Experiment - Verification of Ohm's Law

Objective - To verify Ohm's Law.

Apparatus - Ohm's Law trainer having milli-ammeter, voltmeter, rheostat, connecting wires.

Theory - Ohm's Law deals with the relationship between voltage and current in an ideal conductor. This relationship states that: "The potential difference (voltage) across an ideal conductor is proportional to the current through it. The constant of proportionality is called the 'resistance', R. Ohm's Law is given by -

$$V = IR$$

where V is the potential difference between two points which include a resistance R. I is the current flowing through the resistance.

OR

Ohm's Law states that the current through a conductor between two points is directly proportional to the voltage across the two points, and inversly proportional to the resistance between them.

$$I = V/R$$

Ohm's Law is among the most fundamental relationships in Physics. It relates the current, voltage and resistance for a circuit element so that if we know the two of the three quantities we can determine the third. Thus, if we measure the current flowing in a resistor of known value, we can deduce the voltage across the resistance according to $V = IR$. Similarly if we measure the voltage across a resistor and the current through it, we calculate the resistance of the element to be $R = V/I$.

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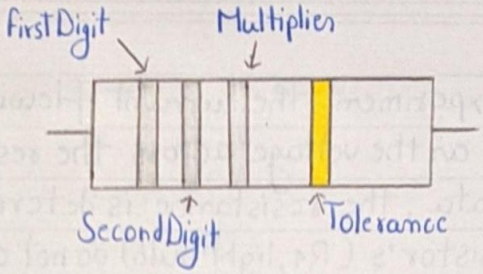
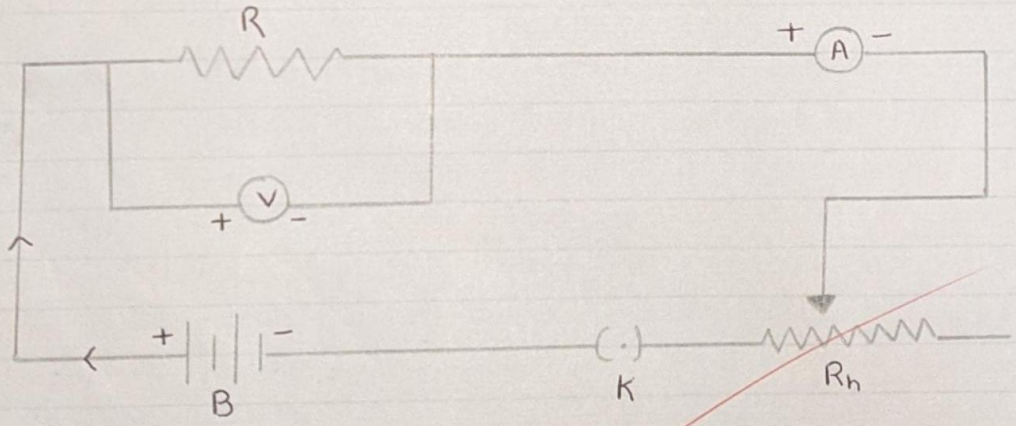
Color	Number	Multiplier
Black	0	10^0
Brown	1	10^1
Red	2	10^2
Orange	3	10^3
Yellow	4	10^4
Green	5	10^5
Blue	6	10^6
Violet	7	10^7
Gray	8	10^8
White	9	10^9



Tolerance	
Gold	5%
Silver	10%
(No Band)	20%

Circuit Diagram -



A - Ammeter
V - Voltmeter
R - Resistor
B - Battery
K - Key
R_h - Rheostat

In this experiment current flows through a resistor will be measured as the voltage across the resistor is varied. From the graph of the data, the resistance is determined for Ohmic resistors. Non Ohmic resistors (R4, light bulb) do not Obey Ohm's Law.
Ammeters are connected in series so that the current flows through them. The ideal ammeter has a resistance of zero so that it has no effect on the circuit. Real ammeters have some internal resistance.
Voltmeters are connected in parallel to resistive elements in the circuit so that they measure the potential difference across (one each side of) the element. The ideal voltmeter has infinite internal resistance. In practice, voltmeters have approximately several mega Ohm's of internal resistance so that only a minuscule ammount of current can flow through the voltmeter. This keeps the voltmeter from becoming a significant path for current around the element being measured.
Resistors are labeled with color-coded bands that indicate resistance and tolerance. The first two colour bands give the first two digits of the value. The third band gives the multiplier for the first two, in powers of 10. The last band is the tolerance meaning the true value should be ±X% of the color code value. For examples, a resistor that has two red bands a black multiplier bands has a resistance of 22 ohms.

Procedure - Set the voltage to various value from 0 to 5 V. in steps of 0.5 V and note down the corresponding value of Current.
Plot I as a function of V. (I on Y axis and V on X-axis).
Find the slope of the Curve.

Slope = 1/R

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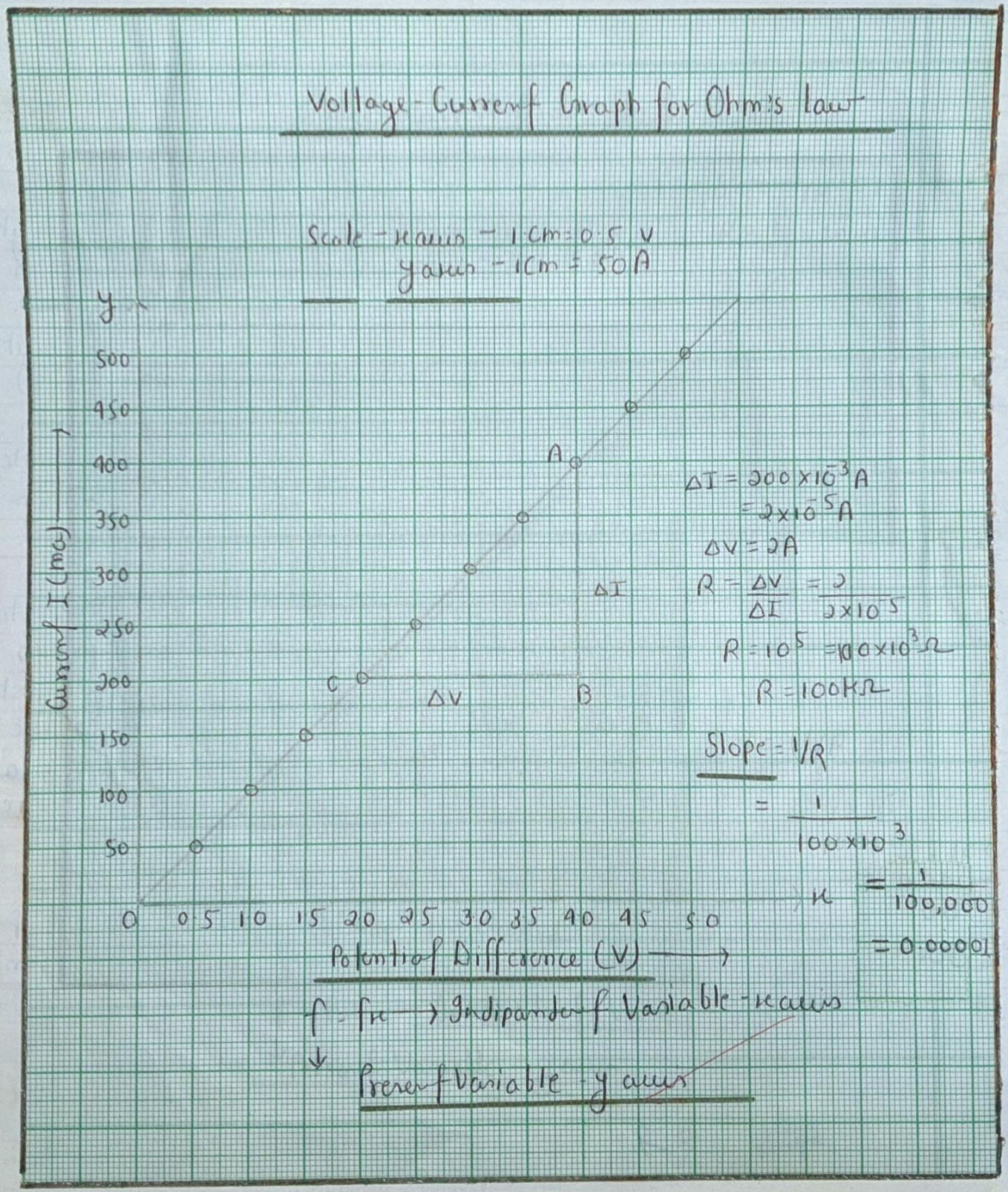
Voltage - Current Graph for Ohm's Law



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Observation Table

S.No.	Voltage (In Volts)	Current (in ma)	Current (in A)	R=V/I (in ohm)
1	0.5V	50ma	0.05A	10Ω
2	1.0V	100ma	0.1A	10Ω
3	1.5V	150ma	0.15A	10Ω
4	2.0V	200ma	0.2A	10Ω
5	2.5V	250ma	0.25A	10Ω
6	3.0V	300ma	0.3A	10Ω
7	3.5V	350ma	0.35A	10Ω
8	4.0V	400ma	0.4A	10Ω
9	4.5V	450ma	0.45A	10Ω
10	5.0V	500ma	0.5A	10Ω

Result - By observing the observation table, it is proved that the ratio of potential difference and current is constant, further the graph between V and I is a straight line. Thus, potential difference at the ends of the conductor is directly proportional to the current flowing through it. Thus Ohm's Law is verified by this experiment.

Precautions - 1. All the connection should be tight.

2. Ammeter is always connected in series in the circuit while voltmeter is parallel to the conductor.

3. The electrical current should not flow the circuit for long time otherwise its temprature will increase and the result will be affected. (Because the Physical State of the Conductor (temprature, pressure etc.) should be unchanged.)

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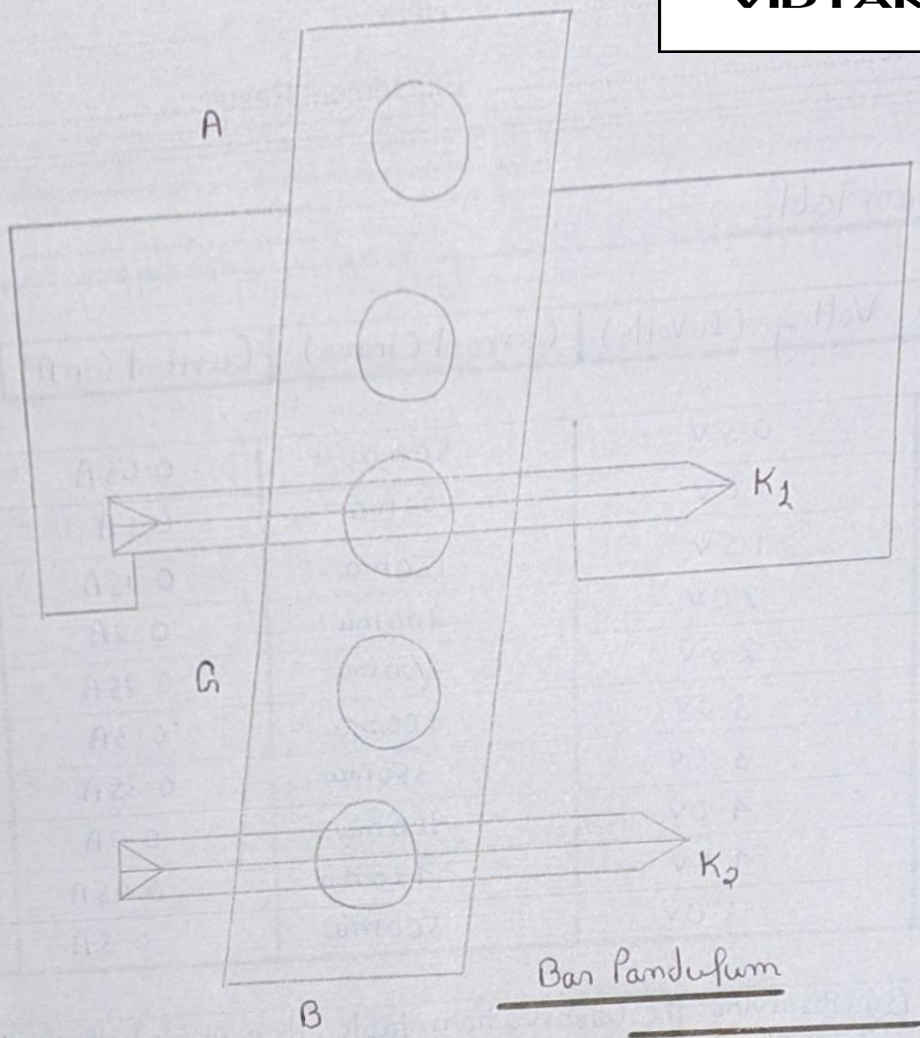

Bar Pendulum

Observation -

Table of measurment of l and T -

No. of Hole	Distance of C.G. from hole (m)	No. of Oscilation	Time Taken(s)	Preodic Time
1	0.45	20	31.7	1.58
2	0.40	20	30.9	1.54
3	0.35	20	30.6	1.53
4	0.30	20	30.5	1.52
5	0.25	20	20.6	1.53
6	0.20	20	30.0	1.56
7	0.15	20	33.8	1.69

Position of GG -

0.15	20	33.9	1.69
0.20	20	31.5	1.57
0.25	20	30.6	1.53
0.30	20	30.8	1.52
0.35	20	30.6	1.53
0.40	20	31.1	1.55
0.45	20	31.6	1.57

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Measurment of acceleration due to gravity (g) by a bar Pendulum

Aim - To determine the value of g with the help of bar pandulum.

Apparatus used - Bar Pandulum, Stop watch, Knife edges, rigicaf support.

FormulaUsed - The value of g can be calculated by the following formula -

$$T = 2\pi\sqrt{L/g}$$

$$g = \frac{4\pi^2 l}{T^2}$$

where, L = The distance between the sespension and oscilatiam.

$$\frac{\left(\frac{k^2}{l} + l\right)}{}$$

T = time period

Discription of Apparats - A bar pandulum consists of a uniform rect-angular bar abaut one meters long with holes drilled along its lenght at eaual distance from the other. The centre lies on the straight line passing through the centre of gravity of the pandulum. A Sharp knife edge is attached to same heavy frame provided with levedding screws to make the knife edge Horizontaf.

Principle - The principle is based an the inter changeability of the centers of suspensian and oscilafiam. The time period are remain same for the suspension point and the correspondent oscilatian point.

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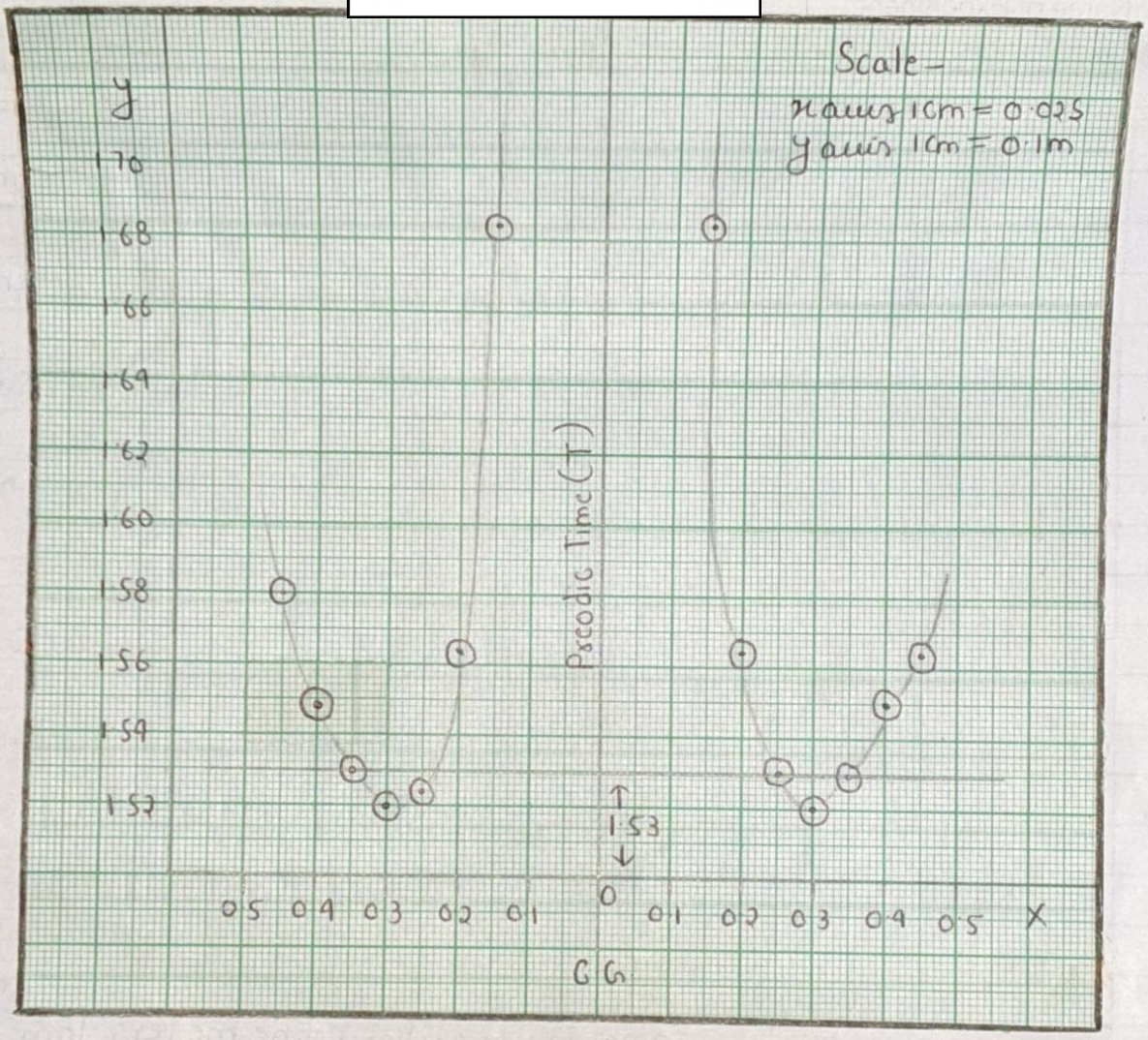

From graph -

$L = AC + BD/2 = 0.6 + 0.6/2 = 0.6\,m$

$T = 1.53\,Sec$

So by the formula - $g = \frac{4\pi^2 L}{T^2} = \frac{4 \times (3.14)^2 \times 0.6}{(1.53)^2}$

$= \frac{4 \times 9.8596 \times 0.6}{2.3409} = 10.1124\,m/s^2$

The distance between these two points is given by the following formula –

$$L = K^2/l + l$$

with the help of L, (g) can be calculated.

$$g = \frac{4\pi^2 l}{T^2}$$

Result - The value of acceleration due to gravity -

$$g = 10.1124 \text{ m/s}^2$$

Standard Result – The value of $g = 9.8 \text{ m/s}^2$

Percentage error - $\frac{\text{Standard Value} - \text{experimental value}}{\text{Standard Value}} \times 100$

$$= \frac{9.8 - 10.1124}{9.8} \times 100$$

$$= \frac{0.3124}{9.8} \times 100$$

$$= 3.187\% \approx 3\%.$$

Sources of error - ① The knife edge made to be Horizontal.
② The amplitude of oscilation should be small.
③ Curve Should be drawn Smoothly.
④ Pandulum Should be Vibrate only in Vertical plane.

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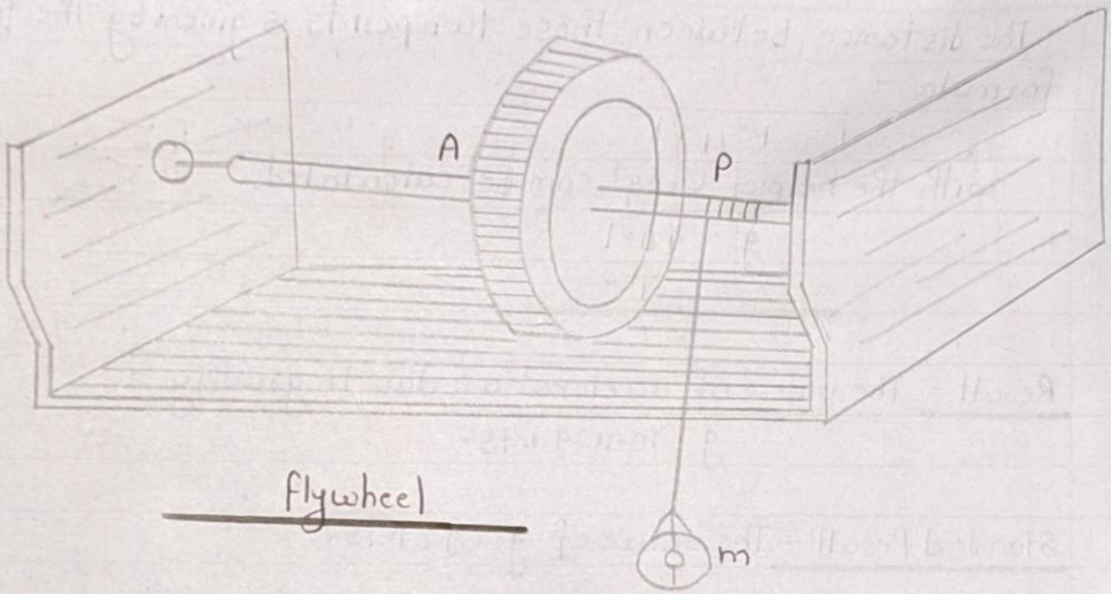

Flywheel

Observation -

Table of determination of n_1, n_2, S, t

S No.	Total load applied m kg	n_1	n_2	t
1	500g	10	22	22.65
2	0.5 Kg	5	17	18.25
3	1 Kg	6	31	28.35
4	1.5 Kg	8	46	33.15
5	1.5 Kg	2	30	235
6	1.5 Kg	4	40	61.15
7	2 Kg	5	67	39.25

M.S.R = 2.2 cm = 22mm

V.S.R = 6 × 0.1 = 0.06mm

T.S.R = 22.06 mm = 2.206 cm

$r = D/2 = 2.206/2 = 1.102$ cm

Radius $r = D/2$

Least Count - $\frac{\text{Main Scale Radius (L.C)}}{\text{Total No. of Division in V.S}} = \frac{0.1}{10} = 0.01$mm

Moment of Inertia of a — Flywheel

Aim - To determine the moment of inertia of a fly wheel about its own axis of rotations.

Apparatus used - flywheel, meter Scale, Vernier callipers, Stopwatch Set of weights and a pan.

Formula used - The moment of Inertia I of the flywheel is given by -

$$I = \frac{mr\left(\frac{gt^2 n_1}{4\pi^2 n_2^2} - r\right)}{\left(1 + \frac{n_1}{n_2}\right)}$$

where m = mass suspended at the end of String.

r = radius of the axle.

n_1 = number of revolutions made by the wheel before the wheel.

n_2 = number of revolutions made by the flywheel.

t = time taken by the wheel in n_2.

g = acceleration due to gravity.

Description of Apparatus - A flywheel is a large heavy wheel, through the centre of which passes along cylindrical axle, The centre of gravity lies on its axis of rotation So that when it is mounted over the hell bearings. it comes to rest in any desired position. To increase the moment of inertia it is usually made thick at the rim as :-

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Calculation:-

$$I_1 = \frac{500 \times 1.102\left(\frac{9.8\times(22.6)^2\times 10}{4\times 3.14\,(22)^2} - 1.102\right)}{1+10/22} = 0.1635\ \text{Kgm}^2$$

$$I_2 = \frac{0.5\times 1.102\left(\frac{9.8\times(18.2)^2\times 5}{4\times 3.14\,(17)^2} - 1.102\right)}{1+5/17} = \frac{0.0183\times 11.196\times 30}{38} = 0.1617\ \text{Kgm}$$

$$I_3 = \left.1\times 1.102\left(\frac{9.8\,(28.3)^2\times 6}{4\times 3.14\,(31)^2} - 1.102\right)\right/ 53 = \frac{9.4373}{53} = 0.1781\ \text{Kgm}^2$$

$$I_4 = \frac{1\times 1.102\left(\frac{9.8\,(33.1)^2\times 8}{4\times 3.14\,(46)^2} - 1.102\right)}{1+8/46} = \frac{1.102(199.36-1.102)}{54/46} = 0.1798\ \text{Kgm}^2$$

$$I_5 = \frac{1.5\times 1.102\left(\frac{9.8\times(61.1)^2\times 4}{4\times 3.14\,(40)^2} - 1.102\right)}{1+9/40} = \frac{1.5\times 1.102\,(265.04-1.102)}{1.1} = 0.1181\ \text{Kgm}^2$$

$$I_6 = \frac{1.5\times 1.102\left(\frac{9.8\,(23)^2\times 2}{4\times 3.14\,(30)^2} - 1.102\right)}{1+2/30} = \frac{1.5\times 1.108\,(183.7\times 1.102)}{32/30} = 0.186\ \text{Kgm}^2$$

$$I_7 = \frac{2\times 1.102\left(\frac{9.8\,(39.2)^2\times 5}{4\times 3.14\,(67)^2} - 1.102\right)}{1+5/67} = \frac{2.204\,(278.25-1.102)}{72/67} = 0.1921\ \text{Kgm}^2$$

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Calculation -

$$I = \frac{mr\left(\frac{gt^2 n_1}{4\pi^2 h} - r\right)}{\left(1 + n_1/n_2\right)}$$

So mean,

$$MI = \frac{0.1635 + 0.1617 + 0.1781 + 0.1798 + 0.1861 + 0.1881 + 0.1921}{7}$$

$$MI = 1.0812\ Kgm^2 = 0.1779\ Kgm^2$$

1.0812
0.1779 Kg/m²

Result - The moment of the inertia of the flywheel is

Precautions and Sources of error -

1. There should be uniform winding on the axle.
2. The string loop should be loose.
3. Friction should be made small by greasing the ball bearings.
4. The dia meters of axle should be measured of various points.
5. Mass should fall freely.
6. Mass should start with zero velocity.

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