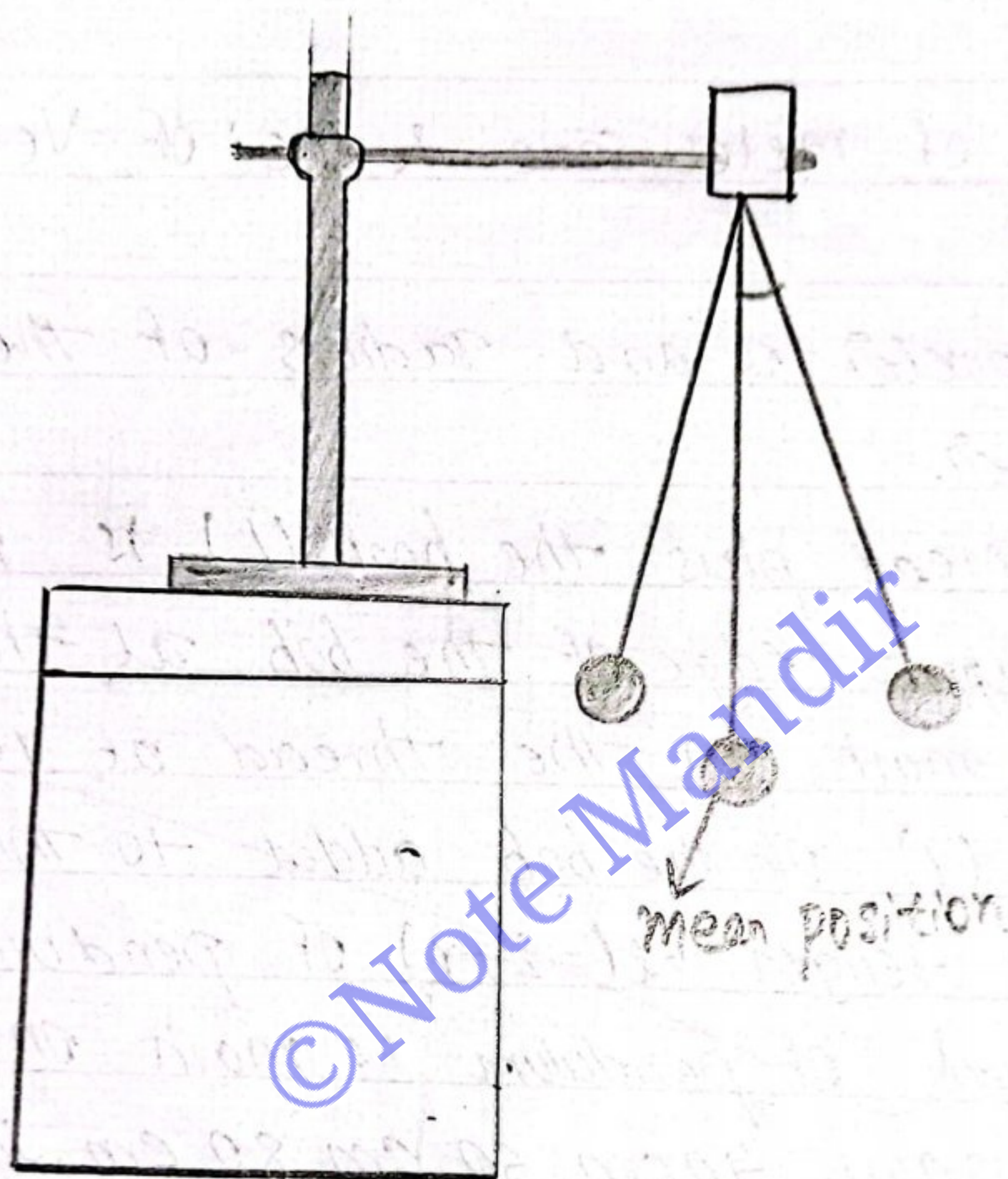


Fig:- Experiment setup for simple pendulum

- 7 Mark point of suspension with the ink of pen. That increase 20 cm length in next step mark and then note the time again for 20 oscillations using stop watch.
Here the length is changed by loosening the split of pieces of cork in clamp & pulling the thread until the next mark on thread is reached.
- 8 Repeat operations 4 and 5 for different effective length for 60 cm, 80 cm, 100 cm, 120 cm, 140 cm, 160 cm & so on.
- 9 Find the mean value of g from the table
- 10 Plot the graphs of L vs T and L vs T^2
- 11 Finding the value of g and length of second pendulum from the length.

OBSERVATION

L.C of a meter scale = 0.1 cm

L.C of a stop watch = 0.01 sec

Now, for Vernier Caliper

Vernier constant (V.C) = 0.01 cm

Zero error $\pm$ 10 divs.

Table-1: Determination of diameter of bob

No. of obs	Main scale reading (a) cm	Vernier reading (x) divs.	Value of Vernier reading $b = x \times V.C$	Total (a+b) cm	Mean diameter (cm)	Corrected diameter (mean $\pm$ correction) cm	Radius $r = (d/2)$ cm
1	1.9	2	$0.01 \times 2 = 0.02$	1.92	5.87		
2	1.9	8	0.08	1.98	3		0.975
3	1.9	7	0.07	1.97	≈ 1.95 2 cm		1 cm

Table-2: Determination of value of g

No. of obs	Length from point of suspension to upper edge of the bob (L) cm	Effective length $l = (L + r)$ cm	Time for 20 oscillations (t) sec	Time period $T = (t/20)$ sec	T^2	$(\frac{L}{T^2})$	$g = 4\pi^2(\frac{L}{T^2})$ cm/s ²	Mean (g) cm/s ²
1	9	10	15.36	0.768	0.589	16.97	66.92	
2	19	20	18.02	0.901	0.811	24.66	972.55	
3	29	30	22.32	1.116	1.245	25.89	950.07	
4	39	40	25.08	1.254	1.572	25.44 24.21	1003.31	942.731
5	49	50	28.16	1.408	1.983	25.21 24.88	994.24	cm/s ²
6	59	60	31.06	1.553	2.411	24.88	981.22	
7	69	70	34.12	1.706	2.908	24.07	949.28	
8	79	80	35.72	1.786	3.189	25.08	989.19	
9	89	90	38.16	1.908	3.640	24.72	974.91	
10	99	100	40.89	2.0445	4.179	23.92	943.96	

$$g = 942.731 \text{ cm/s}^2$$

$$g = 9.42 \text{ m/s}^2$$

CALCULATION

From graph between L and T : length of second pendulum is the length at 1.2 sec : $L_1 = \underline{100 \text{ cm}}$

From graph between L and T^2 : length of second pendulum is the length at $T^2 = 4 \text{ s}^2$: $L = \underline{100 \text{ cm}}$

$$\begin{aligned} \therefore \text{Mean length of second pendulum } (L) &= \frac{L_1 + L_2}{2} \\ &= \frac{100 + 100}{2} \\ &= 100 \text{ cm} \end{aligned}$$

$$\begin{aligned} \text{Also, slope of line} &= \frac{y_2 - y_1}{x_2 - x_1} \\ &= \frac{0.8 - 2.4}{20 - 60} \\ &= 0.04 \end{aligned}$$

$$\begin{aligned} \therefore \text{Value of } g &= 4\pi^2 \times \frac{1}{\text{slope}} \\ &= \frac{4\pi(3.14)^2}{0.04} \\ &= 985.96 \text{ cm/s}^2 \approx 9.86 \text{ m/s}^2 \end{aligned}$$

$$\begin{aligned} \therefore \text{Mean Value of } g &= \frac{g_{\text{table}} + g_{\text{graph}}}{2} = \frac{9.42 + 9.86}{2} \\ &= 9.64 \text{ m/s}^2 \end{aligned}$$

RESULT

Hence, Value of acceleration due to gravity at lab and length of second were found to be $g = 9.64 \text{ m/s}^2$ and $l = 1 \text{ m}$ respectively by using simple pendulum method.

PERCENTAGE ERROR

1. For g :

Standard Value of g (S.V) = 9.80 m/s^2

Observed value of g (O.V) = 9.42 m/s^2

$$\% \text{ error in } g = \left| \frac{\text{S.V} - \text{O.V}}{\text{S.V}} \right| \times 100 \% = 4.03\%$$

2. For length of second pendulum:

Standard Value of l (S.V) = 100 cm

Observed Value of l (O.V) = 99 cm

% error in length of second pendulum

$$= \left| \frac{\text{S.V} - \text{O.V}}{\text{S.V}} \right| \times 100 \%$$

$$= 100 - 1$$

?

CONCLUSION

Hence, the value of acceleration due to gravity and length of second pendulum are determined by simple pendulum method experimentally.

SOURCE OF ERROR

1. High amplitude of oscillation of bob.
2. Air may disturb vibrations.
3. Spinning of bob cannot be completely avoided.
4. Careless in starting and stopping the stop-watch as well as recording data.

PRECAUTION

1. The amplitude of vibration should be small (about 4° to 6°).
2. The bob should move along the reference line without jerky motion.
3. The strings should be held firmly.
4. The stop clock should be started and stopped carefully.
5. The string should move in a direction perpendicular to the cut in the cork.
6. Experiment should not be performed near the door or window to avoid disturbance of wind.
7. Graph should be plotted carefully.

25/10/21
10

EXPERIMENT NO:- 2

NAME OF EXPERIMENT:- TO DETERMINE THE COEFFICIENT OF VISCOSITY FOR GLYCERINE USING STOKES METHOD

APPARATUS REQUIRED

1. Viscous liquid - glycerine
2. Tall jar
3. Steel ball
4. A stop watch
5. A screw gauge
6. Meter scale
7. Rubber bands or thread
8. A thermometer

THEORY

Viscosity:- It is defined as the property of fluid by virtue of which it opposes the relative motion between its consecutive layers. Here, backward dragging force that acts tangentially on the layers of fluid during their motion is known as viscous force.

According to Stoke's law, when a spherical body falls through a viscous medium, its velocity increases at first and finally attains constant velocity. This maximum constant velocity is called terminal velocity.

When the spherical body of radius 'r' falls through a viscous medium of coefficient of viscosity with terminal velocity 'v'.

Weight of sphere = Viscous force + up-thrust

$$\text{Or, } W = F_v + U$$

$$\left(\frac{4}{3} \pi r^3 \rho \right) g = 6\pi \eta r v + \left(\frac{4}{3} \pi r^3 \sigma \right) g \quad \because V_t = v \text{ (taken)}$$

$$\therefore \eta = \frac{2}{9} r^2 \frac{(\rho - \sigma) g}{v}$$

If d is the diameter of the ball then $r = d/2$

$$\eta = \frac{2}{9} \times \frac{d^2}{4} \times \frac{(\rho - \sigma) g}{v}$$

Suppose this spherical ball takes time t to cover the distance l , then $v = \frac{l}{t}$

$$\therefore \eta = \frac{2}{9} \times \frac{d^2}{4} \times \frac{(\rho - \sigma) g}{\frac{l}{t}} = \left(\frac{d^2}{\frac{l}{t}} \right) \times \frac{(\rho - \sigma)}{18l}$$

$$\therefore \eta = \frac{d^2}{\frac{l}{t}} \times \frac{(\rho - \sigma) g}{18l}$$

PROCEDURE

1. Take a tall transparent jar and fill it almost completely with glycerin.
2. Make two marks A and B keeping the distance about $AB = 30\text{cm}$ or above on the jar and tie two rubber bands on the marks around the jar.
3. Measure the radius of a steel ball using micrometer or screw gauge.
4. Drop the ball gently at the liquid surface. The ball then begins to fall through the liquid. The velocity of ball will be constant when reaches at A.
5. Start the stop watch when ball reaches at mark A and stop the watch when ball reaches at mark B. Note the time shown in the watch.
6. Repeat the operations 3, 4, and 5 for five to ten balls of different sizes.
7. Take the temperature of liquid and its density from the physical table.

OBSERVATION

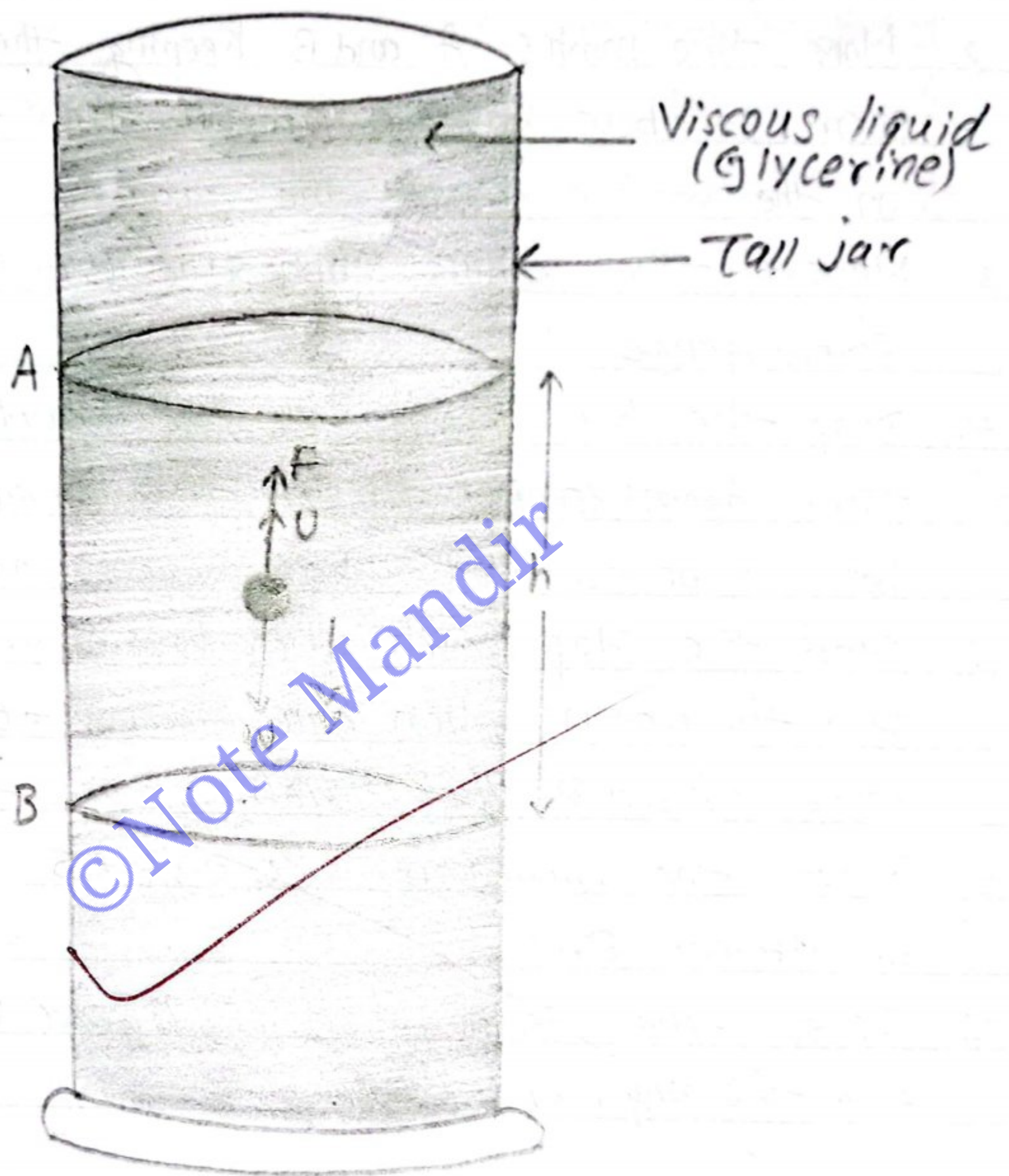
Temperature of liquid = 18.5°C

The name (nature) of liquid used = Glycerine

Name of spherical ball = Steel

Standard value of viscosity of given liquid (η) = 9.54×10^{-3} poise

Density of the given liquid (ρ) = 1.26 gm/cc



Density of the ball (σ) = 7.85 gm/cc

Distance between band A and B (h) = 30 cm

For micrometer screw gauge

Number of Circular scale division (N) = 100 divs

Value of 1 main scale division ($\pm$) = 1 mm

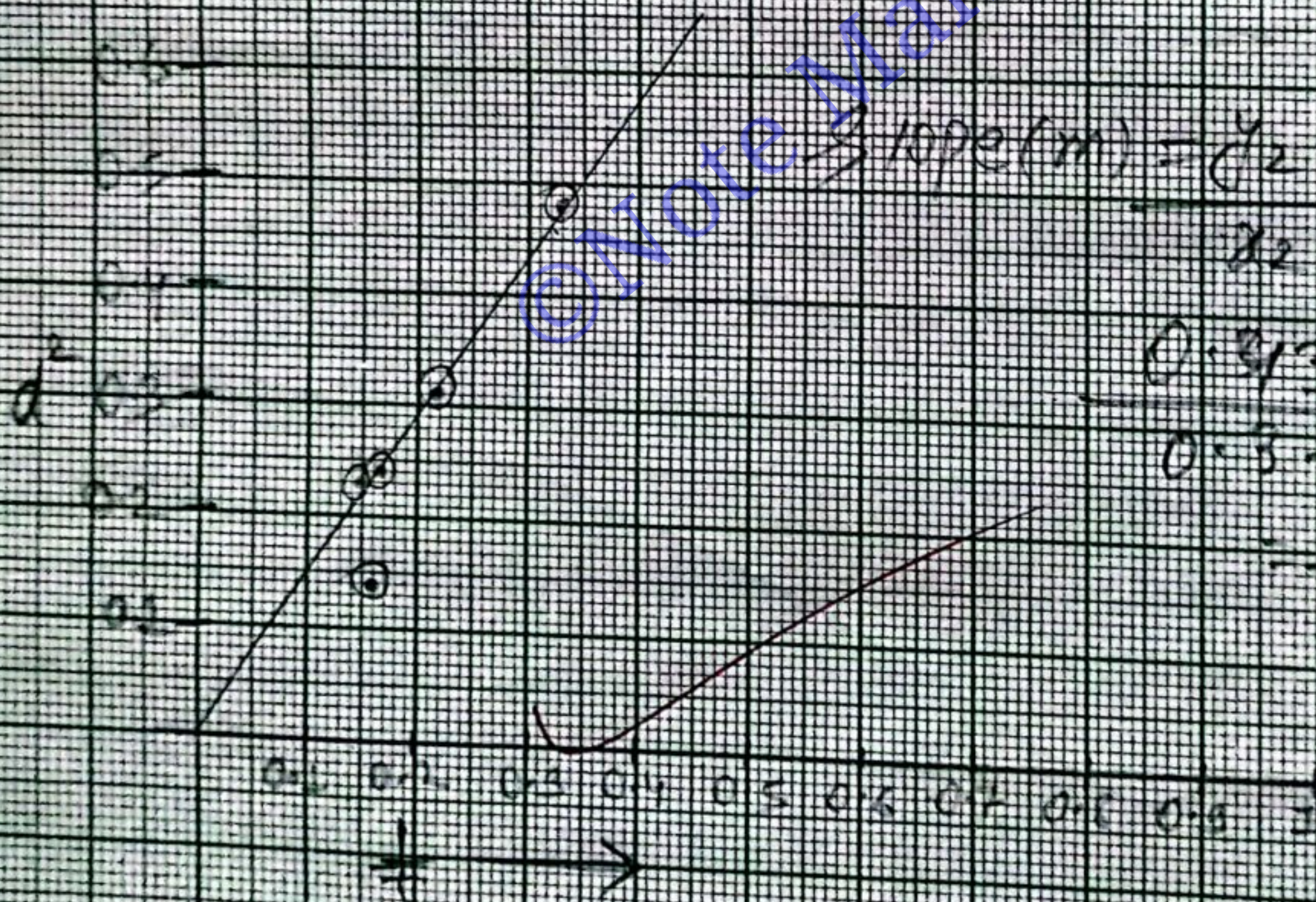
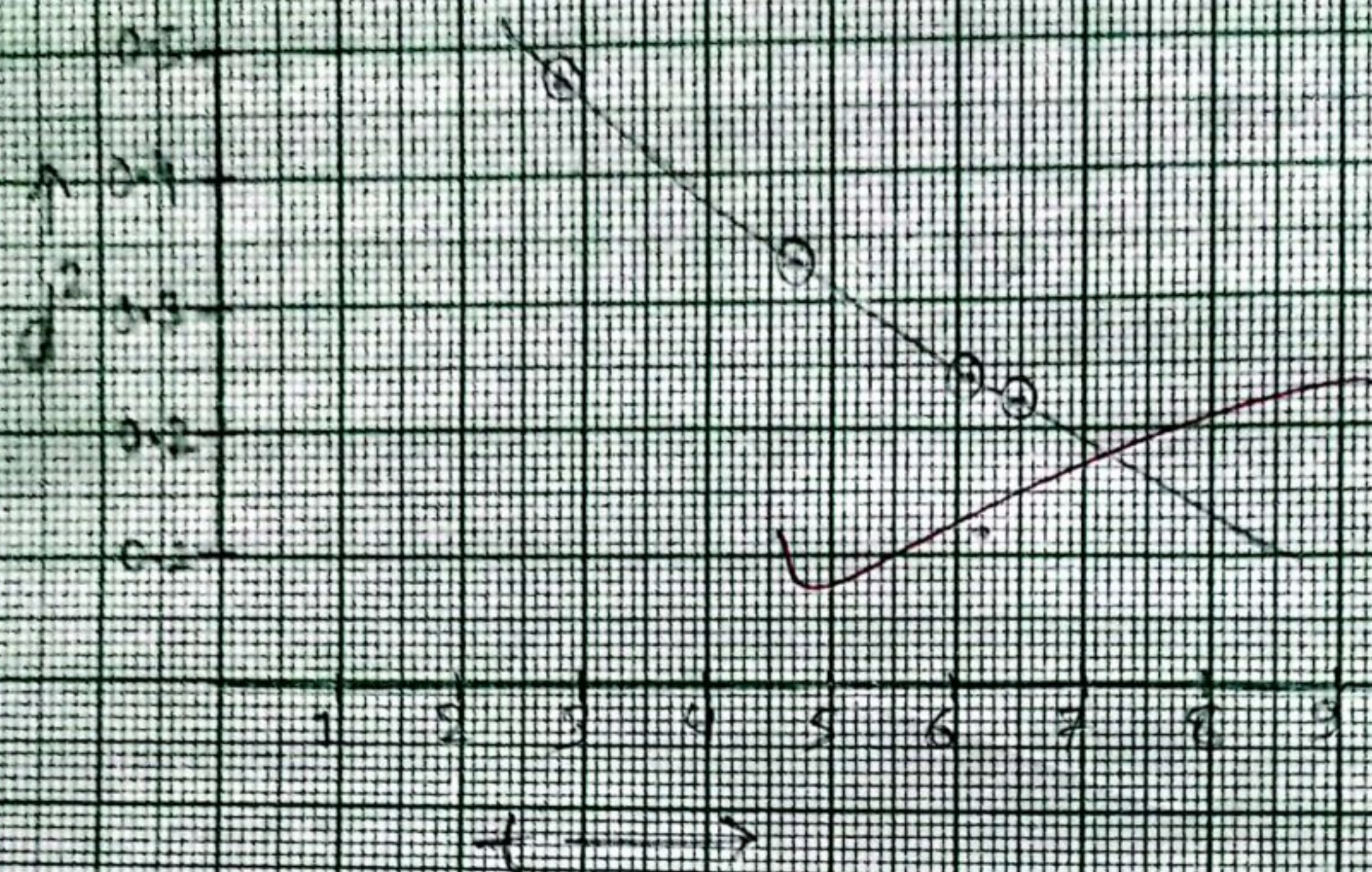
$\therefore$ pitch (P) = 0.1 mm

(LC) = 0.01 mm

Table - 1: For diameter and radius of steel ball

No. of Obs	Ball	Main Scale reading (a) mm	Circular Scale reading (b) divs	Value of CSD $C = (b \times LC)$ mm	Total ($a + C$) mm	Mean diameter mm (apparent)	corrected Radius of $\frac{d^2}{2}$ cm $\frac{(mm)^2}{2}$ (corrected)	Radius (r) d in mm
1	A	6	86	0.86	6.86	6.73	6.936	48.108
		6	858	0.58	6.58			
2	B	4	55	0.55	4.55	4.56	4.76	22.657
		4	65	0.65	4.65			
3	C	5	33	0.33	5.33	5.39	5.596	31.352
		5	46	0.46	5.46			
4	D	4	75 71	0.75 0.71	4.75 4.71	4.63	4.83	23.328
		4	63	0.63	4.63			
5	E	3	50	0.50	3.50	3.50	3.70	13.69
		3	45	0.45	3.55			

Plot of d^2 vs t



$$\text{slope}(m) = \frac{y_2 - y_1}{x_2 - x_1}$$

$$\frac{0.313 - 0.1}{0.3 - 0.2} = 1.213$$

Table-2: - Determination of Coefficient of Viscosity

NO. OF Obs.	Ball	Time of Fall From A to B (t) sec	Terminal Velocity $V = \frac{h}{t}$ cm/s	diameter in cm (r) d^2 in cm (r)	Coefficient of viscosity $\eta = \frac{2r^2(P-\sigma)}{9v}$ poise	Mean value of η (poise)
1	A	2.96	20.27	0.48108	8.5369	
2	B	6.5	9.8	0.226576	8.8298	8.01294
3	C	4.7	12.76	0.3131	8.8276	
4	D	6.25	9.6	0.23289	8.741	
5	E	6.38	9.4	0.1369	5.1294	

From graph

we know, relation: $d^2 \propto \frac{1}{t}$

If we p.

Table-3: For graph

d^2	0.48108	0.226576	0.3131	0.23289	0.1369
$\frac{1}{t}$	0.3378	0.1538	0.2127	0.16	0.1567

We know, relation: $d^2 \propto \frac{1}{t}$

If we plot the graph, square of diameter versus reciprocal of time ($\frac{1}{t}$), we obtained straight line passing through origin.

$$\text{Slope (m)} = \frac{d^2}{\frac{1}{t}} = d^2 t$$

Coefficient of viscosity from graph (η_{graph})

$$\frac{2 d^2 (\rho - \sigma) g}{9 \times \text{length between points AB}} \times t$$

$$= \frac{1}{18} \cdot \frac{(7.85 - 1.26) \times 9.8 \times 1.43}{60}$$

$$= 8.55 \text{ poise}$$

$$\text{Coefficient of viscosity } (\eta) = \frac{\eta_{\text{cal}} + \eta_{\text{graph}}}{2}$$

$$= \frac{8.01294 + 8.55}{2}$$

$$= 8.28 \text{ poise}$$

Percentage Error:-

Standard value of $\eta^{(SV)}$ = 8.3 poise

Observed value of $\eta^{(OV)}$ = 7.98 poise

$$\% \text{ error} = \left| \frac{SV - OV}{SV} \right| \times 100 \%$$

$$= \left| \frac{8.3 - 7.98}{8.3} \right| \times 100 \%$$

$$= 3.58 \%$$

RESULT

Hence, coefficient of viscosity of given liquid was found to be 8.28 poise

CONCLUSION

Hence, coefficient of viscosity of given liquid was measured in laboratory

SOURCE OF ERROR

1. The spherical balls may be not be perfectly spherical.
2. The present of impurities in the liquid & on the surface of balls.
3. The noted value of terminal velocity may not be constant

PRECAUTIONS

1. The ball must be perfectly spherical in shape
2. The ball should not touch the wall of the jar while falling in liquid
3. The temperature of the viscous material should be constant

21.10.17

EXPERIMENT NO:-3

NAME OF EXPERIMENT:- TO DETERMINE MAGNETIC MOMENT OF THE GIVEN BAR MAGNET USING DEFLECTION MAGNETOMETER BY TAN-A POSIT. POSITION.

APPARATUS REQUIRED

1. Deflection magnetometer
2. Meter scale
3. Bar magnet
4. Conn

THEORY

Deflection magnetometer is a type of magnetometer which works on the principle of tangent law. It is used to determine the magnetic moment, pole strength and magnetic field, etc. It consists of a small magnetic needle pivoted at the centre of a circular scale.

Tangent A position of Gauss

In this position, the centre of the needle is on the prolongation of the axis of the bar magnet. Hence the intensity F due to magnet is-

$$F = \frac{2Md}{(d^2 - l^2)^2} \quad \text{--- (i)}$$

Where M is the moment of the magnet, d is the distance of the centre of the needle from the centre of the magnet, l is the semi-magnetic length of the magnet.

Since the ~~the~~ needle is under the influence of two mutually perpendicular fields F due to the magnetic and H due to the earth, the tangent law holds good.

$$F = H \cdot \tan \theta \quad \text{--- (ii)}$$

From eq (i) and (ii)

$$F = \frac{2Md}{(d^2 - l^2)^2} = H \tan \theta$$

$$\text{or } M = \frac{H (d^2 - l^2)^2 \tan \theta}{2d}$$

$$\therefore m = \frac{H (d^2 - l^2)^2 \tan \theta}{2l \times 2d}$$

PROCEDURE

1. First of all, the magnetometer was adjusted so that its arms were perpendicular to the magnetic meridian, when the pointer reads $90^\circ - 90^\circ$ in the scale.
2. The bar magnet NS was placed on one of the arm with its axis perpendicular to the magnetic meridian i.e. placed along the arms with its center at a distance ' d ' from the centre of the pivoted needle ~~was say~~ with its N-pole pointing towards the needle. The distance ' d ' was adjusted such that the deflection θ should be between 30° and 60° . The deflection of the needle was read from both the ends of the pointer. That gave two readings.
3. Next the magnet was placed on the same arm at the same distance with its S-pole pointing towards the ~~the~~ needle.

The distance 'd' was adjusted such that the deflection θ should be between 30° and 60° .

- The deflection was again noted. This gave two more readings.

4 Operations (2) and (3) were repeated on the other arms at the same distance. This gave 4 more readings. Thus we had 8 readings, the means of these gave θ .

OBSERVATIONS

Real length of the magnet (x) = 5 cm

$$\frac{x}{2} = 2.5 \text{ cm}$$

Effective length of the magnet ($2l$) = 85 % of real length (x)

$$\frac{85}{100} \times 2.5$$

$$2l = 2.125, l = 1.0625$$

Horizontal component of earth magnetic field at lab (H) = 0.34 Oersted.

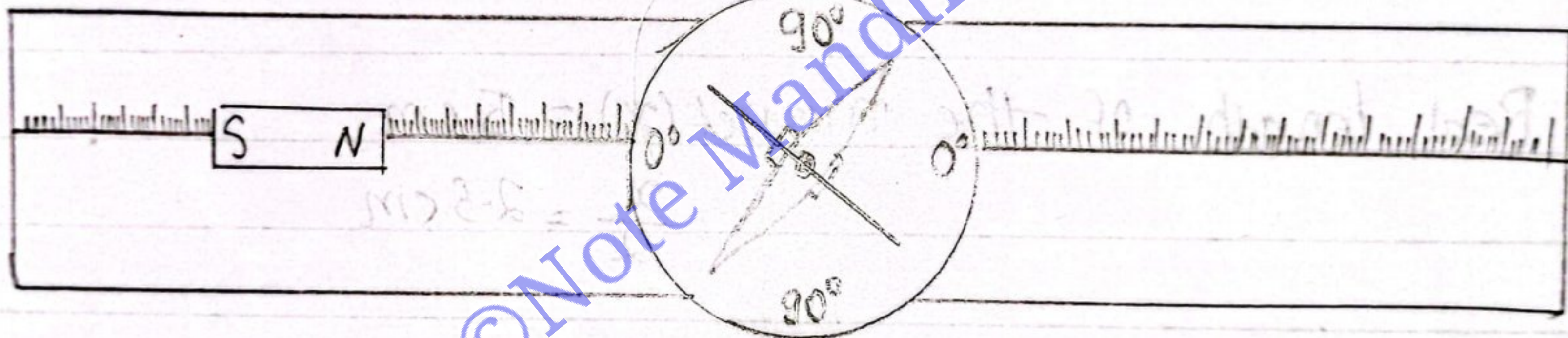


Fig: Tangent A position of gauss

OBSERVATION TABLE

NO. of obs	Distance of the magnet in m	Position of the magnet in arm	N-pole pointing	Deflection			magnetic moment $m = \frac{4\pi (d^2 - e^2)^2}{\mu \cdot 2d} \times H \tan \theta$	Mean (M)
				End I	End II	Mean		
1		East	East	55	57			
2	$d_1 = 0.12$		west	49	44	50	0.23	
3		west	East	49	48			
4			west	52	48			
5		East	East	40	37			
6	$d_2 = 0.14$		west	40	35	37	0.27	0.3
7		west	East	39	37			
8			west	36	32			
9		East	East	31	28			
10	$d_3 = 0.16$		west	25	23	30	0.42	
11		west	East	35	33			
12			west	33	30			

$$M = m = \frac{M}{2L} = \frac{0.3 \text{ Am}^2}{0.2 \times 0.02 \text{ m}} = 7.5 \text{ Am}$$

RESULT

In Ton A position, The magnetic moment and the pole strength of the magnet for Ton A position are found to be, $m = 0.3 \text{ Am}^2$ and $m = 7.5 \text{ Am}$ respectively.

CONCLUSION

Hence, the magnetic moment and pole strength of a given bar magnet are determined by using deflection magnetometer experimentally.

SOURCES OF ERROR

1. There may be magnet & magnetic substance near the near the working table.
2. There may be friction at the pivot of the needle.
3. Position of magnetometer may not be exactly on the magnetic meridian.
4. The pointer of needle in magnetometer may be thick and not straight.

PRECAUTIONS

1. Magnetic substance should be removed from table.
2. Magnetometer should be placed on the magnetic meridian.
3. The needle of the magnetometer should be free to rotate.
4. The deflection of needle should lie between 30° to 60° .
5. Parallax error between needle and its mirror image should be removed while measuring the deflection of needles.
6. All the readings should be measured carefully.

EXPERIMENT NO:-4

NAME OF EXPERIMENT:- TO DETERMINE MAGNETIC MOMENT OF THE GIVEN MAGNET USING DEFLECTION MAGNETOMETER BY TANGENT-B POSITION.

APPARATUS REQUIRED

1. Deflection magnetometer
2. Meterscale
3. Bar magnet

THEORY

Deflection magnetometer is a type of magnetometer which works on the principle of tangent law. It is used to determine the magnetic moment, pole strength and magnetic field, etc. It consists of a small magnetic needle pivoted at the centre of a circular scale.

Tangent B position of gauss

In this position the centre of the needle is on the equatorial line of the bar magnet. Hence the intensity due to the magnet is

$$m = \frac{M}{(d^2 + l^2)^{3/2}} \frac{\mu}{4\pi} \quad \text{--- (i)}$$

But according to tangent law of magnetic forces

$$f = H \tan \theta \quad \text{--- (ii)}$$

Now,

From above eq (i) and (ii)

$$\frac{\mu}{4\pi} \cdot \frac{m}{(d^2 + l^2)^{3/2}} = H \tan \theta$$

$$M = \frac{4\pi}{\mu_0} (d^2 + l^2)^{3/2} H \tan \theta$$

$$\text{and pole strength } \frac{(m)}{2L} = \frac{M}{2L}$$

$2L$ = Effective length of Bar magnet.

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From eq (i) and (iii)

$$m = \frac{M}{(d^2 + l^2)^{3/2}} = H \tan \theta$$

$$\frac{M}{H} = (d^2 + l^2)^{3/2} \tan \theta \quad \text{--- (iii)}$$

$$\text{or } M = H(d^2 + l^2)^{3/2} \tan \theta$$

$$\text{or } m \cdot 2l = H(d^2 + l^2)^{3/2} \tan \theta$$

$$\therefore m = \frac{H(d^2 + l^2)^{3/2} \tan \theta}{2l} \quad \text{--- (iv)}$$

PROCEDURE

1. Magnetometer was adjusted so that its arms were along the magnetic meridian when the pointer reads $90^\circ - 90^\circ$.
2. The bar magnet NS was placed on one of the arms with its axis perpendicular to the magnetic meridian with adjusted distance 'd' that makes deflection 'θ' between 30° & 60° .
3. Deflection of the needle was read and subtracted from 90° to get θ and two readings were taken.
4. Again, bar magnet was placed on the same arm, N-pole pointing to West. The deflection was again noted and two readings were taken.
5. Operations (2), (3) & (4) were repeated on another arm at the same distance which gave 3 more readings.



Figure:- Tangent B position of Gauss

OBSERVATIONS

Value of H in lab = 0.34 oerstedReal length (x) = 5 cm

$$\text{Effective length } (2l) = 5 \times 0.85 \\ = 4.25$$

$$\therefore l = \frac{4.25}{2}$$

$$2.12 \text{ cm.}$$

OBSERVATION TABLE

No. of Obs.	Distance of the magnet cms (d)	Position of the Magnet	N-pole pointing	Deflection θ			Mean m
				End I	End II	Mean (θ)	
1	$d_1 = 0.12$	North	East	55	57		
2			West	49	45	50	0.23
3		South	East	52	48		
4			West	49	44		
5	$d_2 = 0.14$	North	East	40	35		
6			West	39	37	36	0.86
7		South	East	40	37		
8			West	36	31		
9	$d_3 = 0.16$	North	East	31	28		
10			West	25	22	30	0.32
11		South	East	35	32		
12			West	33	30		

$$m = \frac{M}{2L} = \frac{0.5 \text{ Am}^2}{2 \times 0.02 \text{ m}} = 12.5 \text{ Am}$$

RESULT

In Tan B position : The magnetic ~~am~~ moment and the pole strength of the magnet for Tan B position are found to be $M = 0.5 \text{ Am}^2$ and $m = 12.5 \text{ Am}$

CONCLUSION

Hence, the magnetic moment and pole strength of a given bar magnet are determined by using deflection magnetometer experimentally.

SOURCES OF ERROR

1. There may be magnetic substances and magnet near the working table.
2. There may be friction at the pivot of the needle
3. Position of magnetometer may not be exactly on the magnetic meridian

PRECAUTIONS

1. Magnetic substances should be removed from table
2. Magnetometer should be placed on the magnetic meridian
3. The needle of the magnetometer should freely rotate
4. The deflection of needle should lies between 30° to 60°

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EXPERIMENT NO:- 5

NAME OF EXPERIMENT:- DETERMINATION OF VELOCITY OF SOUND IN AIR AT NTP USING RESONANCE TUBE AND ALSO DETERMINE THE END CORRECTION OF RESONANCE TUBE.

APPARATUS REQUIRED

- i Resonance tube apparatus
- ii Tuning forks
- iii Rubber pad
- iv Vernier Calipers
- v Thermometer

Description of the Apparatus

Resonance tube:- It is simply a metallic (or glass) tube & is taken as a closed organ pipe in which the length of vibrating air column may be changed. It works on the principle of resonant vibration of air column in pipes. Using resonance tube, we can determine the velocity/speed of sound in air (at any temperature & pressure) as well as end correction of a tube.

Further, resonance tube apparatus experiment consists of mainly two apparatus.

- i) Tuning fork
- ii Resonance tube apparatus.

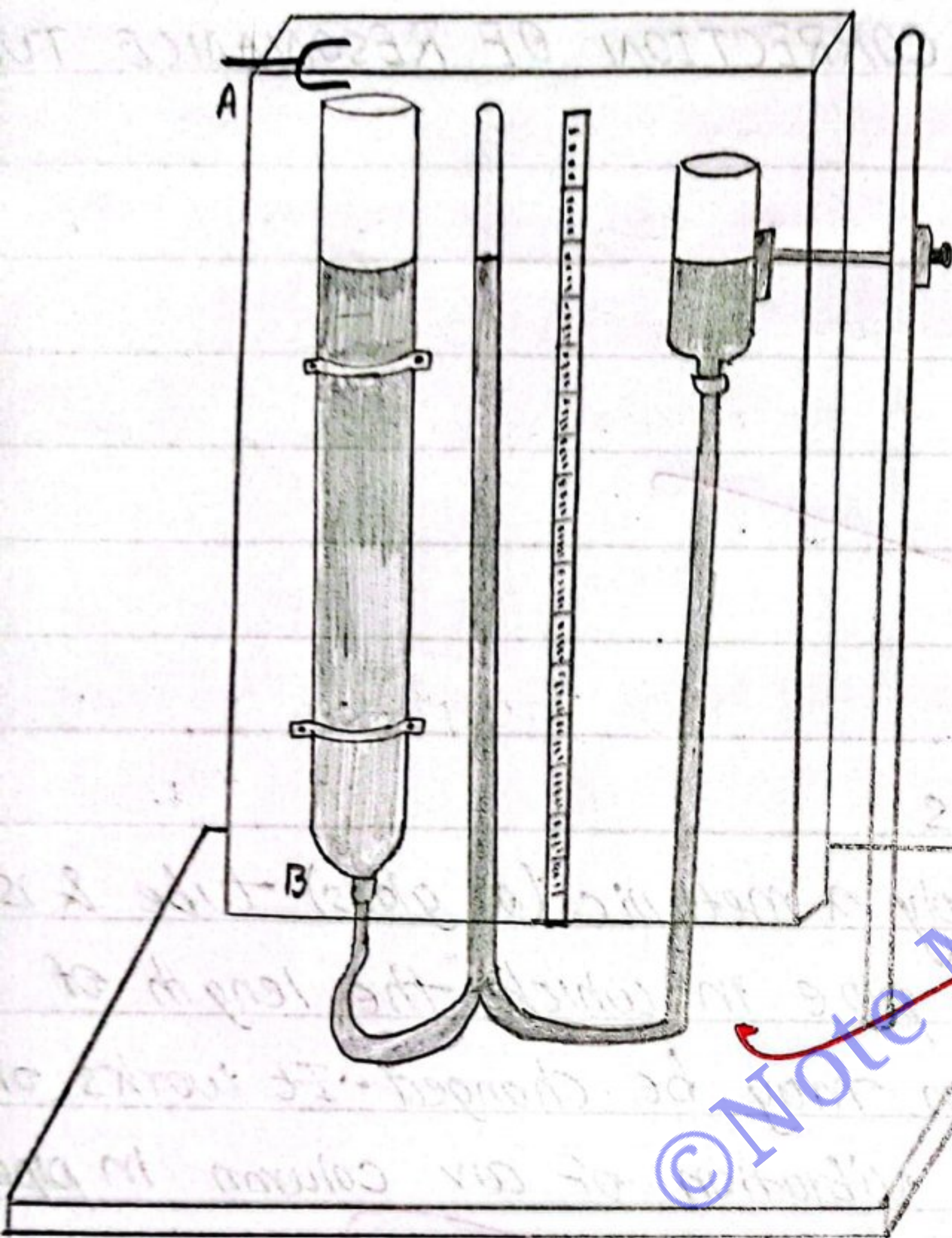


Fig (i) Resonance tube apparatus

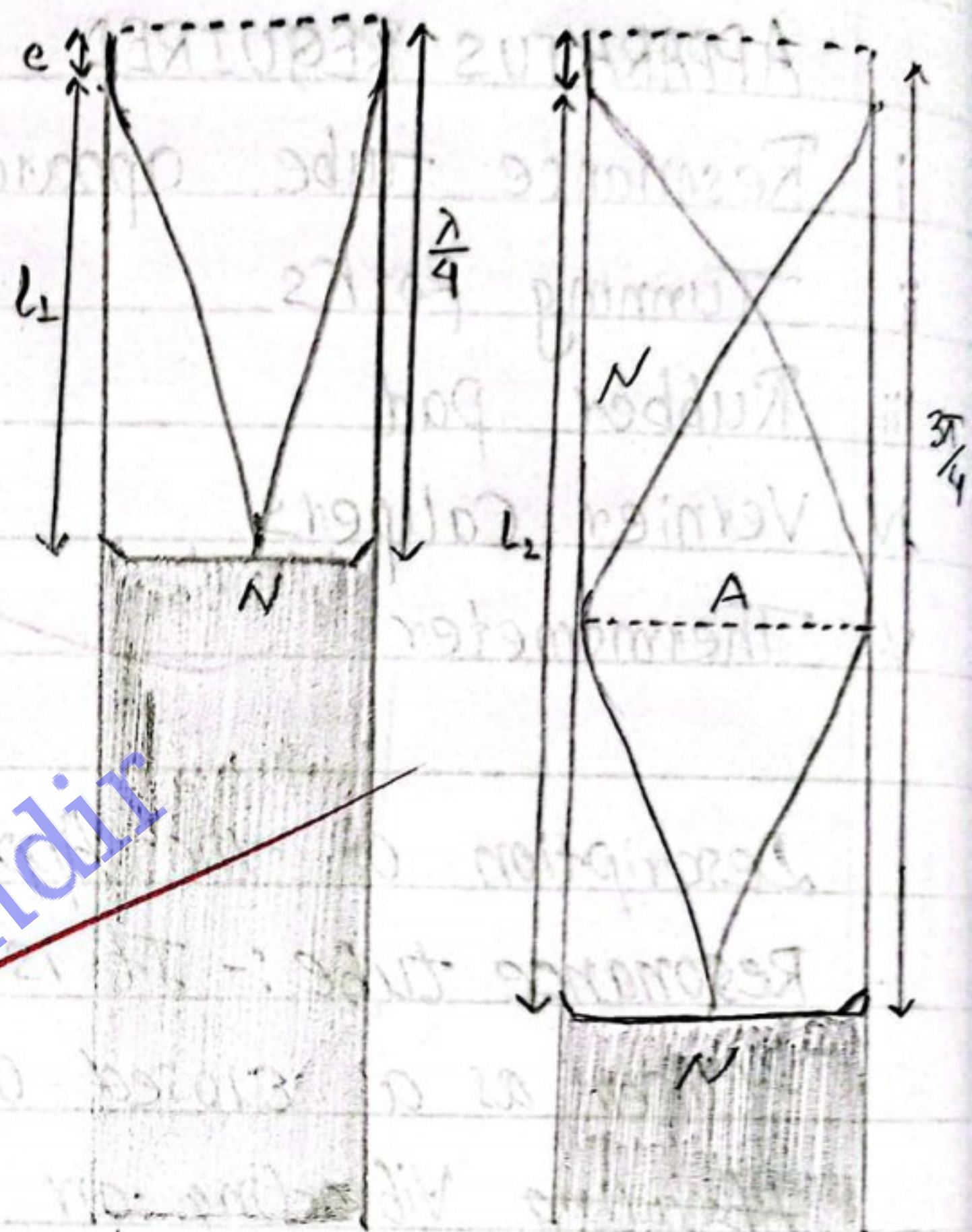


Fig (ii) First resonance Fig (iii) Second resonance

THEORY

For first resonance:-

At first vibration tuning fork of known frequency 'f' is horizontally held over open end of resonance tube. Then, water level in the tube is so adjusted to that position at which resonant vibration of air column occurs & hence loud sound is produced due to resonance phenomena.

So, at condition of 1st resonance:

→ The effective length of resonant vibrating air column is given by: $l_1 + e = \frac{\lambda}{4}$ — (i)

Where, l_1 : 1st resonating length,

e : end correction of a tube

λ : wavelength of sound-wave from tube

For 2nd resonance:

Further, the level of water gradually decreases/lower (i.e., length of air column increases) from 1st resonance position until another loud sound is obtained due to ~~res~~ resonant vibration of air column. This is the position of 2nd resonance & as shown in fig (iii). [In this case, sound is heard weaker in comparison to 1st resonance].

So, for second resonance, we have;

$$\text{Effective length of air column: } l_2 + e = \frac{3\lambda}{4} \quad \text{--- (ii)}$$

Where, l_2 : 2nd resonating length

Now,

Subtracting eq (i) from eq (ii) we get:

$$l_2 - l_1 = \frac{\lambda}{2}$$

$$\text{or, } \lambda = 2(l_2 - l_1)$$

$$\text{So, velocity of sound: } v = f\lambda = 2f(l_2 - l_1) \quad \text{--- (iii)}$$

Where,

f = frequency of the tuning fork.

This equation (iii) gives the velocity / speed of sound at lab temperature ($\theta^\circ\text{C}$) in moist air.

$$\therefore V_\theta = 2f(l_2 - l_1) \quad \text{--- (iv)}$$

Also,

for speed of sound at NTP in moist air:-

We know,

$$V \propto \sqrt{T} \quad [\because T = (273 + \theta) \text{K}]$$

So,

$$\frac{V_0}{V_\theta} = \sqrt{\frac{T_0}{T_\theta}} = \sqrt{\frac{273}{273 + \theta}}$$

$$\therefore V_{NTP} = V_0 = V_\theta \sqrt{\frac{273}{273 + \theta}} \quad \text{--- (v)}$$

This equation (v) gives the velocity of sound at NTP/STP in moist air. This value of speed of sound is found to be approximately equal to experimental value: 332 m/sec at NTP.

Further, at NTP, the velocity of sound in dry air can be calculated by using the relation,

$$(V_{\text{dry}})_{\text{NTP}} = V_t \sqrt{\frac{P - 0.375p}{P}} \sqrt{\frac{273}{273 + t}}$$

$$\therefore (V_{\text{dry}})_{\text{NTP}} = V_t \sqrt{\frac{P - 0.375p}{P}} \cdot \left[1 - \frac{\gamma t}{2} \right] \quad \text{--- (vi)}$$

Where, P is the atmospheric pressure, p is the aqueous tension at the temperature $t^\circ\text{C}$ and γ is the coefficient of cubical expansion of air i.e. $\gamma = \frac{1}{273}^\circ\text{C}^{-1}$

Again, from equation (i) and (ii), we can calculate the end correction as:

$$e = \frac{l_2 - 3l_1}{2} \quad \text{--- (vii)}$$

And the estimated value of end correction by Rayleigh is formula: $e = 0.3D$, where D is the internal diameter of resonance tube.

Further, we can use graphical method.

for 1st resonance

From equation (i), we have: $l_1 = \frac{1}{4}\lambda - e$

$$\therefore l_1 = \left(\frac{v}{4f}\right) - e \quad [\because v = f\lambda] \quad (*)$$

This equation is similar to the equation of straight line.

$$y = mx + c \quad \text{So,}$$

Slope of line (m) = $\frac{v}{4} \Rightarrow v = 4 \times \text{slope of line}$ & y -intercept = $0 \Rightarrow -e$.

PROCEDURE

1. At 1st a resonance tube was taken and filled the water reservoir with water.
2. Then taken a tuning fork of known frequency and striking it with a rubber pad. After that, it was held little above open end of tube in horizontal position so that the prongs vibrate in the vertical plane & which set air column of tube in resonant vibration.
3. For this, the level of water is adjusted approximately to about 16cm, 17cm, 22cm, 26cm, 29cm for the fork of frequencies 512 Hz, 480 Hz, 384 Hz, 288 Hz, respectively. [Large frequencies is preferred]

4. If loud sound is not heard, the level of the water it is slightly adjusted below or above to that suggested in step 3 for given frequency. When maximum loud sound is heard, the position of water is noted. This gives the first resonating length L_1 .
5. Now, the water level is lowered to about three times from the value L_1 . Then step 4 is repeated by slightly lowering or raising the water level for the approximate length of $3L_1$. This loud sound corresponding to the position of 2nd resonating length L_2 .
6. Step 4 and 5 are repeated for two times.
7. Then the room temperature and atmospheric pressure are also noted down.

OBSERVATION

LC of resonance tube = 0.1 cm

Vernier constant: $V.C. = 0.01 \text{ cm}$

Internal diameter of the resonance tube (d) = 2.75 cm

Room temperature (t) = 4°C 25°C

Atmospheric pressure =

Coefficient of cubical expansion of air (γ) =

Frequency of tuning fork (f) = 512 Hz

OBSERVATION TABLE

Table 1:- Observation table for internal diameter of resonance-tube.

No. of Obs	Reading of the			Total = (a+b) cm	Mean Diameter (d) cm
	Main scale (a) cm	Vernier scale (y) divs.	Value of Vernier scale reading $b = (y \times v.c.)$		
1	0.7 2.7	3	0.03	2.73	
2	0.7 2.7	2	0.02	2.72	
3	0.7 2.7	8	0.08	2.78	2.75
4	0.7 2.7	5	0.05	2.75	
5	0.7 2.7	7	0.07	2.77	

Internal diameter of tube = 2.75 cm

Table 2:- For determination of Velocity of sound in air

Position	No. of Obs.	Length of air column		Mean length cm	$V_t = 2f(L_2 - L_1)$ cm/s
		Increasing	Decreasing		
First resonance	1	17.5	19.6		
	2	19	20.6	$L_1 = 19.36$	
	3	18.7	20.3		
	4	18.4	20.2		
	5	19	20.3		40258.44 cm/s
Second resonance	1	58.4	59.6		
	2	58.3	59.7	$L_2 = 58.67$	
	3	58.2	59.8		
	4	58.9	60		
	5	58.5	59.7		

CALCULATIONS

The Velocity of sound in air at 25°C (or NTP)

$$V_0 = \sqrt{\frac{273}{273+t}} \times V_t$$

$$= \sqrt{\frac{273}{273+25}} \times 40253.44 \text{ cm}$$

$$= 38773.02 \text{ m/s} \quad 385.27 \text{ m/s}$$

End correction of resonance tube, $e = \frac{l_2 - 3l_1}{2}$

$$= \frac{58.67 - 3 \times (19.36)}{2} = \frac{59.76 - 58.08}{2}$$

$$= \frac{1.68}{2} = 0.84 \text{ cm}$$

$$= -0.42 \text{ cm}$$

$$= 0.42 \text{ cm}$$

RESULT

Hence, the velocity of sound in air at room temperature i.e. 25°C is 38773.02 m/s

And the end correction $e = 0.42 \text{ cm}$

CONCLUSION

Hence, the velocity of sound in air at room temperature and end correction of resonance tube was calculated.

PRECAUTIONS

1. Resonance tube should be vertical.
2. The tuning fork should be vibrated gently only by a rubber pad.
3. The prongs of the fork should be vibrated in a vertical plane above the open end of the tube.
4. The reading of the lower meniscus of the water level should be noted.
5. The vibrating fork should be held horizontally.

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EXPERIMENT NO: 6

DETERMINATION OF FREQUENCY OF AC MAINS
USING SONOMETER

APPARATUS REQUIRED

- 1) Bridges
- 2) Sonometer
- 3) Weight hanger
- 4) Horse shoe magnet
- 5) A set of slotted wt.
- 6) Micrometer screw gauge
- 7) Non-magnetic wire (brass)
- 8) Step down transformer and AC supply
- 9) At least five tuning forks (known frequency)

DISCUSSION OF APPARATUS

A sonometer is a hollow wooden box having thin stretched metallic wire under action of tension. It is used to determine the unknown frequency of given AC main source as well as tuning fork and also verify the laws of transverse vibration of string.

When AC signals is passed through the conductor, then the current direction reverse periodically and which consequently cause the reverse in dire-

ction of force. So, the conductor vibrates. Here, at condition of resonant vibration by adjusting the length of the wire segment, the frequency of AC source can be made equal to the natural frequency of the wire segment. As a result, the wire vibrates with maximum amplitude. At this stage the length of the wire segment is called the resonating length and it increases with increase in the mass of the suspended weights.

Further, ~~carrying~~ in the presence of magnetic field, current carrying conductor experiences a magnetic force, which is periodic i.e. In this case, the frequency of forced vibration is same as the frequency of AC.

THEORY

When the string segment of the length i.e. of the sonometer wire vibrates with maximum amplitude at resonant, the frequency of the applied AC is equal to the natural frequency of the wire.

At condition of resonance $(f)_{ac} = (f)_{\text{at resonance; for string}}$

$$\text{i.e. } (f)_{ac} = \frac{1}{2l} \sqrt{\frac{T}{\mu}}$$

where, $T = mg$ ∴ The tension of the wire and ' μ ' is the linear density or mass per unit length of the wire.

$$\mu = \frac{AP}{l} = \frac{\pi d^2}{4} \rho$$

where, d is the diameter of the wire and ρ is the density of its material.

PROCEDURE

- 1) At first, the sonometer is placed on the table and then attach a hanger of wt. (above 0.5 kg) at the free end of the string, which passes over the pulley.
- 2) The diameter is measured with screw gauge at different points along its length. The horse shoe magnet is placed at the middle of sonometer so as to produce a magnetic field perpendicular to the wire. The bridges are placed on either side of the magnet at equal distance from the magnet and are closed to each other.
- 3) The sonometer wire is connected to the AC power supply (2-4 V) but not more than this value otherwise overheating of the wire will be happened.

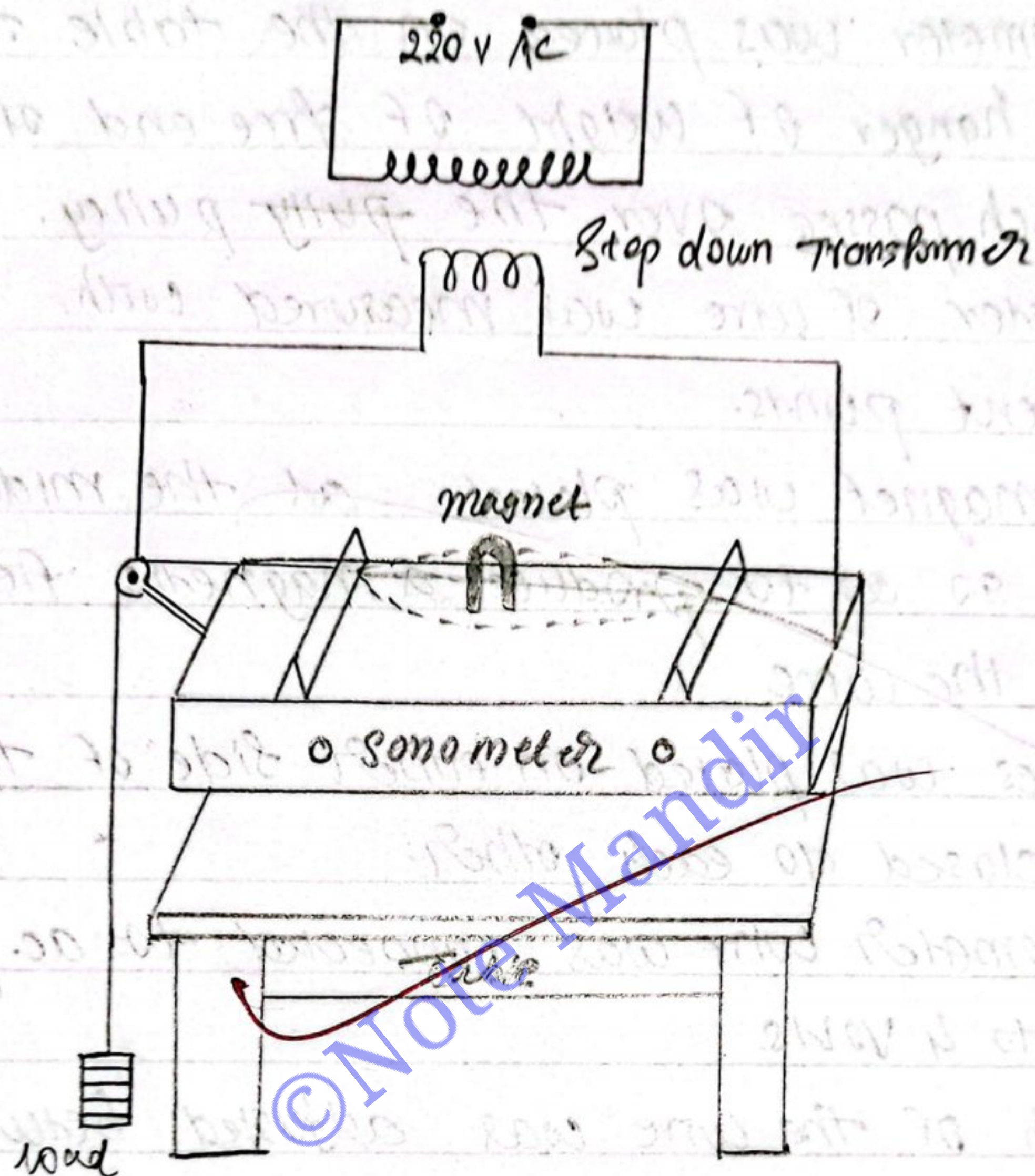


Fig: - Sonometer Experiment with a.c mains

$$f = \frac{1}{T}$$

The length of the wire will be happened is adjusted between the two bridges till the wire vibrates with maximum amplitude at resonance.

4) The resonating length (l) is noted down and step 6 and 7 are repeated with different tensions by increasing the wt. Some process is also repeated for decreasing load on the wire. The mass per unit length of wire μ , can be calculated by $\mu = \frac{\pi d^2 \rho}{4}$

5) By knowing the linear density μ of a wire, the frequency of AC mains supply is calculated by using the formula for given different value of load on wire.

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

OBSERVATIONS

For micrometer screw gauge:

Pitch (P) = 1 mm

Least count (L.C) = 0.01 mm

Zero error of instrument = -0.29 mm

Zero correction (a) = +0.29 mm

For frequency of AC Main:

a) Table for determination of the diameter of wire

S.N	M.S reading (x) mm	(S reading (y) (mm)	$y \times L.C$	Diameter $= x + (y \times L.C)$ (mm)	Mean diameter (d') mm	Corrected diameter $d = (d' \pm \sigma)$ (mm)
1)	0.2	93	0.93	1.13		
2)	0.2	86	0.86	1.06	1.086	0.996
3)	0.2	87	0.87	1.07		

b) Table for determination of frequency of AC mains

$\therefore$ Actual diameter = 7.96×10^{-4} m

Density of wire (ρ) = 8400 kg/m^3

S.N	Mass on the pan cm/kg	Tension $T = mg$ (N)	Resonating length (μ)m			$f = \frac{1}{2L} \sqrt{\frac{T}{\mu}}$	Mean Frequency (Hz)
			Increa- sing	Decre- asing	Mean		
					(μ)m		
1	0.5	5	0.49	0.47	0.48	36.02	
2	0.75	7.5	0.58	0.57	0.578	36.63	
3	1	10	0.65	0.66	0.65	37.62	37 Hz
4	1.25	12.5	0.725	0.73	0.73	37.45	
5	1.5	15	0.805	0.81	0.8025	37.32	

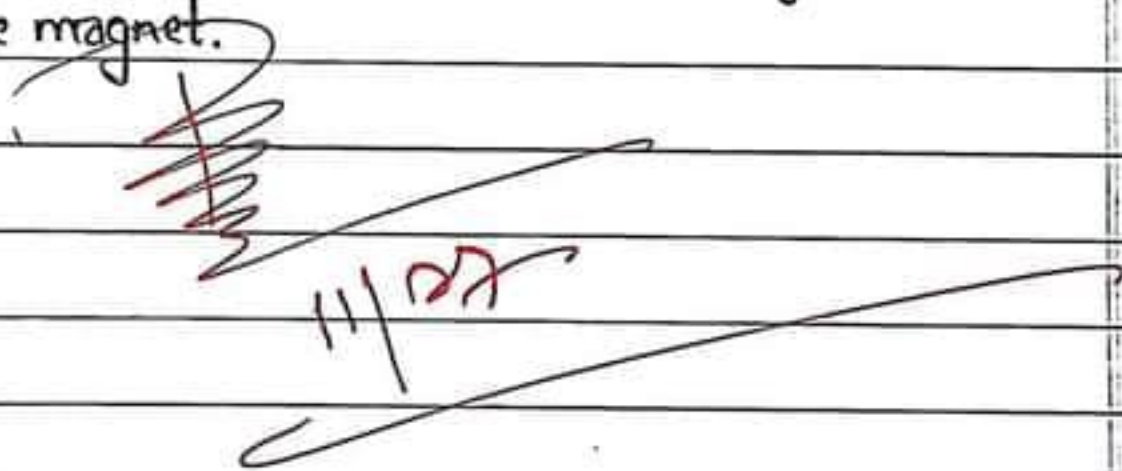
SOURCE OF ERROR

1) There may be kinks in the wire.

- 2) There may be friction in the pulley.
- 3) The resonant point may be not exact.
- 4) The wire may not be touching the bridges properly.

PRECAUTIONS

- 1) The sonometer wire should be uniform without kinks.
- 2) The pulley should be frictionless.
- 3) The diameter of the wire must be measured accurately at different points.
- 4) The wire should be horizontal and pass freely in between the poles of the magnet.



EXPERIMENT NO:-7

NAME OF EXPERIMENT:- TO DETERMINE THE RESISTANCE AND RESISTIVITY OF GIVEN UNKNOWN WIRE USING PO BOX.

APPARATUS REQUIRED

- 1 PO Box
- 2 Micro meter Screw gauge
- 3 Unknown wire
- 4 Galvanometer
- 5 Power supply
- 6 Connecting wire
- 8 Meter scale and thread

THEORY

→ PO box office is a compact form of wheat stone bridge. This device was first used in post office to find the resistance of telegram wire so it is named as post box. It works on the wheat stone bridge principle.

Let P , Q and R be resistance of arms respectively, AB , BC and CD . X be resistance of given wire which is connected between A and D . The value of R is varied by keeping P and Q constant in such a way that galvanometer shows null deflection. ~~At this~~

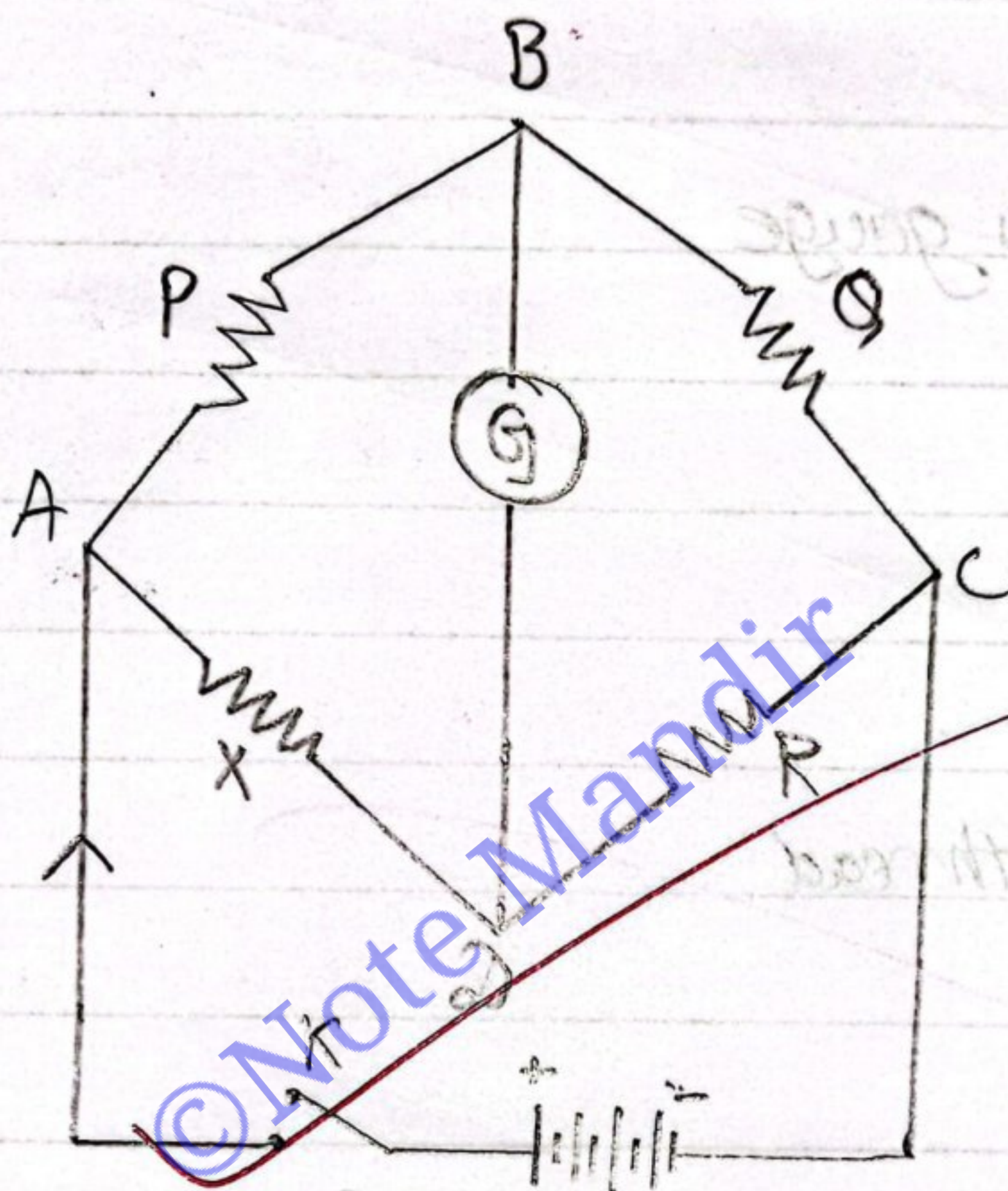


Fig: Wheat stone bridge

At this condition

$$\frac{P}{\phi} = \frac{X}{R}$$

$$\therefore X = \frac{PR}{\phi}$$

Let, L , d and A be the length, diameter and ~~etc~~ cross section area of given unknown wire.

Then resistivity of wire is given by

$$P = \frac{\rho A}{L}$$

$$P = \frac{\pi d^2 \rho}{4L}$$

PROCEDURE

1. Length and diameter of unknown wire was measured with the help of meter scale and micrometer screw gauge.
2. The circuit was connected.
3. $10\text{-}\Omega$, $10\text{-}\Omega$ plugs were taken out from AB and BC arms. Battery key K_1 and galvanometer key K_2 was pressed with no plug out from CD arms, deflection was observed and if infinity plug out from CD arm, deflection was observed in right.
4. Now, the ratio of P and ϕ was kept $10:10$, starting the value of R from zero for which the deflection of galvanometer is in opposite direction are found by trial.

5. The ~~Value~~ Value of R is adjusted beginning from zero for the change of direction of deflection in galvanometer.
6. Keeping the ratio arm $P:Q$ was $10:10$. The change of direction of deflection in the galvanometer was found by trial. And null point is noted.
7. Keeping the ratio arm $P:Q$ was $10:1000$ The value of R for which galvanometer shows null deflection is used for the calculation of unknown resistance X .

OBSERVATION

LC of meter scale = 1 cm

Length of wire (L) = 70 cm

For micrometer screw gauge

No. of circular scale division (N) = 100 divs

Value of 1 main scale division = 1 mm

$\therefore$ Pitch (P) = Value of 1 MSD = 1 mm

$$LC = \frac{P}{N} = \frac{1}{100} = 0.01 \text{ mm}$$

Zero error:

Correction (Z) = + 0.25 mm

Table-1:- For diameter of given unknown wire

No. of Obs	Main Scale reading (A) mm	Circular Scale reading (B) divs.	$C = (B \times LC)$	Total (A+C) mm	Mean diameter mm	Corrected diameter mm
1	0	70	0.7	0.7	.	
2	0	66	0.66	0.66	0.68	0.93
3	0	68	0.68	0.68		

Table 2: For the resistance of unknown wire

P:Q	Resistance in the CD arm (R)	Deflection of galvanometer	Remarks
	0	left	x lies between
10:10	∞	right	0-1
	1	right	$x = 0.5 \Omega$
	2	right	
	1	left	
10:100	2	left	x lies betn
	3	left	3-4
	4	right	$x = 0.35 \Omega$
	5	right	
	5	left	
10:1000	15	left	
	35	Slowly left	$x = 0.36 \Omega$
	36	Null	
	37	Slowly right	
	40		

CALCULATION

Resistance of unknown wire (x) = 0.36Ω

Resistivity of given unknown wire (ρ) = $\frac{\pi d^2 x}{4L}$

$$\frac{\pi (0.93 \times 10^{-3})^2 \cdot 0.36}{4 \times 0.7} \\ = 3.5 \times 10^{-7} \Omega \text{ m}$$

RESULT

The resistance and resistivity of unknown wire are found to be 0.36Ω and $3.5 \times 10^{-7} \Omega \text{ m}$ respectively

SOURCE OF ERROR

- 1 Plugs of the P.O box may be loose
- 2 May be due to the resistance of connecting wires
- 3 May be due to carelessness of the experiment

PRECAUTIONS

- 1 Plugs of P.O box should be tight
- 2 Connecting wires should be as short as possible
- 3 The connections should be made tight
- 4 The battery key should be pressed before galvanometer key

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EXPERIMENT NO:- 8

NAME OF EXPERIMENT:- DETERMINATION OF RESISTANCE AND RESISTIVITY OF THE GIVEN WIRE BY USING METER-BRIDGE.

APPARATUS REQUIRED

1. Meter bridge
2. Battery
3. Galvanometer
4. Jockey
5. Connecting wire
6. Four way key
7. Unknown resistance wire

THEORY

Meter bridge works on the wheat stone bridge principle. It can be used to ^{determine} ~~compare~~ the unknown resistance of wire. When the galvanometer shows null deflection then the bridge is in balanced condition. At the balanced condition the ratio of resistances in the two gaps is equal to the ratio of length of wire on the two ~~st~~ sides of the jockey. Let x be the length of wire between A and B. R be the unknown resistance of wires than at balanced condition.

$$\frac{x}{A} = \frac{100-L}{100-L}$$

PROCEDURE

1. A circuit was connected as unknown resistance x was connected across left gap and known resistance R is in right gap.
2. Plug 1 was removed from the commutator so that current flows from A to C.
3. The jockey is pressed and slid from one end or from A of wire until galvanometer shows null deflection, then length of wire from point A to balanced point was measured. Balance point was obtained again by sliding jockey from another end and noted the length of wire from end A to balanced point.
4. Using the formula resistance of x was determined.

OBSERVATION

Least count of meter scale = 0.1 cm

Length of wire (L) = 70 cm

For micrometer screw gauge

Number of circular scale division (N) = 100 div

$LC = 0.01$

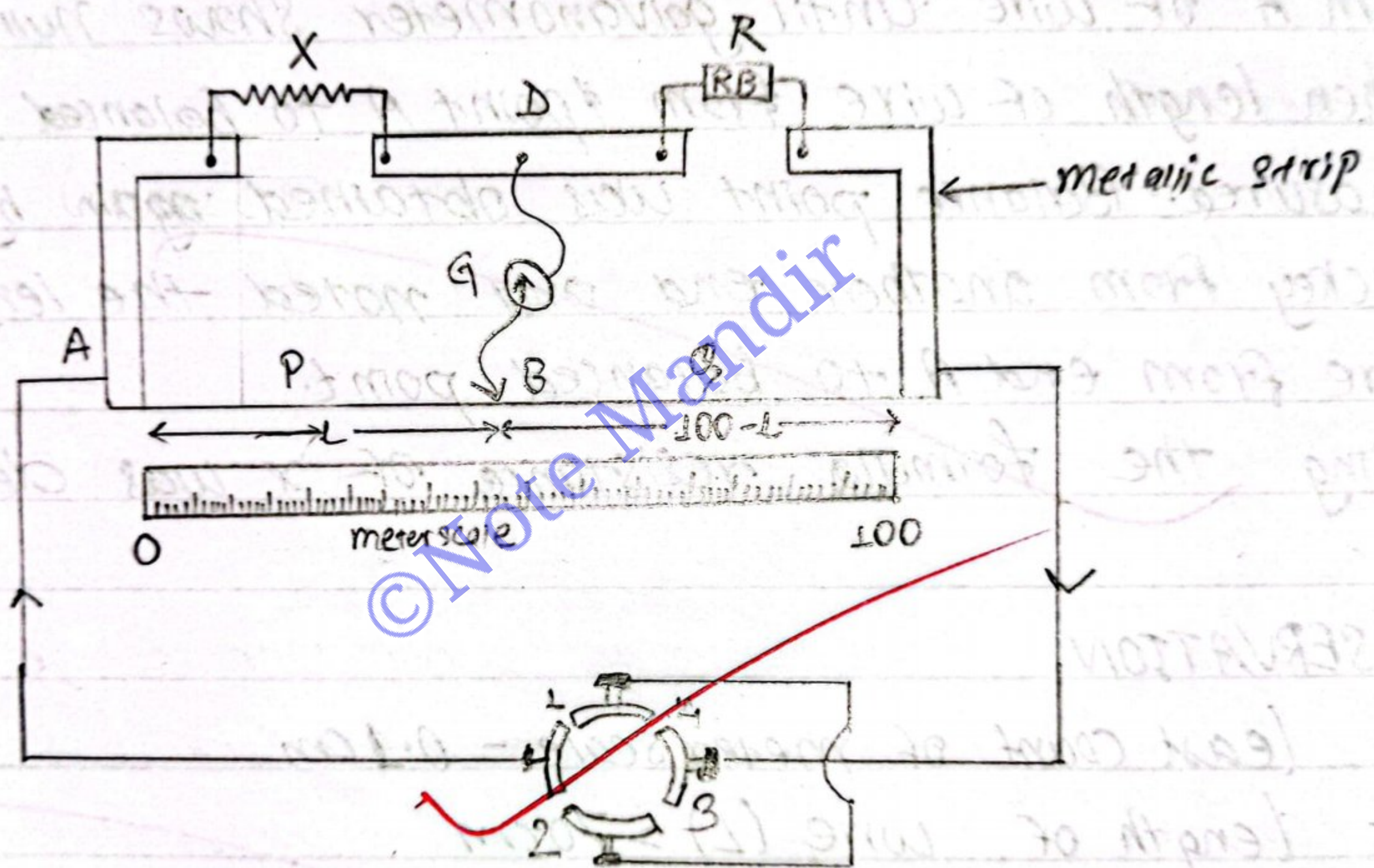


Fig :- Experimental circuit of meter bridge

Table-1: For diameter of given unknown wire

No. of Obs	Main scale reading (A) mm	Circular scale reading (B) divs	Value of CSD $C = (B \times L.C)$ mm	Total $(A + C)$ mm	Mean diameter (mm)
1	0	36	0.36	0.36	
2	0	34	0.34	0.34	
3	0	35	0.35	0.35	0.34
4	0	35	0.35	0.35	
5	0	34	0.34	0.34	

∴ Diameter of wire (d) = 0.34 mm
 $= 3.4 \times 10^{-3} \text{ m}$

Table-2:- For resistance of unknown wire

No. of Obs	Value of R	Length of balanced point from left end.	Direct current	Mean 'l'	Mean 100-L	$X = \frac{(100-L) \times R}{100}$	Mean X
			Sliding from left	Sliding from right			
1	1	14.4	14.5	14.45	8.55	0.169	
2	2	9.4	9.2	9.3	90.7	0.20	0.19
3	3	6.4	6.3	6.35	93.65	0.20	

∴ Resistance (X) = 0.19 Ω

Here,

$$\begin{aligned} \rho &= \frac{\pi d^2 R}{4L} \\ &= \frac{\pi \times 3.4 \times 10^{-3} \times 0.19}{4 \times 70} \\ &= 7.24 \times 10^{-6} \Omega \text{ mm} \end{aligned}$$

RESULT

The resistance and resistivity of given unknown wire are found to be 0.19Ω and $7.24 \times 10^{-6} \Omega \text{ mm}$ respectively.

Conclusion.

Hence, It can be concluded that by the use of meter bridge one can calculate the value of resistance and resistivity of given unknown wire.

SOURCE OF ERROR

1. Wire may not be uniform
2. May be loose connection

Signature
11/27

PRECAUTIONS

1. Wire in bridge should be uniform
2. The connection should be made tight
3. The jockey should be pressed gently while sliding

EXPERIMENT NO.-9

NAME OF EXPERIMENT:- TO DETERMINE THE ANGLE OF DIP IN THE LABORATORY BY USING A DIP CIRCLE

APPARATUS REQUIRED

- 1 Dip circle
- 2 A spirit level

THEORY

Angle of dip is the angle made by the total earth's magnetic field with its horizontal component at that place. The angle of dip varies from place to place at the earth's surface. Its value is 0° at the equator and 90° at the poles.

Angle of dip is measured with the help of dip circle.

The dip angle shown by the needle of dip circle when its plane is in the magnetic meridian is called true angle of dip (δ) or simply true dip.

But, the dip angle shown by the needle of dip circle when its plane is not in the magnetic meridian is called apparent angle of dip or simply apparent dip.

If δ_1 and δ_2 be the values of apparent dip angles at a place in two planes which are perpendicular to each other.

Then, the relation between real and apparent dips at that place is,

$$\cot^2 \delta = \cot^2 \delta_1 + \cot^2 \delta_2$$

$$\frac{1}{\tan^2 \delta} = \frac{1}{\tan^2 \delta_1} + \frac{1}{\tan^2 \delta_2}$$

PROCEDURES

A. By bringing dip circle in magnetic meridian:

1. Magnet and magnetic substances are removed from the working table.
2. The dip circle is placed on the table and leveled by using leveling screws with the help of spirit level.
3. The box of dip circle is rotated about the vertical axis until the magnetic needle becomes vertical and pointed along the $90^\circ-90^\circ$ line.
4. By keeping the position of vertical box same, the zero of vernier scale is brought to coincide zero position of horizontal circular scale at the base by rotating it.
5. From this position, the box is rotated further through 90° about the vertical axis over the horizontal scale to bring the plane of needle in the magnetic meridian. The readings of the upper end and the lower end of the dip-needle are taken.

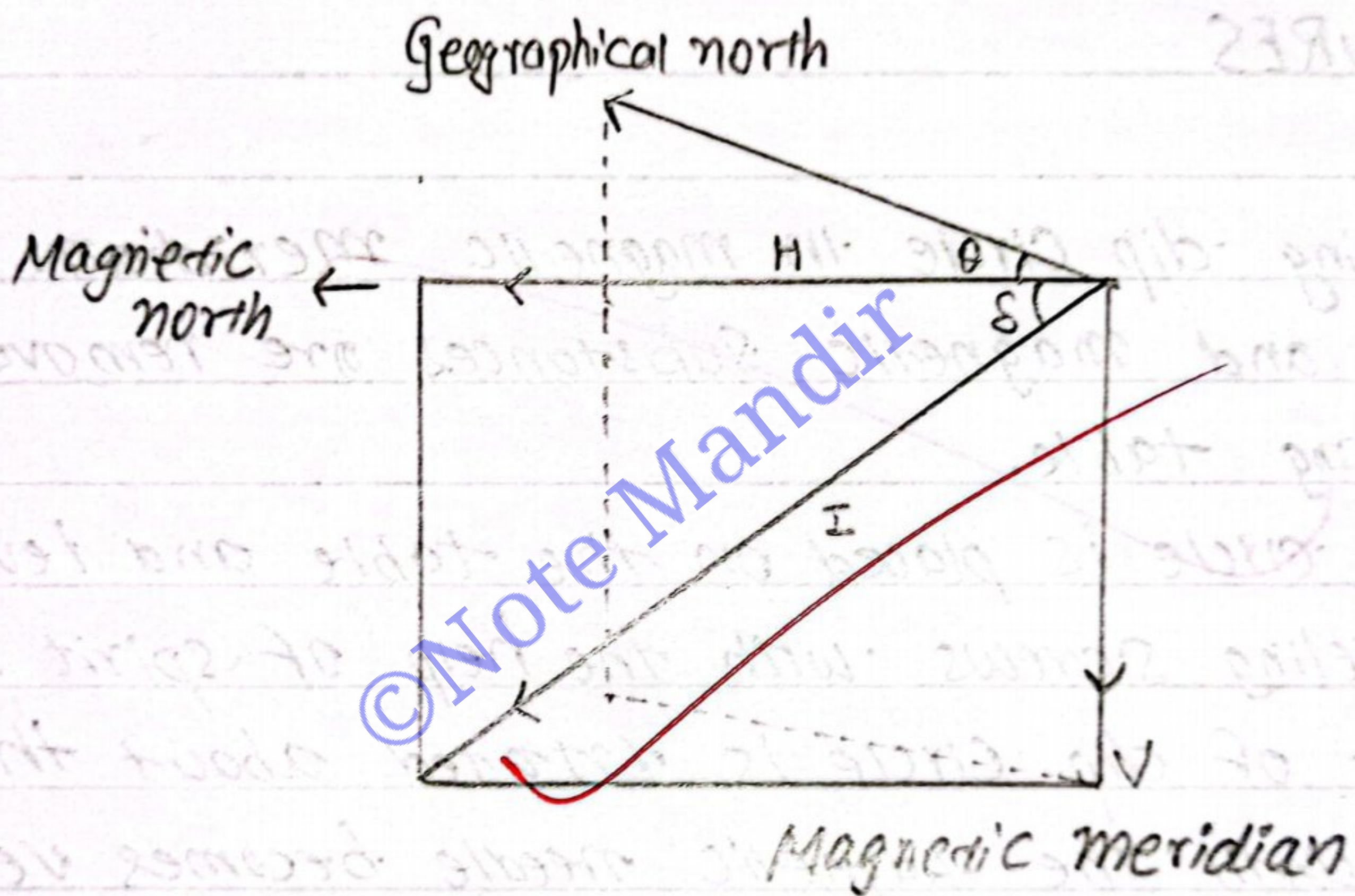


Fig (a)

6. The box is turned through 180° so that plane of dip circle is again in magnetic meridian. The readings of the upper end and the lower end of the dip-needle is taken. The mean of these four readings gives the value of true angle of dip at laboratory.

B. Without bringing the dip circle in the magnetic meridian:

1. Repeated Steps 1 and 2 as in case A
2. By keeping the position of vertical box, same, the zero of vernier scale is brought to coincide zero position of the horizontal circular scale at the base by rotating it.
3. Keeping the horizontal circular scale fixed, the vertical box is rotated about the vertical axis over horizontal scale by an angle θ . Then, the reading of the both ends of needle are noted.
4. The vertical box is further rotated by 180° from this position (i.e. $\theta + 180^\circ$) over horizontal scale & then reading of needle is noted down.
5. Mean of four readings gives the apparent dip of a plane.
6. Now, the box is rotated back to initial position (i.e. angle on horizontal scale is θ). It is rotated by 90° . Two Readings (top and bottom) of dip needle are taken.

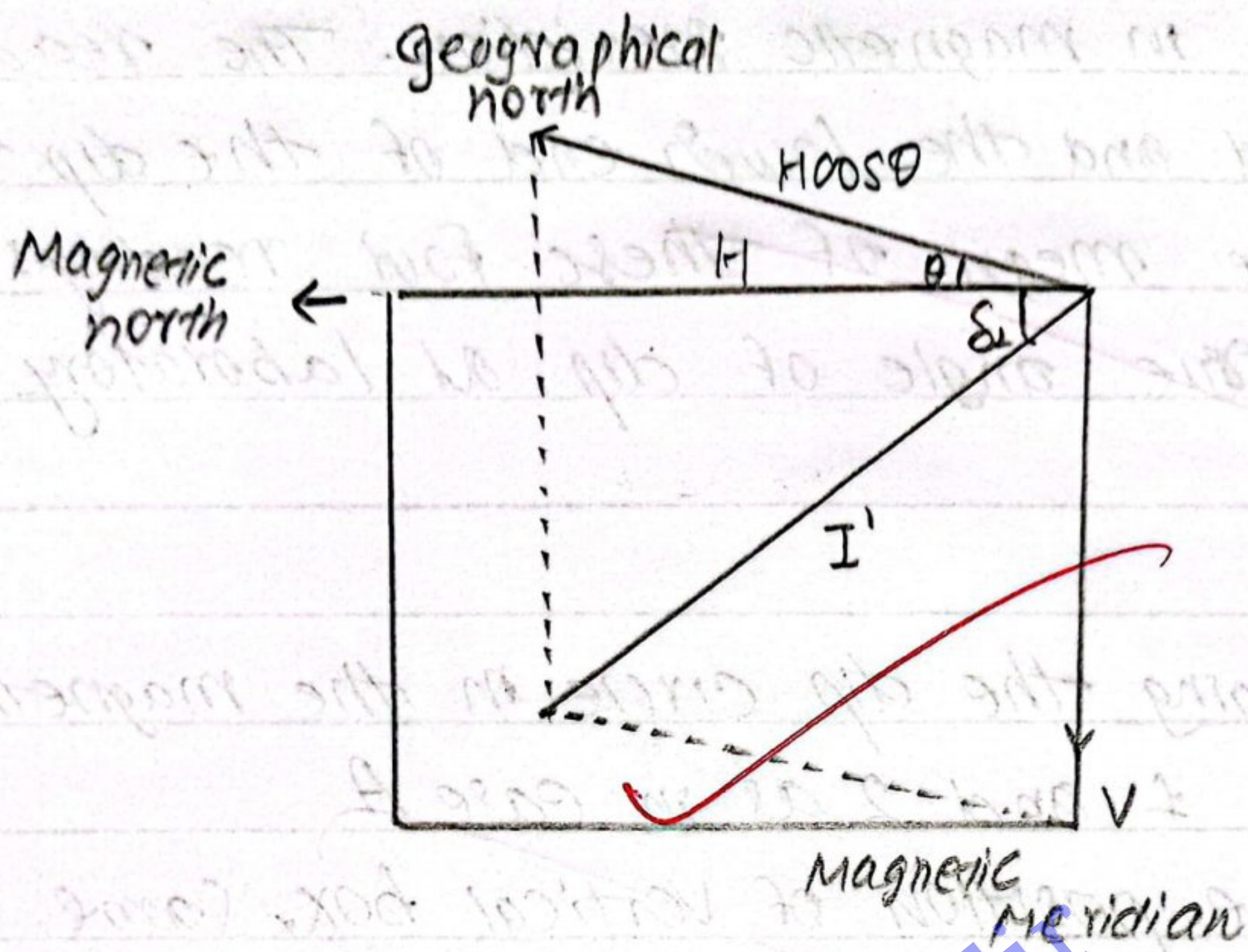


Fig (b)

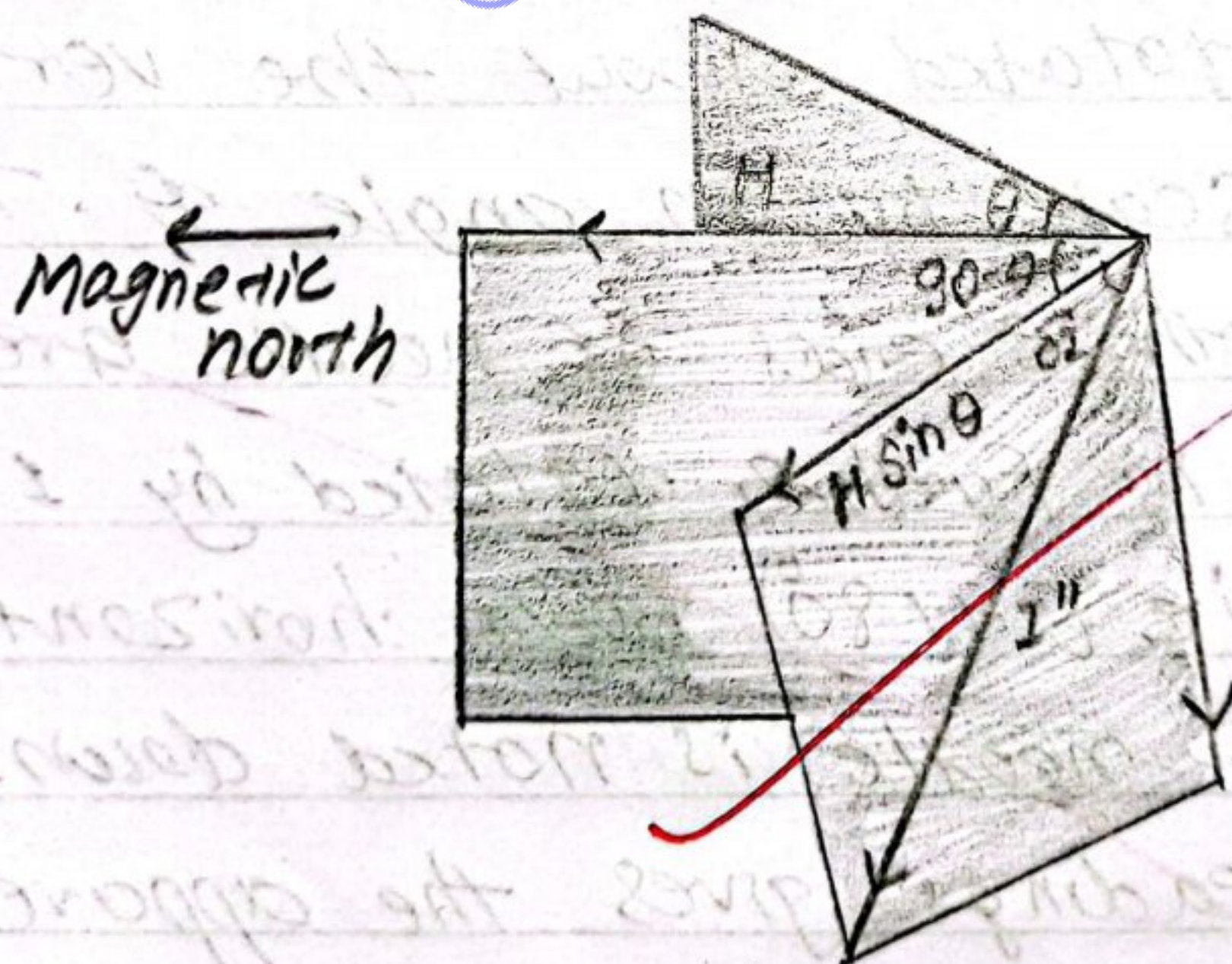


Fig (c)

The vertical box is further rotated by 180° from this position (i.e. $0 + 90^\circ + 180^\circ = 0 + 270^\circ$ position) ~~over~~ over horizontal scale, & then two readings (top and bottom) of needle are noted.

7. Mean of four readings gives the apparent dip of a plane perpendicular to the first plane.
8. Finally by using the formula the true angle of dip is calculated.

OBSERVATION

LC of vertical scale = 1°

Table 1

No. of Obs	Position at which the box is fixed	Reading of dip Needle		Mean δ
		Upper end	Lower end	
1	90°	45	45	$\delta' = 36$
2	$90^\circ + 180$	27	27	

Table 2

No. of Obs	Position at which the box is fixed	Reading of dip Needle		Mean
		Upper end	Lower end	
1	10°	51	50	$\delta_1 = 55.5$
2	$10^\circ + 180^\circ$	60	59	
3	$10^\circ + 90^\circ$	50	50	$\delta_2 = 41.5$
4	$10^\circ + (90^\circ + 180^\circ)$	33	33	

CALCULATION

Here, From the above table. 2, we have

$$\cot^2 \delta = \cot^2 \delta_1 + \cot^2 \delta_2$$

$$\text{or } \frac{1}{\tan^2 \delta} = \frac{1}{\tan^2 \delta_1} + \frac{1}{\tan^2 \delta_2}$$

$$\text{or } \tan^2 \delta = \frac{\tan^2 \delta_1 \cdot \tan^2 \delta_2}{\tan^2 \delta_1 + \tan^2 \delta_2}$$

$$\text{or } \delta = \tan^{-1} \left(\sqrt{\frac{\tan^2 \delta_1 \cdot \tan^2 \delta_2}{\tan^2 \delta_1 + \tan^2 \delta_2}} \right)$$

$$[\text{Where } \delta_1 = 55^\circ, \delta_2 = 41.5^\circ]$$

$$\text{or } \delta = \tan^{-1} \left(\sqrt{\frac{\tan(55)^2 \cdot \tan(41.5)^2}{\tan(55)^2 + \tan(41.5)^2}} \right)$$

$$\text{or } \delta = \tan^{-1}(0.752)$$

$$\text{or } \delta = 36.94^\circ$$

Thus, The value of angle of dip founded by bringing the dip circle in magnetic meridian is 36°

Further, The value of angle of dip founded by without bringing the dip circle in magnetic meridian is 36.94°

$$\therefore \text{Average value of true angle of dip} (S_{\text{avg}}) = \frac{\delta + \delta'}{2}$$

$$\frac{36.94 + 36}{2} = 36.47^\circ$$

CONCLUSION

Hence, it can be concluded that with the help of dip circle, the angle of dip at a place can be determined.

SOURCES OF ERROR

1. May be due to presence of magnetic materials near the working table.
2. May be error in levelling of the dip circle.
3. Improper position of pointers of the needle in vertical scale.

PRECAUTIONS

1. The dip circle should be leveled properly with the help of spirit level.
2. The magnetic substance should be removed from the working table.
3. The window of the box should be closed while taking reading.

21/11/27

EXPERIMENT NO:- 10

NAME OF EXPERIMENT:- TO VERIFY THE LAWS OF PARALLEL COMBINATION OF RESISTANCE USING METER-BRIDGE

APPARATUS REQUIRED

- 1 Meter bridge
- 2 Battery
- 3 Four way key (commutator)
- 4 Connecting wire
- 5 Galvanometer
- 6 Two unknown resistance wire
- 7 Jockey

THEORY:

Metre bridge work on the principle of wheat stone bridge. It can be used to compare the unknown resistance of two wires. When the galvanometer shows null deflection then the bridge is in balanced condition. At the balanced condition, the ratio of resistance in the two gap is equal to the ratio of length of wire on two sides of the Jockey.

Let 'l' be the length of wire between A and B. X be the unknown resistance of wire

$$\frac{X}{R} = \frac{l}{100-l}$$

PROCEDURE

1. A circuit was connected as unknown resistance 'X' was connected across left gap and known resistance R in right gap.
2. The jockey is pressed and slid from one end or from A of wire. Galvanometer shows null deflection. Then again jockey slid from end of meter bridge. Length was noted.
3. The resistance of second wire is also calculated as above.
4. And again, the resistance wire is connected in parallel combination and resistance was calculated.
5. Using formula, the resistance of X was calculated.

OBSERVATION

Table-1 :- Resistance of 1st unknown wire

No. of Obs	Value of R	Length of balanced point from left end	Mean l'	100-l	$X = \frac{R \cdot l}{100-l}$	Mean X_1
Direct Current						
		Sliding from left	Sliding from right			
1	14.4	14.5	14.45	85.55	0.168	
2	9.4	9.2	9.3	90.7	0.20	0.19
3	6.4	6.3	6.35	93.65	0.20	

$\therefore$ Resistance of $(X_1) = 0.19 \Omega$

Table-2: Resistance of second unknown wire

No. of Obs	Value of R	Length of balance point from left end		Mean (l)	100-l	$\frac{l}{100-l} \times R$ $X_2 = \frac{l}{100-l} \times R$	mean (X_2)
		Direct Current					
		Sliding from left	Sliding from right				
1	1	12.8	12.5	12.65	87.35	0.145	
2	2	8.2	8.1	8.15	91.85	0.177	0.173
3	3	6.1	6.3	6.2	93.8	0.198	

$\therefore$ Resistance (X_2) = 0.173 Ω

Table-3:- Resistance of parallel combination of unknown wire X_1 and X_2

No. of Obs	Value of R	Length of balance point from left end		Mean (l)	100-l	$\frac{l}{100-l} \times R$ $X_p = \frac{l}{100-l} \times R$	mean (X_p)
		Direct Current					
		Sliding from left	Sliding from right				
1	1	6.2	6.4	6.3	93.7	0.067	
2	2	3.2	3.2	3.2	96.8	0.066	0.067
3	3	2.1	2.3	2.2	97.8	0.067	

$\therefore$ Resistance (X_p) = 0.067 Ω

Table-4:

X_1	X_2	Parallel combination	
		Calculated $\left(\frac{X_1 \times X_2}{X_1 + X_2}\right)$	Observed (X_p)
0.19	0.173	0.09	0.087

RESULT

The Observed and calculated value of resistance of parallel combination are found to be almost equal.

CONCLUSION

Here, The law of parallel combination of resistance are verified.

SOURCE OF ERROR

- 1 Wire may not be uniform
- 2 May be loose connection
- 3 May be due to carelessness of the experiment
- 4

PRECAUTION

- 1 Wire in bridge should be uniform
- 2 The jockey should be pressed gently
- 3 All key should be tight.