

FIND VOLUME OF A CYLINDER BY VERNIER CALLIPERS

APPARATUS:

- * Vernier Callipers.
- * Solid cylinder.

PROCEDURE:

1. Find vernier constant of vernier callipers.
2. Find zero error and zero correction of vernier callipers.
3. To find the length, place the cylinder lengthwise and for measure the diameter place it diametrically between the lower jaws.
4. Note the main scale reading (M) just to the left of the vernier.
5. Note the main scale division (M) coinciding with main scale division and multiply it with vernier constant to get the fraction to be added (F).
6. Add main scale reading with fraction (F) to get observed reading.

7. In case of zero error apply zero correction to get the total reading of length and diameter of cylinder.

8. Repeat it three times to take their mean value.

9. Calculate area of cross section by $A = \pi r^2$

10. Find the volume of cylinder by $V = A \times l = \pi r^2 l$

PRECAUTIONS:

1. Measure the length and diameter at different positions.

2. Jaws should not be pressed very hard.

3. Vernier reading should be observed normally.

4. Zero correction must be applied in case of zero error.

Observation

$$L.C = \frac{\text{Smallest division on main scale}}{\text{Total no. of divisions on vernier scale}} = \frac{1}{10} = 0.1 \text{ mm} \text{ or } 0.01 \text{ cm}$$

$$Z.E = \pm \text{null cm}$$

$$\text{Zero correction} = \pm \text{null cm}$$

Table

Quantity to be measured	No. of Obs.	Main scale Reading M (cm)	Vernier scale Reading N(div)	Fraction to be added $f = N(0.01)$	Observed Reading $R = M + f$ (cm)	Mean (cm)
Length	1	2.4	2	0.02	2.42	$l = 2.43$ (cm)
	2	2.4	3	0.03	2.43	
	3	2.4	4	0.04	2.44	
Diameter	1	0.8	5	0.05	2.45	$d = 0.86$ cm
	2	0.8	6	0.06	2.46	
	3	0.8	7	0.07	2.47	

Calculation

$$\text{Mean diameter of cylinder} = d = 0.86 \text{ cm}$$

$$\text{Radius of cylinder} = r = \frac{d}{2} = 0.43 \text{ cm}$$

$$\text{Mean length of cylinder} = l = 0.23 \text{ cm}$$

$$\text{Volume} = \pi r^2 l = (3.14) \times (0.43)^2 \times (0.23) = 1.41 \text{ cm}^3$$

"EXPERIMENT"

(i) AREA OF CROSS SECTION OF A GIVEN WIRE BY USING MICROMETER SCREW GAUGE

APPARATUS:

* Screw Gauge.

* Wire.

PROCEDURE:

Area of cross section of wire.

1. Find the pitch of screw gauge.

2. Find least count of screw gauge.

3. Find the zero error and zero correction.

4. Note the linear scale reading (M).

5. Note the circular scale division coinciding with pitch line and multiply it with least count to get the fraction to be added (F).

6. Add the main scale reading and fraction to get the observed diameter of wire.

7. In case of zero error apply

Observation

$$\text{Least count} = \frac{\text{Pitch of screw}}{\text{Total no. of divisions on circular scale}} = \frac{0.5 \text{ mm}}{50} = 0.01 \text{ mm} \text{ or } 0.001 \text{ cm}$$

$$\text{Zero error} = \pm \text{null mm}$$

$$\text{Zero correction} = \pm \text{null mm}$$

Table

Quantity to be measured	No. of Obs.	Main scale Reading M (mm)	Circular Scale Reading N (div)	Fraction to be added $f = (N \times 0.01)$	Observed Reading $R = M + f$ (mm)
Diameter	1	0.5	47	0.47	0.97
	2	0.5	47	0.47	0.97
	3	0.5	47	0.47	0.97

Calculation

$$\text{Mean diameter} = d = 0.97 \text{ mm}$$

$$\text{Mean radius} = r = \frac{d}{2} = \frac{0.97}{2} = 0.485 \text{ mm}$$

Area of cross section of wire

$$= A = \pi r^2$$

$$= 3.14 \times (0.485)^2$$

$$= 0.738$$

(ii) VOLUME OF A SMALL SPHERE USING MICROMETER SCREW GAUGE.

PROCEDURE:

Volume of a small sphere.

1. Find the pitch of screw gauge.
2. Find the least count of screw gauge.
3. Find zero error and zero correction.
4. Place the wire between the studs and rotate the milled head slowly until the sphere is pressed gently.
5. Note the linear scale reading (M).
6. Note the circular scale division coinciding with pitch line and multiply it with least count to get the fraction to be added (F).
7. Add the main scale reading and fraction to get the observed diameter of wire.

In case of zero error apply zero correction to get the total value of diameter of wire.

Repeat it three times to take their mean value.

Find radius ' r ' of the sphere.

Find the volume of sphere by using $V = \frac{4}{3} \pi r^3$.

PRECAUTIONS:

Measure the diameter of wire at different positions.

Studs should not be pressed very hardly.

Circular scale should be observed normally.

Zero correction must be applied in case of zero error.

Rotate the screw in the same direction to avoid the back-lash error.

Observation

Least count = Pitch of screw

$$= \frac{0.5 \text{ mm}}{50} = 0.01 \text{ mm or } 0.001 \text{ cm}$$

Zero error = $\pm$ nil mm

Zero correction = $\pm$ nil mm

Table

Quantity to be measured	No. of Obs.	Main scale Reading M (mm)	Circular scale Reading N (div)	Fraction to be added $f = N(0.01)$ (mm)	Observed Reading $R = M + f$ (mm)
Diameter	1	0.5	47	0.47	0.97
	2	0.5	47	0.47	0.97
	3	0.5	47	0.47	0.97

Calculation

Mean diameter = $d = 0.97 \text{ mm}$

Mean radius = $r = \frac{d}{2} = \frac{0.97}{2} = 0.485 \text{ mm}$

$$\begin{aligned} \text{Volume of sphere} &= V = \frac{4}{3} \pi r^3 \\ &= \underline{0.4776} \text{ mm}^3 \end{aligned}$$

TO DETERMINE THE VALUE OF 'g' BY FREE FALL, USING AN ELECTRONIC TIMER.

Apparatus:

- * Free Fall apparatus with electromagnet
- * Electronic timer with stop watch & Power supply
- * Steel ball & Connecting wire & Meter rod.

PROCEDURE:

1. Set the free fall apparatus vertically.
2. Fix the electromagnet with the stand and also adjust the timer.
3. Connect the electromagnet and timer with proper power supply.
4. Adjust the height of electromagnet to a suitable distance and magnetise it to attach the metallic ball with it.
5. Then cut off the supply of electromagnet to allow the ball to fall on metal plate of the apparatus.
6. The timer becomes on just after the cut off of electromagnet supply and it becomes automatically switched off when the ball

strikes the plate.
7. Record the time on the timer and repeat it two times to take its mean.

8. Repeat the operation five times by adjusting the different distances.

9. Calculate the value of "g" by using $g = \frac{2s}{t^2}$

PRECAUTIONS:

1. The free fall apparatus must be placed very horizontally.
2. Use the electromagnet properly with great care.
3. Distance should be increased in regular steps.

Table

No. of Obs.	Height of free fall h (cm)	Time of free fall t_1 (sec)	Time of free fall t_2 (sec)	Mean Time $t = \frac{t_1 + t_2}{2}$ (sec)	Value of g $g = \frac{2h}{t^2}$ (cm/sec ²)
1	70	0.38	0.38	0.38	969
2	80	0.40	0.40	0.40	1000
3	90	0.42	0.42	0.42	1020

Calculation

 Mean value of $g = 996 \text{ cm s}^{-2}$

VERIFICATION OF PENOULUM.

OF LAWS OF SIMPLE

(1) Time period is independent of amplitude

APPARATUS:

- * Gnome stand's apparatus
- * Sheet of paper
- * Slotted weight with hanger
- * Ruler
- * A plain mirror strip
- * Drawing pins
- * Protector and lubricating oil
- * An unknown weight.

PROCEDURE:

1. Draw a horizontal line with pieces of chalk and mark three point on line at a distance 5, 10 and 15cm on either sides of mean position.
2. Hold the bob gently with thumb and fore finger and displace it to the 5cm and then released.
3. When oscillations become smooth then note the time for twenty vibration twice and then take their mean.
4. Divide mean value by 20 to find time period.

Name

Repeat pt with displacement of
10cm and 5cm.

For Amplitude relation

Observation

Diameter of bob = $d = 3.48 \text{ cm}$

Radius of bob = $r = \frac{d}{2} = 1.74 \text{ cm}$

Length of thread including hook = $l' = 99 \text{ cm}$

Length of pendulum = $l = l' + r$

$$= 99 + 1.74 = 100.74 \text{ cm (constant)}$$

Mass of bob = log (constant)

Table

No. of obs.	Amplitude (cm)	Time for 20 vibrations t_1 (sec)	Time for 20 vibrations t_2 (sec)	Mean Time $t = \frac{t_1 + t_2}{2}$ (sec)	Time period $T = t/20$ (sec)
1	5	37	37	37	1.85
2	10	37	37	37	1.85
3	15	37	37	37	1.85

Result

Time period of a simple pendulum
is independent of amplitude

- a. Time period is independent of mass of bob.

PROCEDURE:

1. Take three bobs of different masses and measure their masses with spring balance.
2. Hang each of the bob with thread one by one and find the time of twenty vibrations for each pendulum by keeping their length and amplitude constant.
3. Divide the mean value of time by 20 to find their time period.

For mass relation

Observation

Diameter of 1st bob = $d_1 = 3.48 \text{ cm}$

Diameter of 2nd bob = $d_2 = 2.48 \text{ cm}$

Diameter of 3rd bob = $d_3 = 1.48 \text{ cm}$

Radius of 1st bob = $r_1 = 1.74 \text{ cm}$

Radius of 2nd bob = $r_2 = 1.24 \text{ cm}$

Radius of 3rd bob = $r_3 = 0.74 \text{ cm}$

Amplitude of vibration = 5 cm (constant)

Table

No. of obs	Mass of bob $m(\text{gm})$	Time of 20 vibrations $t_1(\text{sec})$	Time of 20 vibrations $t_2(\text{sec})$	Mean time $t = \frac{t_1 + t_2}{2}$ (sec)	Time period $T = \frac{t}{20}$ (sec)
1	30	37	37	37	1.85
2	20	37	37	37	1.85
3	10	37	37	37	1.85

Result

"Time period of a simple pendulum is independent of mass"

C. Time period is directly proportional to square root of length.

1. Take length of a pendulum say 80 cm and find the time for 20 vibrations.

2. Repeat this experiment, different lengths which should be change regularly (say by 20 cm).

3. Divide the time period by 20 to find the time period

4. Find out the ratio $\frac{T}{\sqrt{L}}$ for

each observation which should be constant.

For length Relation

Diameter of bob = $d = 3.48 \text{ cm}$

Radius of bob = $r = \frac{d}{2} = 1.74 \text{ cm}$

Amplitude of vibration = 5 cm (constant)

Mass of bob = $\log (\text{constant})$

Table

No. of Obs.	Length of hook + thread $l' (\text{cm})$	Length of Pendulum $l = l' + r (\text{cm})$	Time of 20 vibration $t_1 (\text{sec})$	Time of 20 vibration $t_2 (\text{sec})$	Mean time $t = \frac{t_1 + t_2}{2} (\text{sec})$	Time period $T = \frac{t}{20} (\text{sec})$	Ratio $\frac{T}{\sqrt{l}} = \text{Constant}$
1	99	100.74	37	37	37	1.85	0.184
2	80	81.74	36	36	36	1.8	0.199
3	70	71.74	33	33	33	1.65	0.194

Result:

Time period is directly proportional to
Square root of length

TO VERIFY LAWS OF VIBRATION OF STRETCHED STRING BY SONOMETER

APPARATUS:

- * Sonometer
- * Tuning fork of different frequencies
- * Rubber pad
- * Two wedges
- * Slotted weights with hanger
- * Paper rider
- * Balance.

PROCEDURE: a. Law of length)

1. Fix the wire at one end of the sonometer and pass the wire over a frictionless pulley. The second end of wire carries a hanger.
2. Put some slotted weights on the hanger so that the wire is stretched.
3. Place two wedges under the sonometer wire.
4. Place a small piece of paper of V-shaped called rider on the wire between wedges.
5. Strike the tuning fork on rubber pads and place its stem on the surface of sonometer box in between the wedges vertically.

6. Set the distance between two wedges such that the paper strip falls down when the stem of vibrating tuning fork is touched with the surface of box.
7. Measure the resonating length 'l' of the wire between them wedges by a meter rod.
8. Repeat the experiment with tuning fork of different frequencies.

b. Verification of law of Tension.

PROCEDURE:

Result

Since $\frac{f}{\sqrt{T}}$ is constant, law of tension is verified.

c. Verification of law of mass

PROCEDURE:

1. Take three wires of different diameters and each wire having different masses per unit length.
2. Stretch the first wire by placing load of 2kg.
3. Replace this wire with another wire of double the wire diameter with the same load of 2kg and find resonating length with a tuning fork of frequency 256Hz. It must be noted that two lengths are equal.

(iv) Repeat the same process with third wire

(v) Cut a wire of 50cm in each case and calculated mass per unit length by dividing total mass with 50cm.

PRECAUTIONS:

1. Very small paper rider should be used

2. The pulley should be low frictioned.

3. Wire should be of uniform cross-sectional area.

4. The weight of hanger should always be included in the load

5. The wire must be straight and without kinks.

TO DETERMINE THE ACCELERATION DUE TO GRAVITY BY SPRING SYSTEM

APPARATUS:

- * Hooke's apparatus with slotted weights
- * Stop watch

PROCEDURE:

1. Suspend a helical spring from a rigid support.
2. Attach a pointer horizontally to the lower end of the spring.
3. Note the position of the pointer on the scale. Now add weight on the hanger.
4. Take reading of the pointer
5. The difference between these readings gives the extension produced in the spring.
6. Pull down the hanger a little and let it go.
7. Measure the time of 20 vibrations on hanger
8. Repeat this observation twice and find the mean time for twenty vibrations
9. Divide this mean time by 20 to get the time period T of the hanger.
10. Repeat the process for six observations with different masses on the hanger.
11. Calculate value of 'g' by the relation, g

$$g = 4\pi^2 \left(\frac{x}{T^2} \right)$$

Observation

Initial position of pointer when weight of hanger is not acting on spring = 0 cm.

Table

No of Obs	Weight hanged including hanger in gram	Extension x (cm)	Time for 20 vibration including hanger's weight		Mean time $t = \frac{t_1 + t_2}{2}$ (sec)	Time Period $T = \frac{t}{20}$ (sec)
			t_1 (sec)	t_2 (sec)		
1	200g	12	14	14	14	0.7
2	250g	15	15	15	15	0.75
3	300g	18	17	17	17	0.85

No of Obs	value of g $g = \frac{4\pi^2 x}{T^2}$ cm/sec ²
1	965.8
2	1052 (1051.6)
3	982.5

Calculation

Mean value of $g = 1000 \text{ cm/sec}^2$

TO FIND UNKNOWN WEIGHT OF A BODY BY VECTOR ADDITION

APPARATUS:

Gravesand's apparatus, Slotted weights with hangers, Plane mirror strip, Drawing pin, thread, A geometry box, solid cylinders (unknown weights), paper sheet, an unknown weight.

PROCEDURE:

1. Place the gravesand's apparatus on the smooth horizontal surface with board be vertically upright.
2. Oil the pulleys to reduce their friction.
3. Fix the paper on the board by means of drawing pins.
4. Take the three pieces of thread and tie their one end together.
5. Pass two ends of thread through the pulleys and hang the slotted weights with them and hang the unknown cylindrical weights with the third one.
6. Place the mirror strip below each thread mark the point at the end of

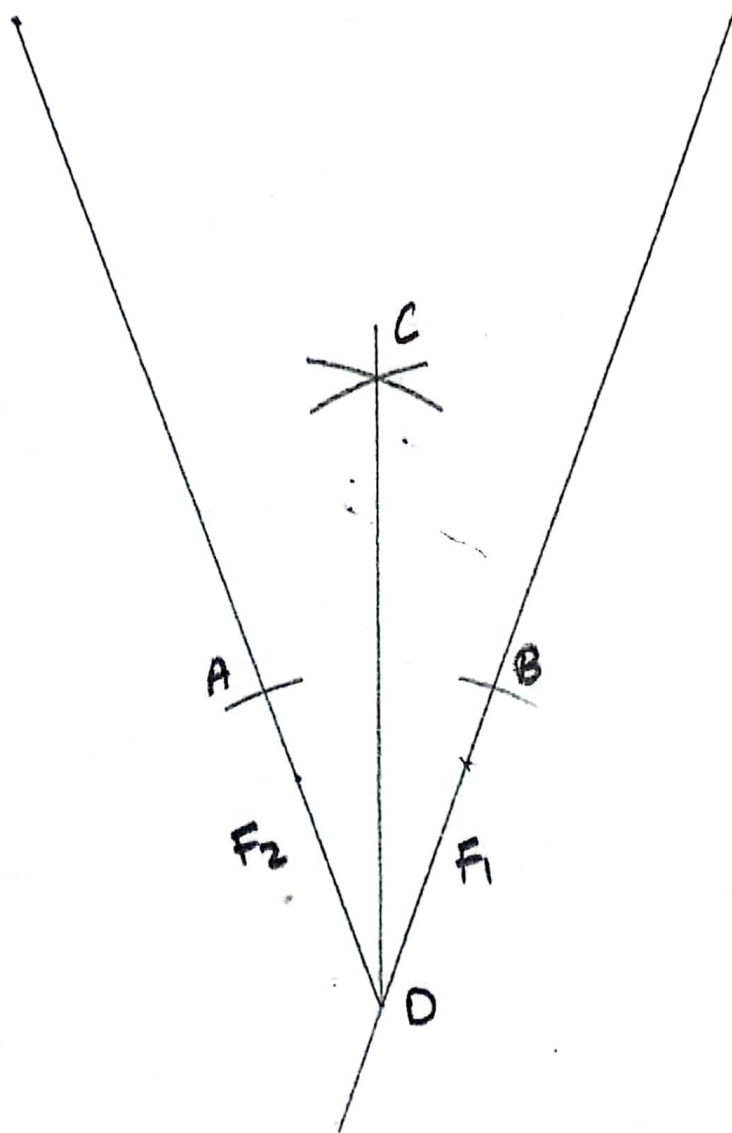
mirror steep in such a way so that thread and its image coincide.

7. Remove the slotted weights and the thread. Join the points with extended lines which meet at point 'O' which the position of knot.
8. Select a suitable scale to cut the line OA and OB to represent forces $\vec{F}_1$ and $\vec{F}_2$.
9. Draw a line AD parallel to OB and join OD. This line OD represents resultant force of $\vec{F}_1$ and $\vec{F}_2$ which is represented by R.
10. Now measure the length of R and read it according to selected scale.

PRECAUTIONS:-

1. The apparatus should be held vertical.
2. Weight should not be touched to the board.
3. Knot should be at the middle of the paper.
4. Pulleys should be oiled to reduced friction.
5. Marks should be pointed very carefully on paper properly.
6. Arrow head should marked on each force vector.

Roll no. 12



TO DETERMINE ^{the refractive index of a} ACCELERATION ^{by critical angle method.} DUE TO GRAVITY BY MASS SPRING

APPARATUS:

- * A glass prism * Drawing board * Sheet of white paper * Drawing pins * Paper pins * Set square protector * Meter rod.

PROCEDURE:

1. Fix a sheet of paper on drawing board by drawing pins.
2. Place a prism on the paper, such position that one of its refractive edges faces is toward the observer. Then mark its boundary with sharp pencil.
3. Remove a prism and fix a paper pin P nearly at the middle of boundary line AB of prism.
4. Replace the prism in its previous position, so that pin P nearly at middle of the boundary just touches the face AB.
5. Look, Now the image of 'P' through face AC and move your eyes from C to A. Then image will become faint and will then disappear. Fix pins at R and S in a line with image of

- P just start to be faint
6. Remove prism and encircle the position of circle.
7. Use relation $\mu = \frac{1}{\sin \theta_c}$ to calculate refractive index.

Precaution

PROCEDURE:

1. The face of prism should be clean.
2. The refractive edge A of ~~object~~ prism should be toward observer.
3. Pins should be fixed erect and vertical.
4. The pins R and S should be fixed in line with image of P just before it disappears.
5. The direction of the rays should be shown by arrow heads.

Table

No. of Obs	Length of hook + thread l' (cm)	Length of Pendulum $l = l' + r$ (cm)	Time for 20 vibration t_1 (sec)	Time for 20 vibration t_2 (sec)	Mean time $t = \frac{t_1 + t_2}{2}$ (sec)	Time period $T = \frac{t}{20}$ (sec)	Ratio $\frac{T}{\sqrt{l}} = \text{const}$
1	99	100.74	37	37	37	1.85	0.184
2	80	81.74	36	36	36	1.8	0.199
3	70	71.74	33	33	33	1.65	0.19

For length relation

Diameter of bob = $d = 3.48 \text{ cm}$

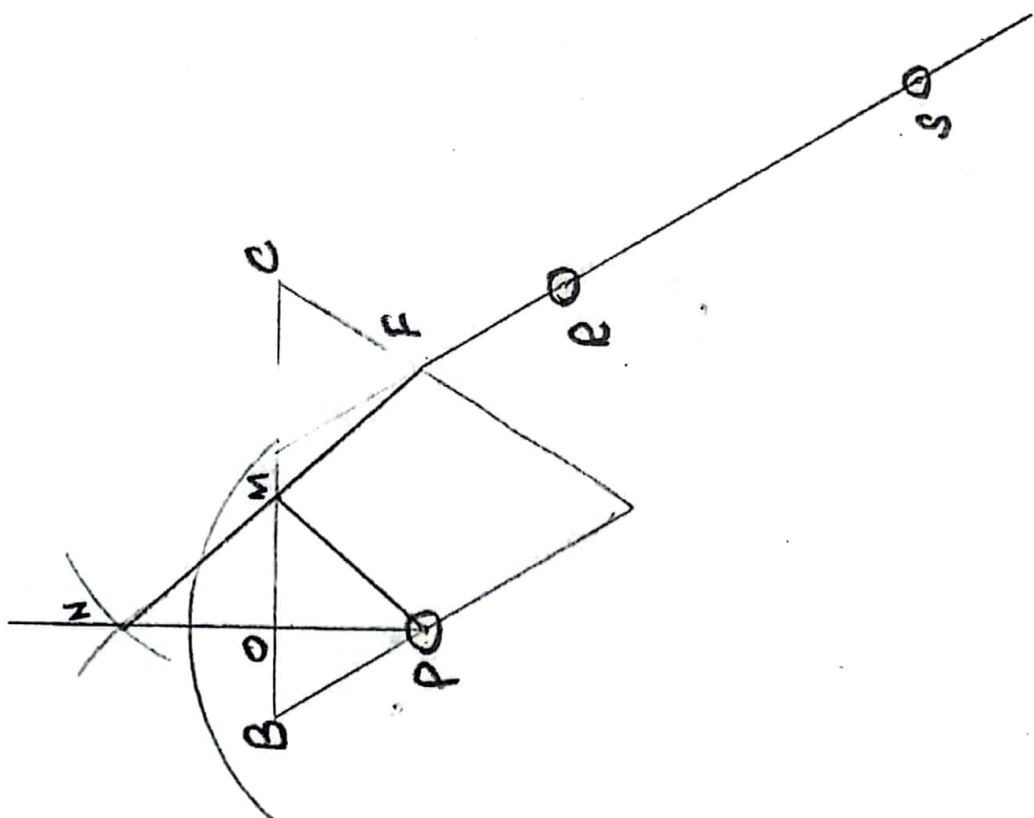
Radius of bob = $\frac{d}{2} = \frac{3.48}{2} = 1.74 \text{ cm}$

Amplitude of vibration = 5 cm (constant)

Mass of bob = log (constant)

Result

"Time period of a simple pendulum is directly proportional to square root of its length"



EXPERIMENT 8

DETERMINE THE RESISTANCE OF A GIVEN WIRE USING A SLIDE WIRE BRIDGE AND ITS SPECIFIC RESISTANCE

APPARATUS:

- * Slide wire bridge
- * Resistance box
- * Unknown resistance
- * Galvanometer
- * Rheostat
- * Cell
- * Tapping key
- * Connecting wires and sand paper.

PROCEDURE:

1. Draw a neat circuit diagram as shown in figure.
2. Clean the ends of connecting wires with sand paper and arrange the apparatus as shown in fig. (a) where G is galvanometer, $R.B$ is a resistance box, X is unknown resistance and K is a tapping key.

3. In order to test the circuit, close the key 'K'. With all the plugs in the resistance box intact and tight, place the jockey somewhere in the middle of the wire. See the direction of deflection in the galvanometer. Now take out the infinity plug from the resistance box and again place the jockey somewhere in the middle of the wire. If the deflection is in the opposite direction, then the connection are correct, otherwise check the connection.

4. Apply a suitable resistance by taking out plugs from the resistance box. Adjust the position of the jockey over the wire AC till there is no deflection in the galvanometer. Adjust the

Resistance R from the resistance box till the balance point is somewhere in the middle of the wire. Measure the lengths l_1 and l_2 .

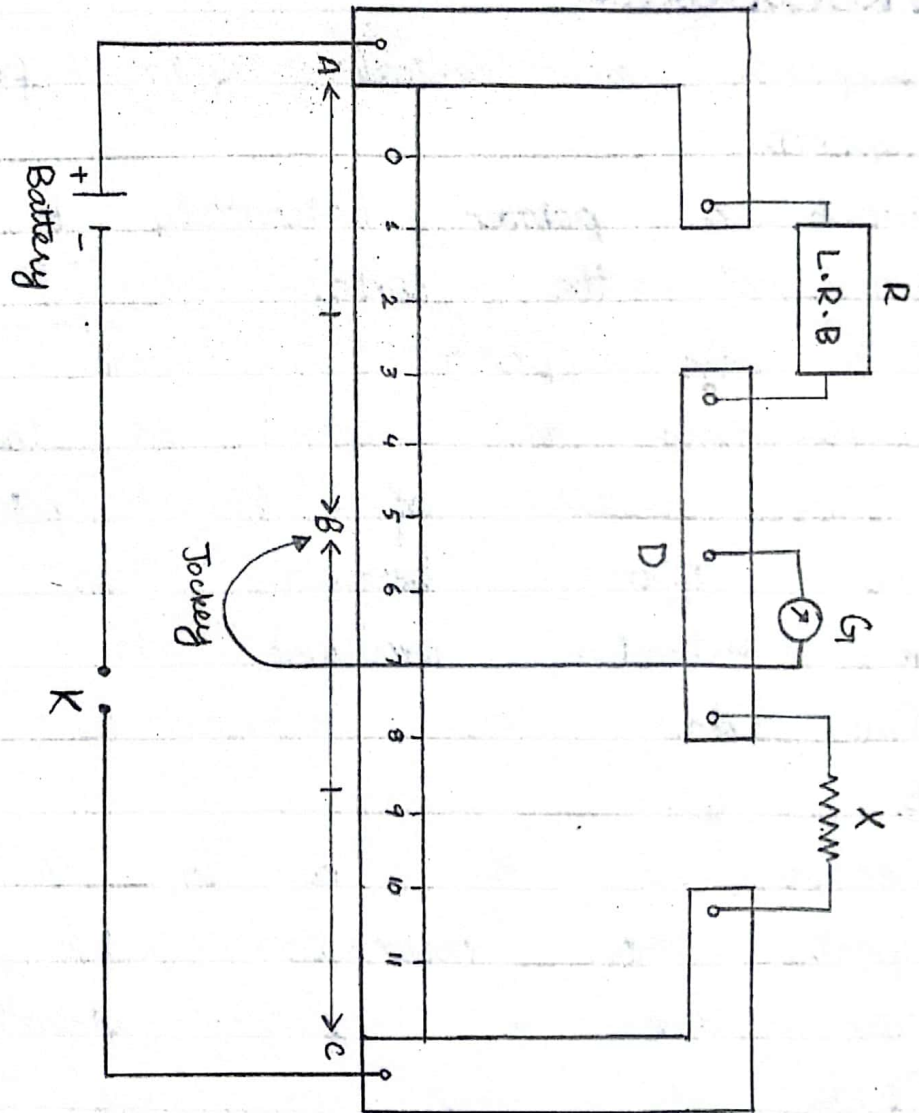
5. Note length of balance point from end A as $AB = l_1$. Also the length of balance point from end C as $BC = l_2$
i.e. $(100 - l_1) = l_2$.

6. Calculate unknown resistance by
$$X = R \left(\frac{l_2}{l_1} \right)$$

7. Take three observations with different values of R and find the mean value of X .

8. Measure the diameter of wire at three different points with screw gauge. Find specific R of a material by relation
$$\rho = \frac{X \pi r^2}{L}$$

Circuit diagram



Observation:

No. of Obs.	Resistance applied by Resistance Box: R (Ohm)	Distance of the balance point B from point A l_1 (cm)	Distance of balance Point B from the end C $l_2 = 100 - l_1$ (cm)	Unknown Resistance $X = R \times \frac{l_2}{l_1}$ (ohms)
1	5Ω	41	59	7.1Ω
2	7Ω	48	52	7.5Ω
3	9Ω	53	47	7.9Ω

Calculation

Mean $X = 7.5\Omega$

Resistivity
 length of unknown = $L = 100$ cm
 Resistance wire (X)

Diameter of resistance
 wire = $d = 0.56$ mm
 $= 0.056$ cm

Radius of wire = $r = \frac{d}{2} = 0.028$ cm

Resistivity or specific resistance
 $= \rho = \frac{\pi r^2 X}{L}$

$= \frac{3.14 \times (0.028)^2 \times 7.5}{100}$

$= 0.0002 \text{ ohm cm}$

EXPERIMENT:

DETERMINE THE RESISTANCE OF
A GALVANOMETER BY HALF
DEFLECTION METHOD AND TO
FIND CURRENT FOR FULL
SCALE DEFLECTION

APPARATUS:

- * Galvanometer * Cell * High resistance box
- * Fractional resistance box
- * Two keys and connecting wires.

PROCEDURE:

1. Draw a neat circuit diagram.
2. Clean the ends of connecting wires and arrange the apparatus as shown in figure. where galvanometer R_g , key K_1 , High resistance box and cell E are connected in series. A fractional resistance box is connected across the galvanometer through key K_2 .

3. Note zero reading of the galvanometer and apply high resistance by the resistance box and cell E are connected in series. Close the key K_1 keeping K_2 open. Adjust R to get large deflection. Note the deflection and find the correct deflection by applying the zero error. The deflection should be equal to an even number of division.

4. Keeping R unchanged close both the keys and adjust the shunt resistance so that the deflection is reduced to half of its original value.

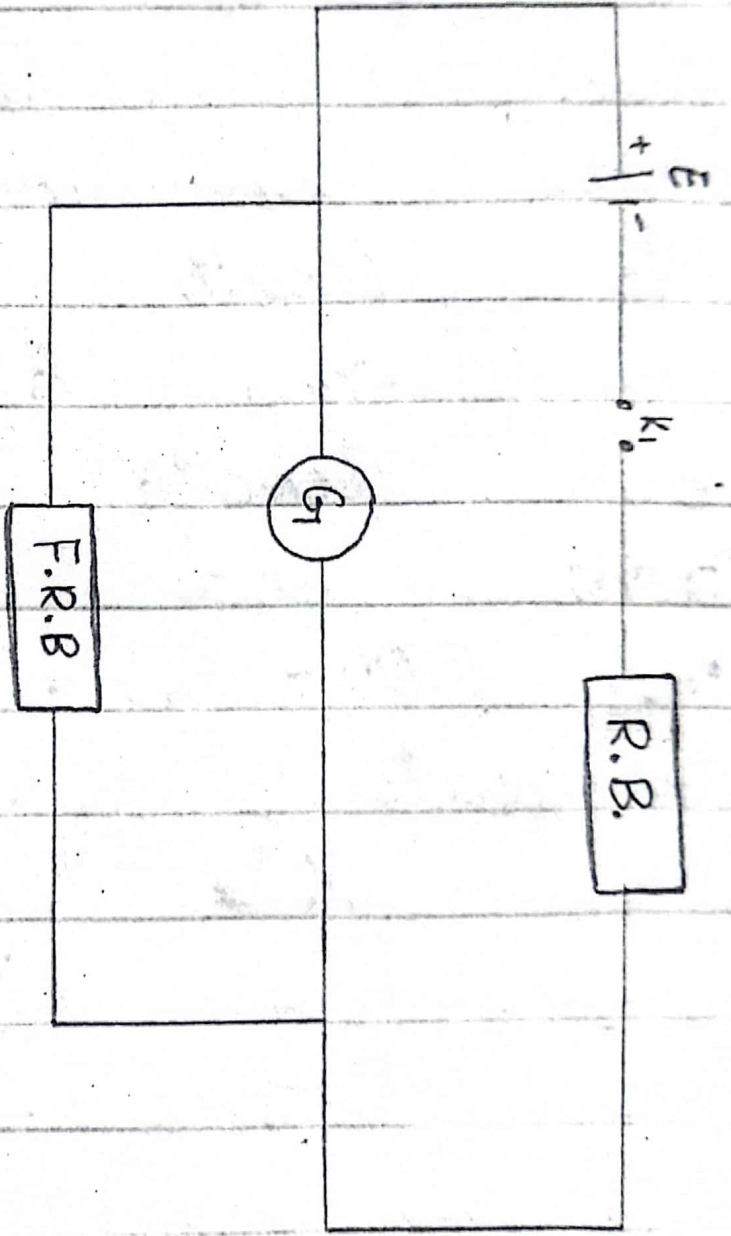
5. Calculate the resistance of galvanometer by.

$$R_g = \frac{R \times S}{R - S}$$

EXPERIMENT:

6. Repeat the experiment thrice for different values of R by keeping Shunt 'S' constant.

2nd order diagram



EXPERIMENT

No. of Obs.	Resistance taken from H.R.B $R(\Omega)$	Deflection on galvanometer $\theta(\text{div})$	Half deflection $\frac{\theta}{2}(\text{div})$	Shunt Resistance $S(\Omega)$	Galvanometer Resistance $R_g = \frac{R \times S}{R - S}(\Omega)$
1	6400	24	12	105	103.3
2	7000	22	11	105	103.4
3	8200	20	10	105	103.6

Calculation

Mean value of $R_g = \underline{103.4 - \Omega}$

PROCEDURE

EXPERIMENT:

TO DETERMINE INTERNAL RESISTANCE OF A CELL USING A POTENTIOMETER.

APPARATUS:

- * Potentiometer
- * Battery
- * Resistance Box
- * Rheostat
- * Two keys
- * Galvanometer
- * Given cell
- * Shunt wire and connecting wires.

PROCEDURE:

1. Draw a neat circuit diagram.
2. Clean the ends of connecting wire and arrange the apparatus.
3. Connect battery E , key K_1 and Rheostat R in series with the wire AB of a potentiometer.
4. Connect the cell C whose internal resistance ' r ' is to be determined, to resistance box $R.B.$ through key K_2 .
5. Connect the positive pole of the cell E to end A where positive pole of the cell ' C ' is also connected with end A . The negative

pole of the cell 'C' is connected to a Jockey J through a galvanometer G.

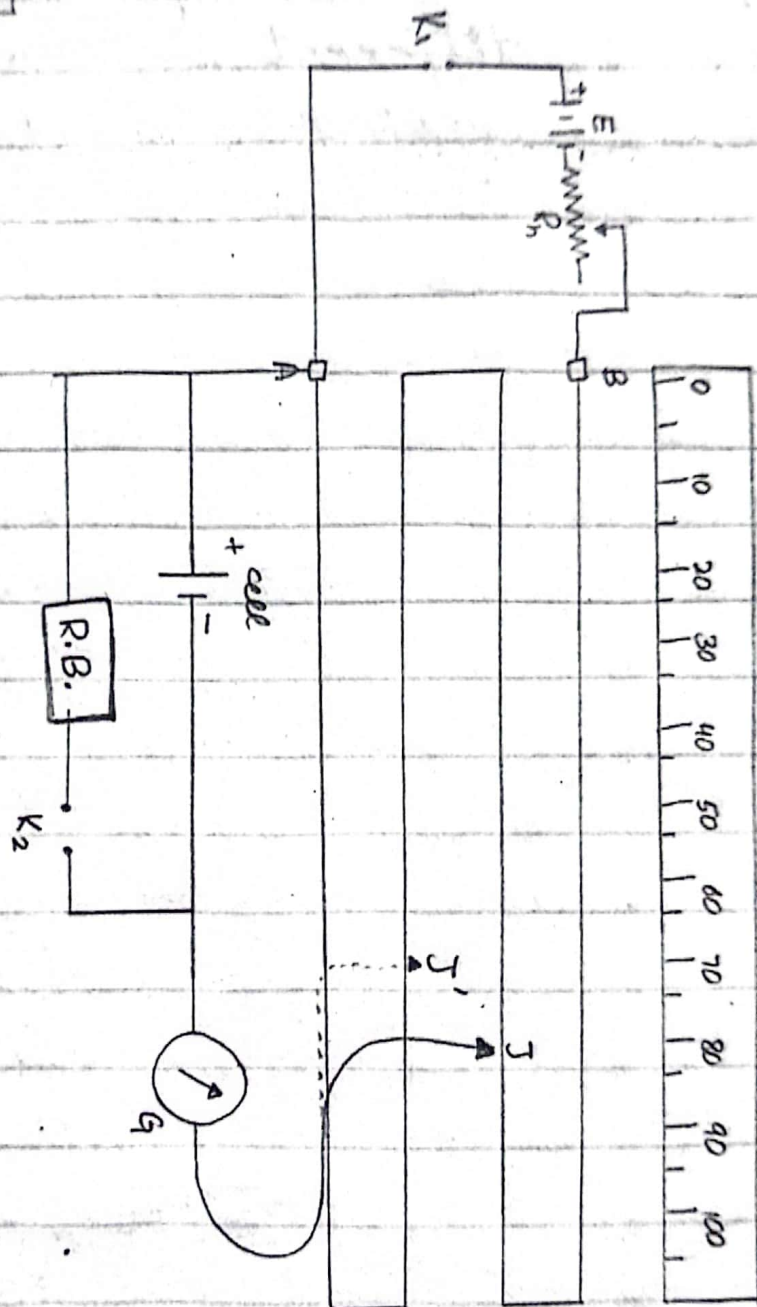
6. Close the key K_1 , keeping the key K_2 open press the jockey on the potentiometer wire first end near A and then near its end B and see that the deflection galvanometer in these two cases.

7. If both the deflection are in opposite direction, then the connections are correct otherwise not.

8. Close key K_1 keeping K_2 open, find the balance point on the wire. Note distance of balance point from end A as l_1 . The value of l_1 remains same for the rest of the experiment.

9. Introduce some suitable resistance R by the resistance box. Close the keys K_1 and K_2 and find balance point. Find distance l_2 of the balance point from end A of the wire.

Circuit Diagram



EXPERIMENT

Observation:

No. of Obs.	Balancing length when k_2 is open L_2 (cm)	Resistance taken from LRB R (Ω)	Balancing length where R is taken out L_1 (cm)	Internal Resistance of cell. $r = \left(\frac{L_1 - L_2}{L_2} \right) R$
1	213	5	178	0.98
2	213	8	190	0.96
3	213	10	194	0.97

Mean internal resistance = $x = 0.97$ ohm

DETERMINE RESISTANCE OF A VOLTmeter BY DRAWING A GRAPH BETWEEN R and V .

APPARATUS:

- * Battery * Voltmeter * Resistance Box
- * Key and connecting wire.

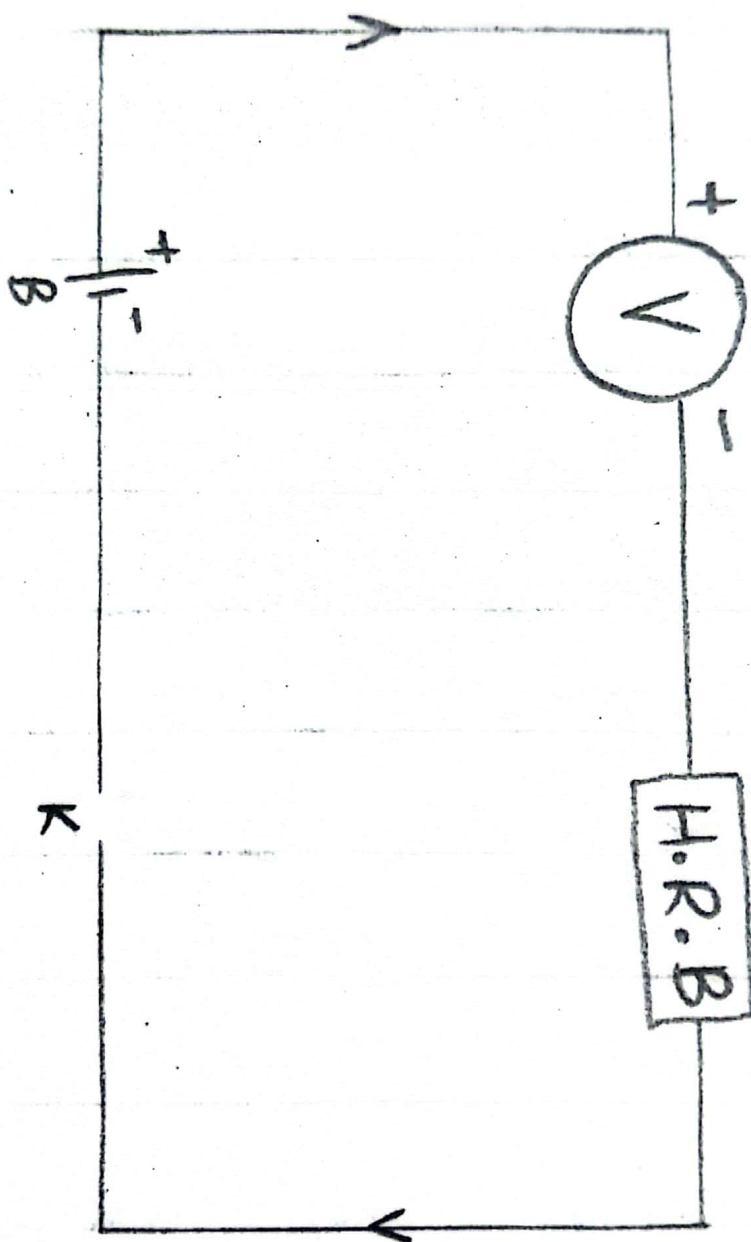
PROCEDURE:

1. Draw a neat circuit diagram
2. Clean the ends of connecting wire and arrange the apparatus where a battery B , key K , resistance R , B and voltmeter V whose resistance R_v is to be determined, are connected in series. See that the positive terminal of the voltmeter is connected to the positive pole of the battery B .
3. Apply some suitable resistance R with the help of resistance box. Insert the plug in the key K and note the reading V of the voltmeter.
4. Increase the resistance R with again note the reading of the voltmeter. Similarly take at least

5. Take six observations by changing resistance in equal steps. Calculate $\frac{1}{V}$ for each observation.

5. Plot a graph between R and $\frac{1}{V}$ taking R along with x -axis and $\frac{1}{V}$ along y -axis. Take the origin as $(0,0)$. The graph will be a straight line.

6. Reproduce this straight line to meet x -axis. Find the value of the intercept of the graph with x -axis which gives the resistance R_v of the voltmeter.



Observation:

No. of Obs.	Voltmeter V (volts)	Voltmeter reading V (volt)	$\frac{1}{V}$ (volts ⁻¹)
1	0	3.03	0.33
2	550	2.56	0.39
3	850	2.38	0.42
4	1050	2.27	0.44
5	1700	2	0.50
6	2600	1.69	0.59
7	2900	1.58	0.63

Resistance of voltmeter = Intercept of graph
 $= R_v = 3000 \text{ ohm}$

Answer Book Number _____

Roll No. in Figure _____

Roll No. in Words _____

Candidate's Signatures _____

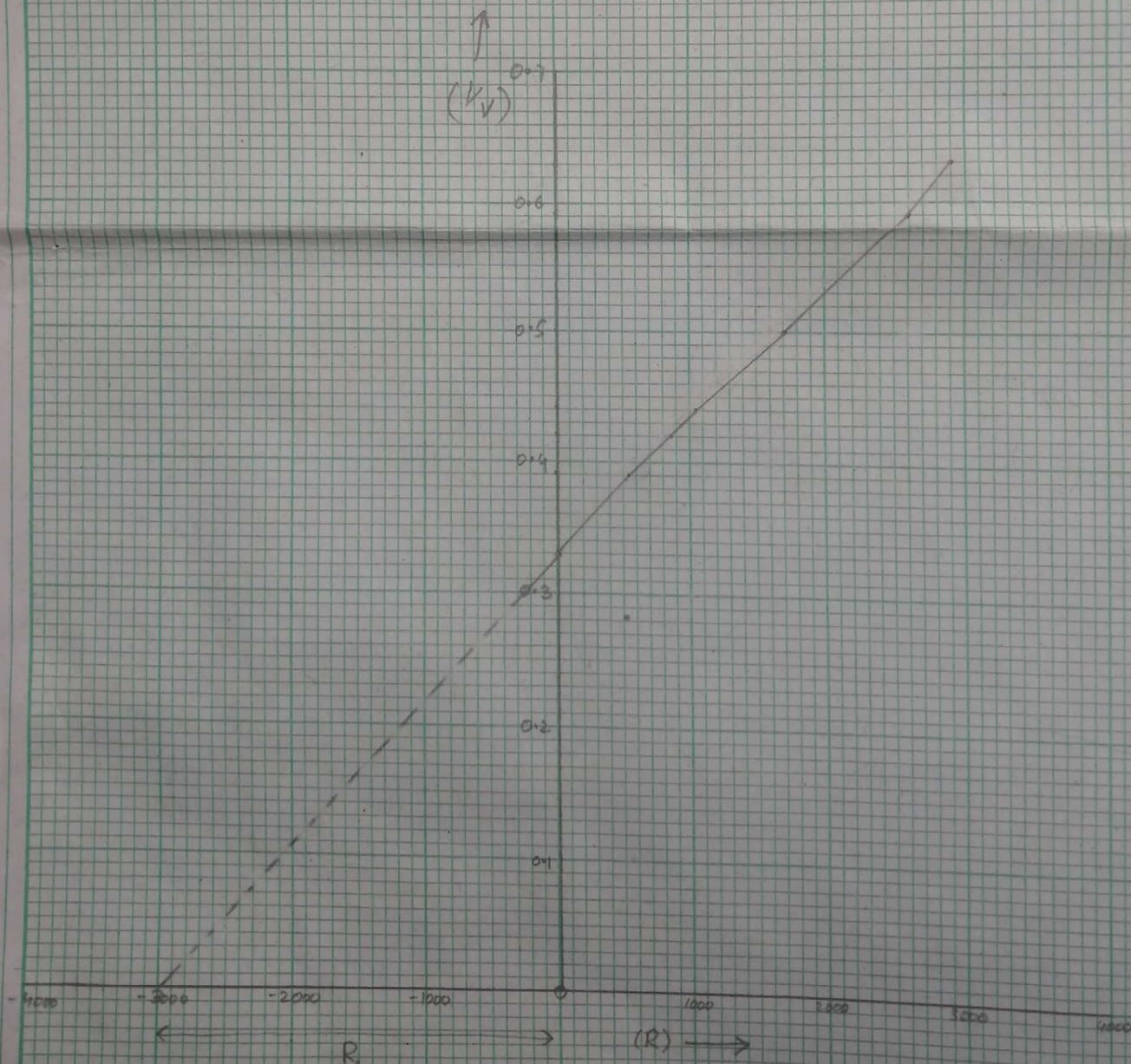
Sign of Dy. Supdt. _____

Scale along x-axis

Small Box = $\frac{1000}{10} = 100 \Omega$
 Big Box = 1000Ω

Scale along y-axis

Small Box = $\frac{0.1}{10} = 0.01 (\text{VOLT})^{-1}$
 Big Box = $0.1 (\text{VOLT})^{-1}$



TO STUDY THE VARIATION OF PHOTO ELECTRIC CURRENT WITH INTENSITY OF LIGHT OF LIGHT----

APPARATUS:

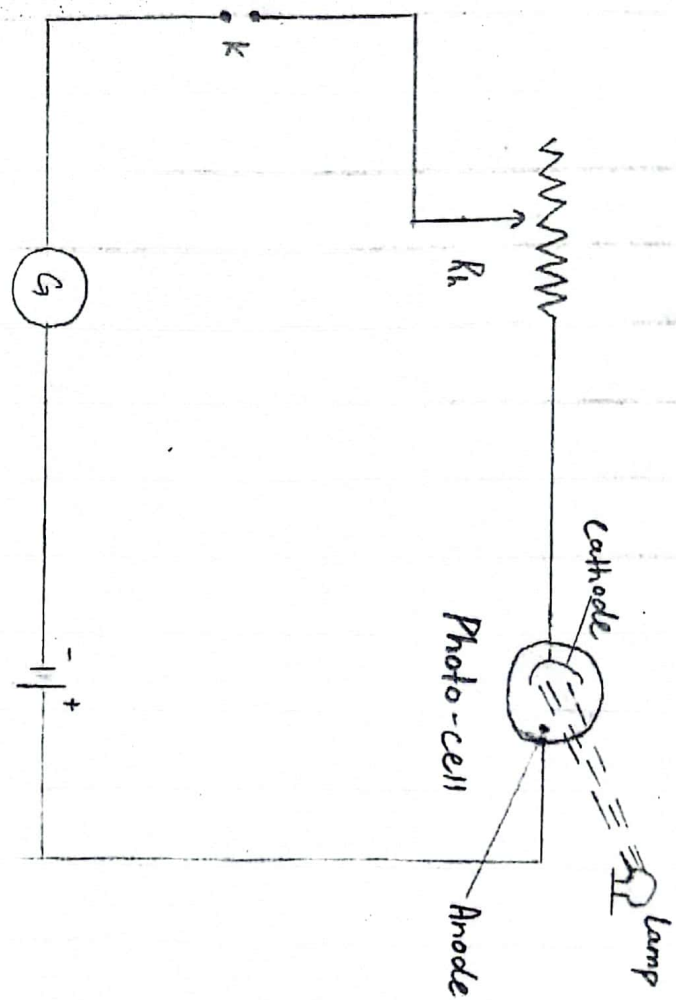
- * Photo cell * sensitive galvanometer
- * Battery * Rheostat * key
- * Electric bulb * Connecting wires.

PROCEDURE:

1. Draw a clean circuit diagram.
2. Clean the ends of connecting wires and arrange the apparatus.
3. Connecting the positive pole of the battery to the anode of the photocell.
4. Switch on the electric bulb.
5. Move the electric bulb toward the photocell decreasing the distance 'd' in regular steps.
6. Note the deflection θ and the distance d. of the photocell from the lamp for each step.
7. Similarly take at least six readings of the galvanometer by changing distance 'd' in regular steps.

8. Calculate $\frac{1}{d^2}$ for each reading.
9. Draw a graph between θ and $\frac{1}{d^2}$ along x-axis.
10. The graph will be straight line.

Circuit diagram.



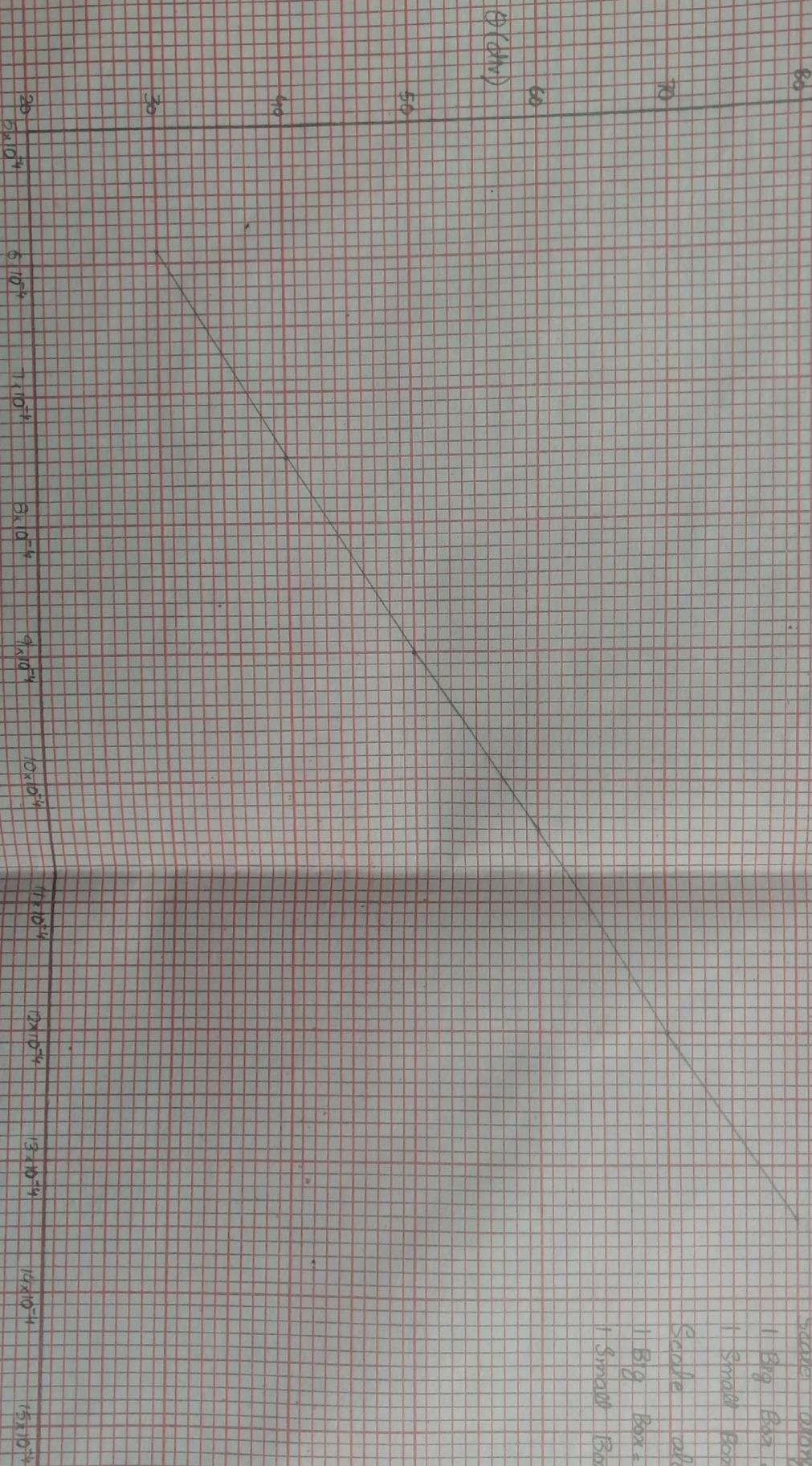
Observation:

No. of Obs.	Distance of Photocell from the lamp filament $d(\text{cm})$	current or deflection in galvanometer $\theta(\text{div})$	$d^2(\text{cm}^2)$	Intensity $\frac{I}{d^2}(\text{cm}^{-2})$	$\frac{I}{\theta} = \text{constant}$
1	41	30	1695	5.9×10^{-4}	0.033
2	36.5	40	1333	7.5×10^{-4}	0.025
3	33	50	1111	9×10^{-4}	0.02
4	31	60	961	10.4×10^{-4}	0.0167
5	29	70	833	12×10^{-4}	0.0142
6	27	80	746	13.4×10^{-4}	0.0125

Conclusions:

The graph between deflection θ and $\frac{1}{d^2}$ is a straight line therefore deflection θ is proportional to $\frac{1}{d^2}$. As deflection is proportional to photoelectric current and $\frac{1}{d^2}$ is proportional to intensity of light, therefore, it is concluded that the photo electric current is proportional to intensity of light.

$1/d^2 \text{ (cm}^{-2}\text{)}$



Scale along x-axis
 1 Big Box = 1×10^{-4}
 1 Small Box = $0.1 \times 10^{-4} = 1 \times 10^{-5}$

Scale along y-axis
 1 Big Box = 10 deg
 1 Small Box = $\frac{10}{10} = 1 \text{ deg}$

TO VERIFY TRUTH TABLE FOR LOGIC GATE OR GATE

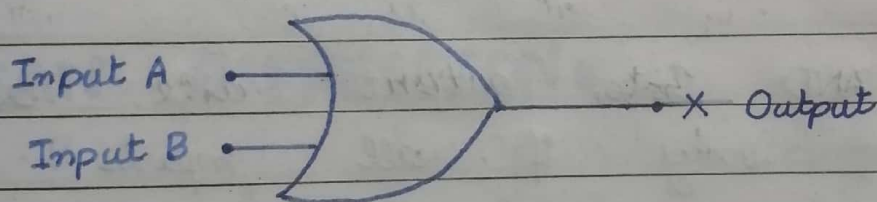
APPARATUS:

- * OR Gate
- * D.C. power supply
- * LED
- * Connecting wire.

PROCEDURE:

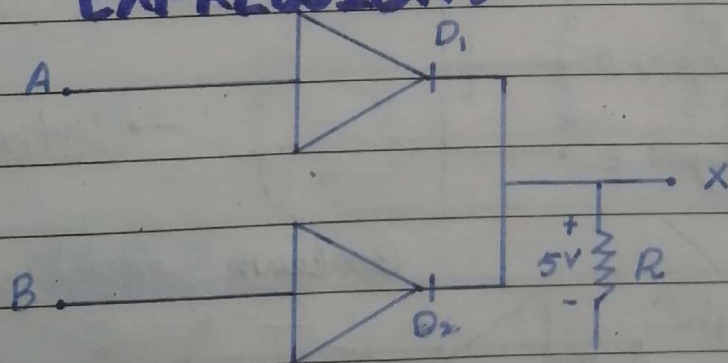
1. Set the apparatus.
2. Turn on power supply.

LOGIC SYMBOL:



BOOLEAN EXPRESSION:

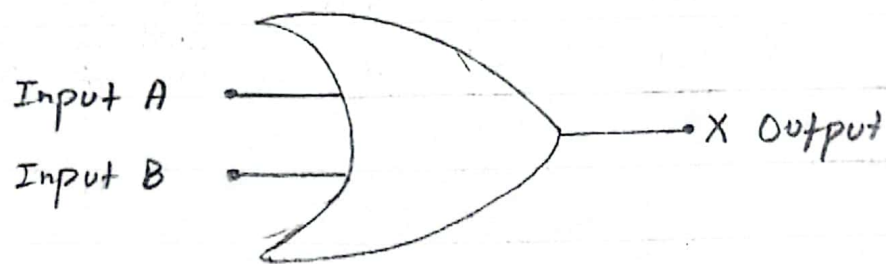
$$X = A + B$$



TRUTH TABLE:

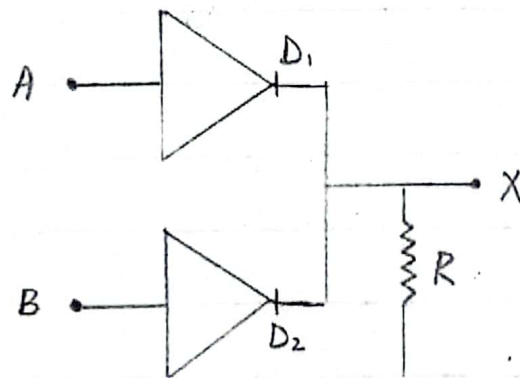
Input		Output
A	B	X
0	0	0
0	1	1
1	0	1
1	1	1

Logical Symbol



Boolean expression

$$X = A + B$$



Truth Table

Input		Output
A	B	X
0	0	0
0	1	1
1	0	1
1	1	1

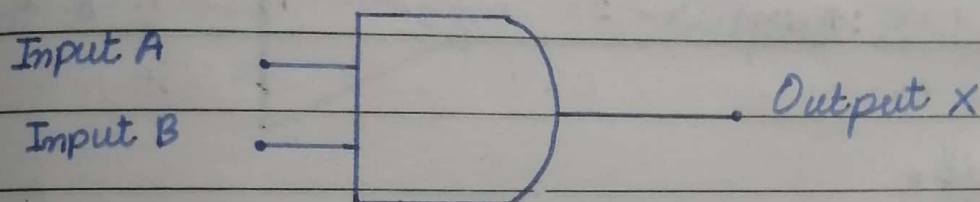
TO VERIFY TRUTH TABLE FOR LOGIC GATES

AND GATE APPARATUS:

And Gate * D.C, Power Supply

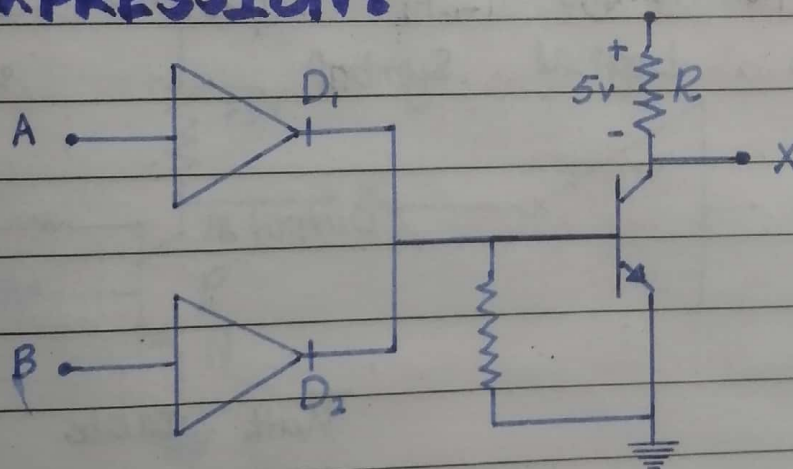
LED * Connecting wire

LOGIC SYMBOL:



BOOLEAN EXPRESSION:

$$X = A \cdot B$$



TRUTH TABLE:

Input		Output
A	B	X
0	0	0
0	1	0
1	0	0
1	1	1

Procedure:

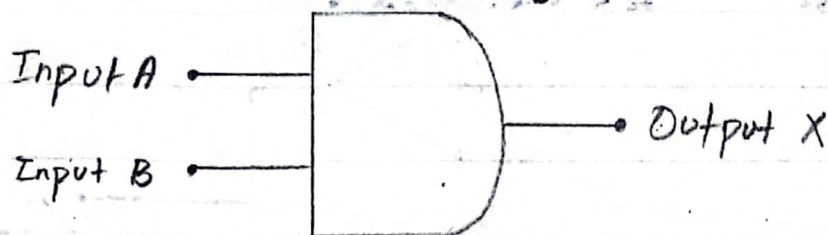
- 1: To set the apparatus according to fig.
- 2: Turn on power supply

3:	(i)	When $A = 0$	$B = 0$	Then $X = 0$
	(ii)	When $A = 0$	$B = 1$	then $X = 0$
	(iii)	When $A = 1$	$B = 0$	then $X = 0$
	(iv)	When $A = 1$	$B = 1$	then $X = 1$

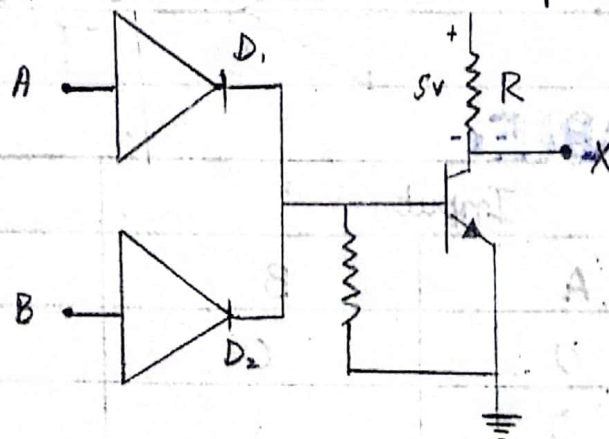
Result:

In AND Gate, output will be high only if all inputs are high

Logical Symbol



Boolean expression



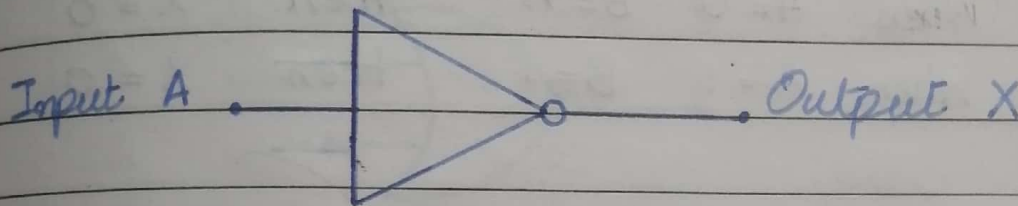
TO VERIFY TRUTH TABLE FOR LOGIC GATES

NOT GATE

APPARATUS:

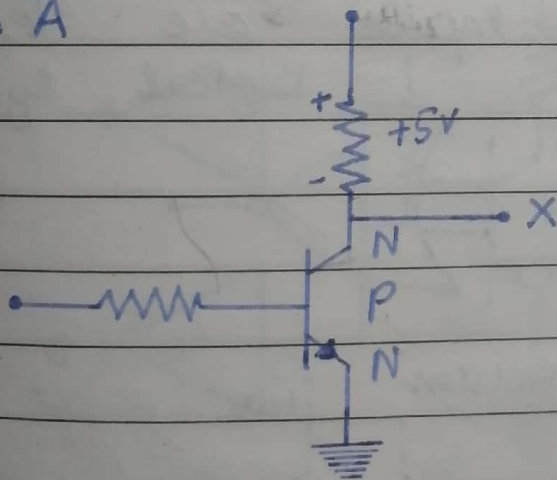
Not gate * power supply * LED
Connecting wire.

LOGIC SYMBOL:



BOOLEAN EXPRESSION:

$$X = \bar{A}$$



TRUTH TABLE:

Input		Output
A	B	X
0	/	1
1		0

Procedure:

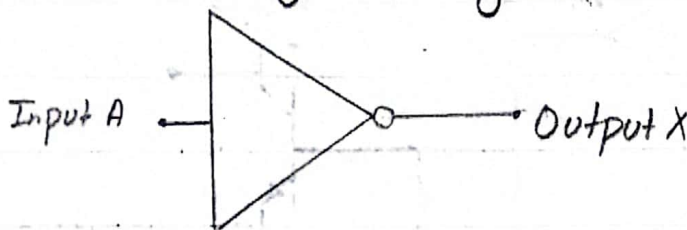
- (i) Set the Apparatus
- (ii) Turn ON Power Supply

- (iii)
- | | | |
|------|--------------|--------------|
| (i) | When $A = 0$ | then $X = 1$ |
| (ii) | When $A = 1$ | then $X = 0$ |

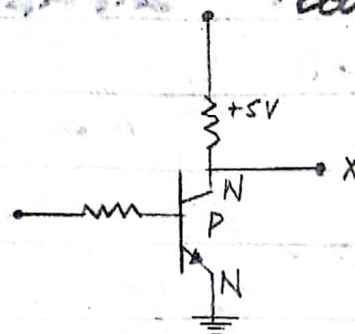
Result:

Output of NOT Gate is
complement of input

Logical Symbol



Boolean expression



Truth table

Input		Output
A	X	
0		1
1		0

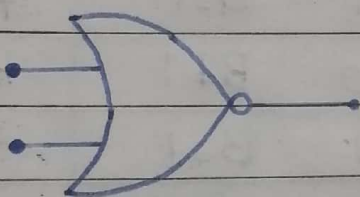
TO VERIFY TRUTH TABLE FOR LOGIC GATES

NOR GATE

APPARATUS:

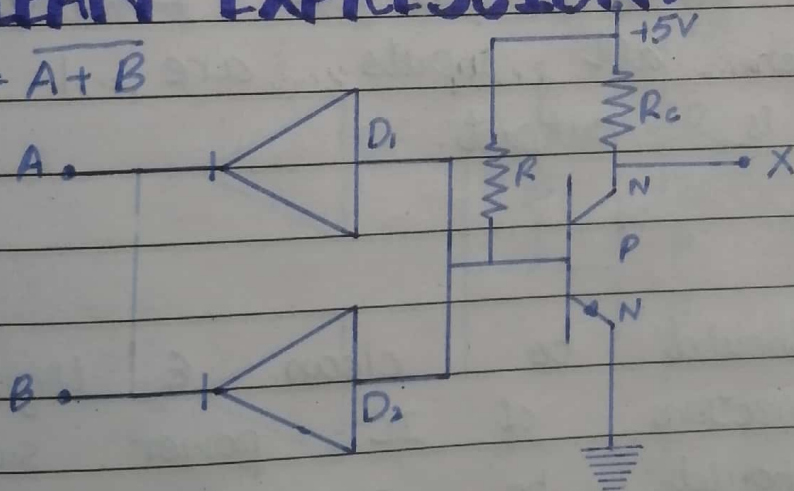
- * NOR Gate
- * Power Supply
- * LED
- * Connecting wire.

LOGIC SYMBOL:



BOOLEAN EXPRESSION:

$$X = \overline{A + B}$$



TRUTH TABLE:

Input		Output
A	B	X
0	0	1
1	0	0
0	1	0
1	1	0

Procedure:

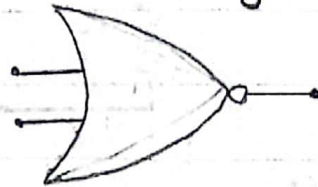
- (i) Set the apparatus
- (ii) Turn ON Power Supply.

(i)	When $A=0$ $B=0$	then $X=1$
(ii)	When $A=1$ $B=0$	then $X=0$
(iii)	When $A=0$ $B=1$	then $X=0$
(iv)	When $A=1$ $B=1$	then $X=0$

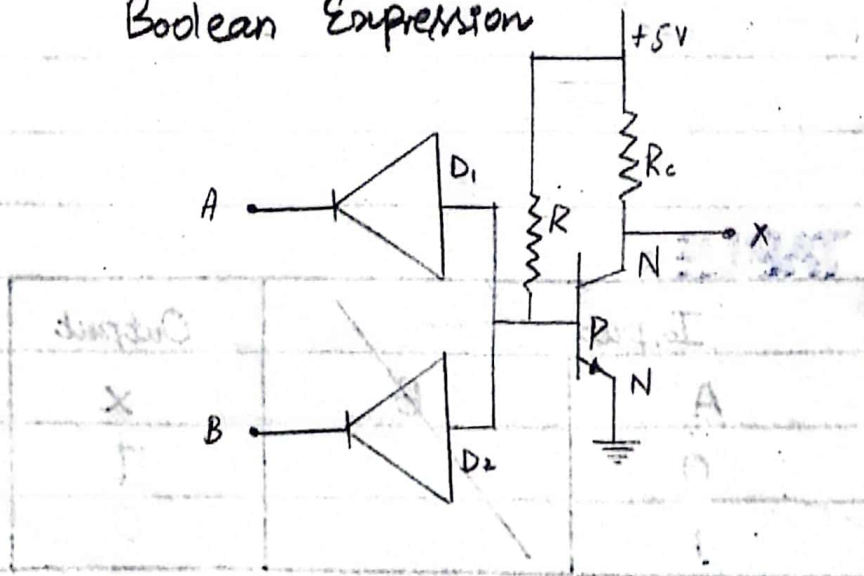
Result:

Output of NOR Gate is High
When all inputs are low

Logical Symbol



Boolean Expression



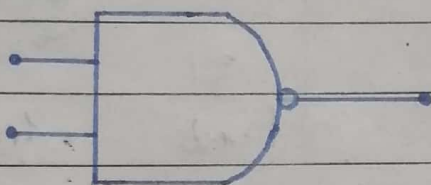
TO VERIFY TRUTH TABLE FOR LOGIC GATES

NAND GATE

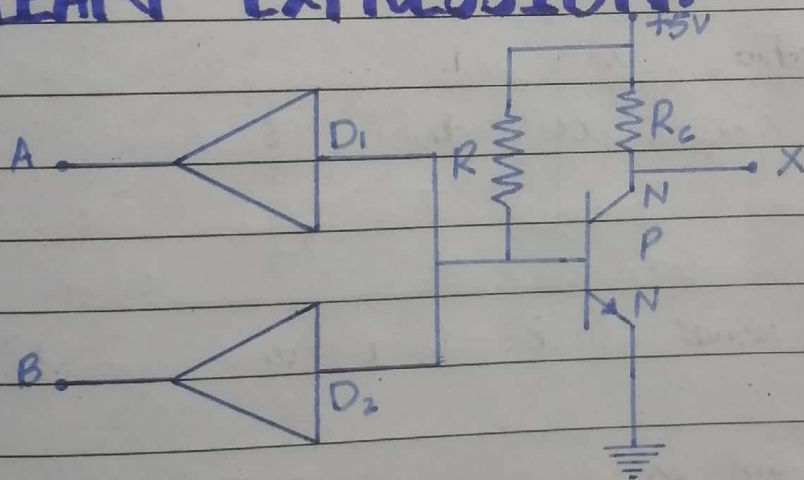
APPARATUS:

- * Nand gate
- * Power Supply
- * LED
- * Connecting wire.

LOGIC SYMBOL:



BOOLEAN EXPRESSION:



TRUTH TABLE:

Input		Output
A	B	X
0	0	1
1	0	1
0	1	1
1	1	0

Procedure:

- (i) Set the apparatus
- (ii) Turn ON Power Supply.

(iii)	(i)	When $A = 0$	$B = 0$	then $X = 1$
	(ii)	When $A = 1$	$B = 1$	then $X = 1$
	(iii)	When $A = 0$	$B = 1$	then $X = 1$
	(iv)	When $A = 1$	$B = 1$	then $X = 0$

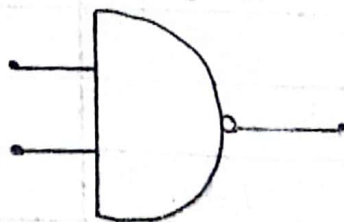
Results

Output of Nand Gate is zero (0) only when all inputs are 1 otherwise is output.

Precautions:

- 1: Connection should be clean & tight.
- 2: Ground connections of IC, power supply & LED should be properly earthed.
- 3: LED should not be reverse biased.
- 4: A suitable resistor should be connected in series with the LED.

Logical Symbol



TO DETERMINE HIGH RESISTANCE USING A NEON FLASH BULB & CAPACITOR

APPARATUS:

- * Neon lamp
- * Capacitor of known capacitance
- * Mega ohm resistance box
- * Power Supply
- * Stop watch
- * Connecting wire
- * Sand paper

PROCEDURE:

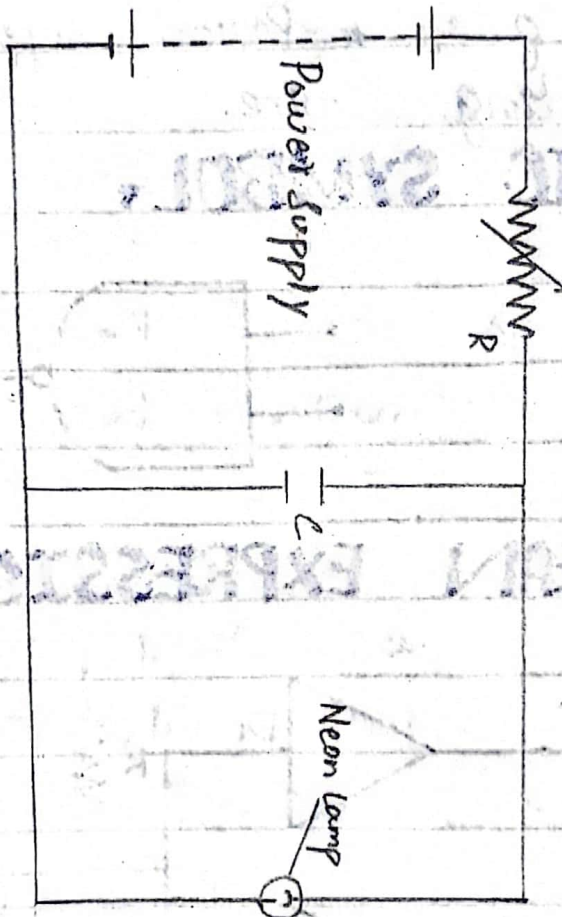
1. Arrange the apparatus and from the power supply apply a suitable potential difference depending upon the neon bulb used in the circuit. Adjust the value of R so to obtain a measurable rate of flashing in the neon bulb.
2. Measure the time of 20 flashes with a stop watch and calculate the flashing period T .
3. Repeat step 2 for different values of R . Also find the flashing period by connecting the unknown resistance instead of R .
4. Draw a graph between flashing time T and resistance R . It will be a straight line.

Compute the value of unknown resistance from the graph.

PRECAUTION:

1. The applied voltage should be kept constant throughout the experiment.
2. The capacitance of capacitor should be selected so as to get a measurable rate of flashing with the unknown resistance.
3. In order to avoid error due to photoelectric effect, the experiment should be performed in a dark room or the neon bulb may be enclosed in a box with a small sighting hole.

Circuit Diagram



Output	A	B
X	0	1
1	1	0
0	0	1
0	1	0

Observation:

No. of Obs.	Resistance (ohm) or $M-\Omega$	Time for 20 flashes		Mean time	Flashing Time Period $T = \frac{t}{20}$ (sec)
		t_1 (sec)	t_2 (sec)		
1	1	10	10	10	0.5
2	2	18	18	18	0.9
3	3	26	26	26	1.3
4	4	34	34	34	1.7
5	5	42	42	42	2.1
6	6	50	50	50	2.5

Time for 20 flashes with unknown resistance = 34 sec

Time period with unknown resistance = $T = \frac{t}{20} = 1.7$ sec

From graph value of R against time period = 4 Ω .

Answer Book Number _____

Roll No. in Figure _____

Roll No in words _____

Candidate's Signature _____

Sign of Dy. Supdt. _____

Scale along x-axis

1 Big Box = 1 m.s

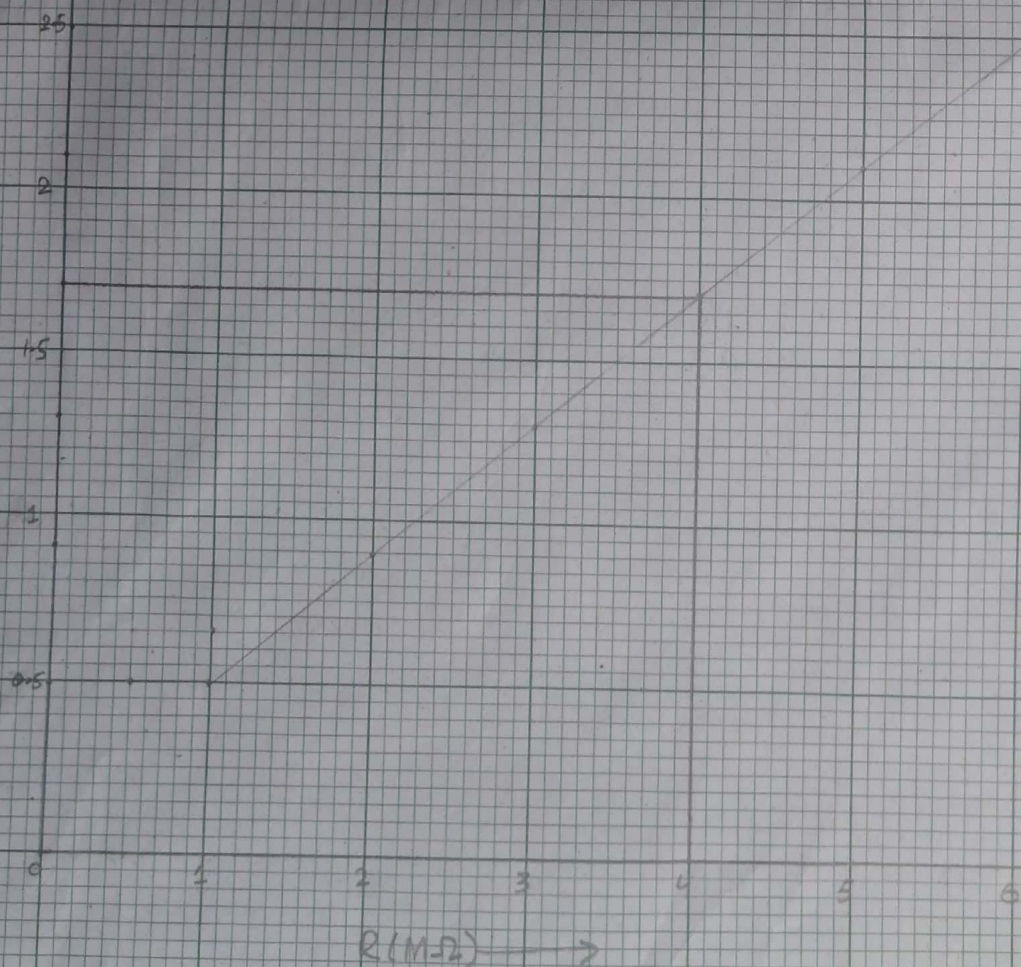
1 Small Box = $\frac{1}{10} = 0.1 \text{ m.s}$

Scale along y-axis

1 Big Box = 0.5 sec

1 Small Box = $\frac{0.5}{10} = 0.05 \text{ sec}$

↑
(T) sec



TO DETERMINE EMF OF A CELL USING POTENTIOMETER

Apparatus:

- * Potentiometer * Battery * Two-way key
- * Rheostat * Key * Shunt wire
- * Galvanometer and connecting wires.

PROCEDURE:

1. Draw a neat circuit diagram.
2. Clean the ends of circuit wires and arrange the circuit.
3. Connect positive pole of the battery E to end A and negative pole through key K .
4. Connect the positive pole of the cell E_1 and that E_2 to end A of the wire and their negative poles connect to a jockey through a two way key K_2 and a galvanometer.
5. Introduce a small resistance by a rheostat and insert the plug in the key K_1 so

that cell E_1 is in circuit.

6. Press the jockey near end A and then near end B of the potentiometer wire and see that the deflection of galvanometer is in opposite direction in these two cases. If the deflection is in the same direction then either decrease resistance introduced by the rheostat or increase the number of cell in the battery E . In case of opposite deflection the connections are correct. Also check for cell E_2 .

7. Put the cell E_1 in the circuit and find the balance point carefully. Determine the length of wire between the balance point J and end A of the wire let it be l_1 . Break the circuit and allow the apparatus to cool so that due to heat produced there is no change in resistance of wire.

8. Now put the cell E_2 in the circuit and similarly find the length l_2 for no deflection of the galvanometer.

9. Repeat the experiment three times by slightly change the resistance from the rheostat and record three pairs of length.

10. Determine unknown E.m.f E_2 by relation

$$E_2 = E_1 \times \frac{l_2}{l_1}$$

11. Measure the E.m.f E_2 with voltmeter & compare it with calculated value.

PREAUTIONS:

1. All connections should be clean and tight.

2. The positive pole of the battery E and positive pole of two cells must be connected to the terminal on zero end of the potentiometer wire.

3. The e.m.f of the battery E should be constant and must be greater than the e.m.f of the either cells.

4. The balance point should be obtained as far away for zero end of the wire as possible.

5. The jockey should not be dragged on wire while changing its position.

Observations and calculations:

emf of a cell $E_1 = 1.3 \text{ Volts}$

No. of Obs	Distance of balance point from end A for cell E_1 l_1	Distance of balance point from end A for cell E_2 l_2	Emf of cell E_2 $E_2 = E_1 \times \frac{l_2}{l_1}$ (volt) (volts)
1.	63	64	1.3
2.	96	97	1.3
3.	142	143	1.3

Mean emf of cell $E_2 = 1.3 \text{ Volts}$

Result,

Mean value of E_2 is 1.3 volts.

TO STUDY THE RELATION BETWEEN CURRENT & CAPACITANCE WHEN DIFFERENT CAPACITORS R USED IN AC CURRENT.

Apparatus:

- * AC milliammeter
- * AC voltmeter
- * Step down transformer (0-12V)
- * Capacitor of different capacitances 0.1, 0.2, ..., 0.5 μ F
- * Connecting wires

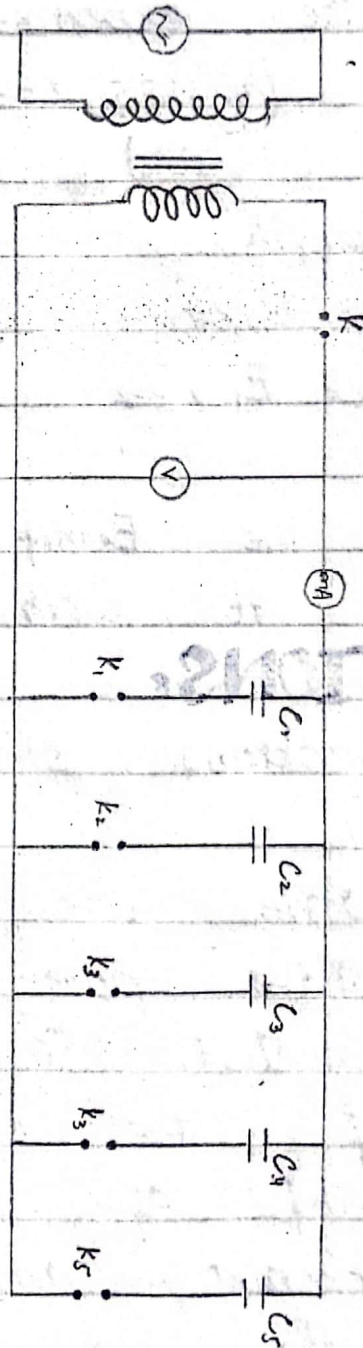
PROCEDURE:

1. Draw a neat circuit diagram
2. Clean the ends of connecting wires and arrange the apparatus
3. Connect the transformer to A.C. main supply.
4. Close the key K_1 and key K_2 and record the value of C_1 and corresponding current.
5. Now open the key K_1 and close key K_2 and record the value of C_2 and current.
6. Similarly repeat the experiment with different capacitors and record the value of current accordingly
7. Draw a graph between C and I
8. This proves that current I is directly proportional to C .

PRECAUTIONS:

1. All connections should be clean and tight.
2. Terminals of the transformer should not be touched with hands.
3. Use of higher voltage in this experiment should be avoided.
4. AC voltmeter and AC milliammeter should be used.
5. Capacitor should not be left in the charged condition after the experiment.

Circuit Diagram.



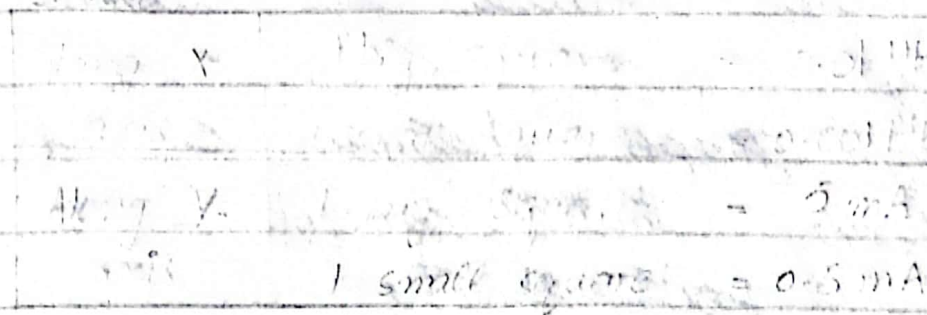
Observations:

No. of obs	Capacitance C (μF)	Current I (mA)	$I/C = \text{constant}$ (Amp/Farad)
1	0.1	4	40
2	0.2	8	40
3	0.3	12	40
4	0.4	16	40
5	0.5	20	40
6	0.6	24	40

Results:

- As the ratio I/C is constant, it means that for a constant applied voltage the current is proportional to capacitance.
- As that graph between I and C is a straight line, the current is proportional to capacitance of a capacitor provided applied voltage kept constant.

Specimen graph



$I(\text{mA})$

Scale along x-axis

1 Big Box = $0.1 \mu\text{F}$

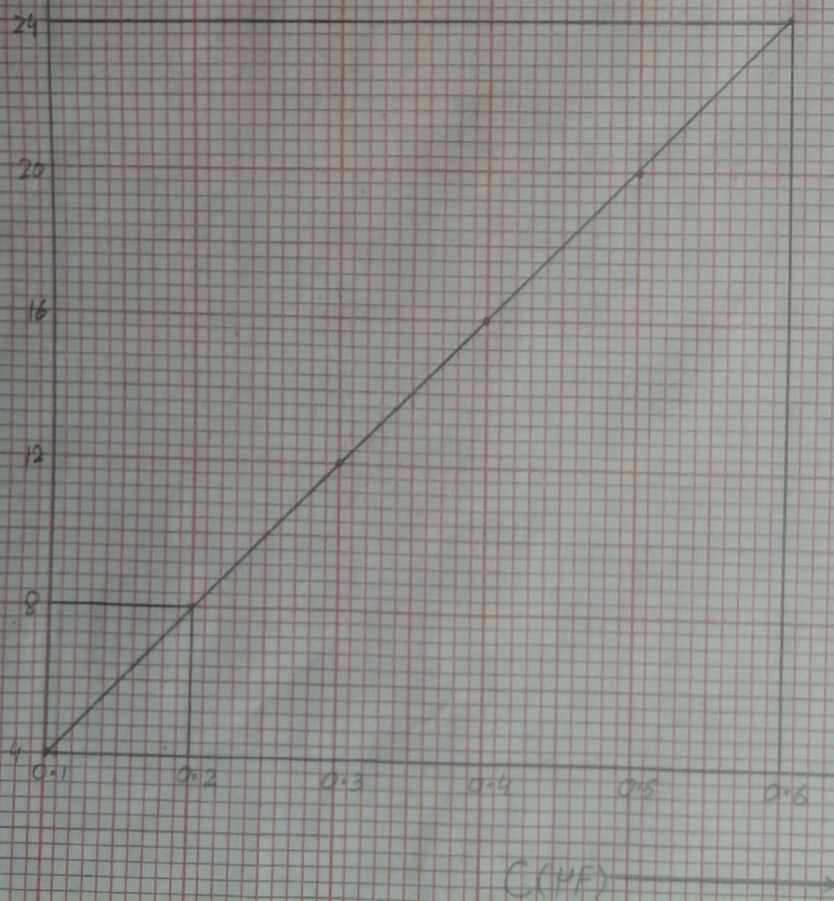
1 Small Box = $\frac{0.1}{10} = 0.01 \mu\text{F}$

Scale along y-axis

1 Big Box = 4 mA

1 Small Box = $\frac{4}{10} = 0.4 \text{ mA}$

$$\begin{aligned} \text{Slope} &= \frac{\Delta V}{\Delta x} = \frac{\Delta I}{\Delta C} = \frac{I_2 - I_1}{C_2 - C_1} \\ &= \frac{24 \times 10^{-3} - 8 \times 10^{-3}}{0.6 \times 10^{-6} - 0.2 \times 10^{-6}} \\ &= 4 \times 10^4 \text{ Amp} \\ &\quad \text{Coulomb}^{-1} \end{aligned}$$



TO THE CHARACTERISTICS OF SEMI CONDUCTOR DIODE AND FORWARD & REVERSE CURRENT RESISTANCE.

APPARATUS:

Semi conductor diode * Voltmeter * Battery
Milliammeter * Rheostat * Connecting
wires, key.

PROCEDURE: (For Forward Biasing)

1. Draw a neat circuit diagram.
2. Identify anode and cathode of the diode.
3. Clean the ends of connecting wire and for plotting the forward voltampere characteristics of diode arrange the apparatus.
4. Move the variable terminal of the rheostat to the extreme position towards the negative end and insert the plug in the key K. The voltmeter and milliammeter will read zero.
5. Adjust the rheostat so as to get the smallest reading on the voltmeter and not the reading of the milliammeter.
6. The reading of the voltmeter gives the anode potential.

and the milliammeter reads the anode current.

1. Increase the anode potential in steps and read the corresponding values of anode current till the current attains its maximum value.

FOR REVERSE BIASING:

1. Draw circuit diagram.
2. Reverse connections of semiconductor diode.
3. Starting from 0 volts, increase anode potential in steps and note corresponding anode current till current starts to show rapid rise.

PRECAUTIONS:

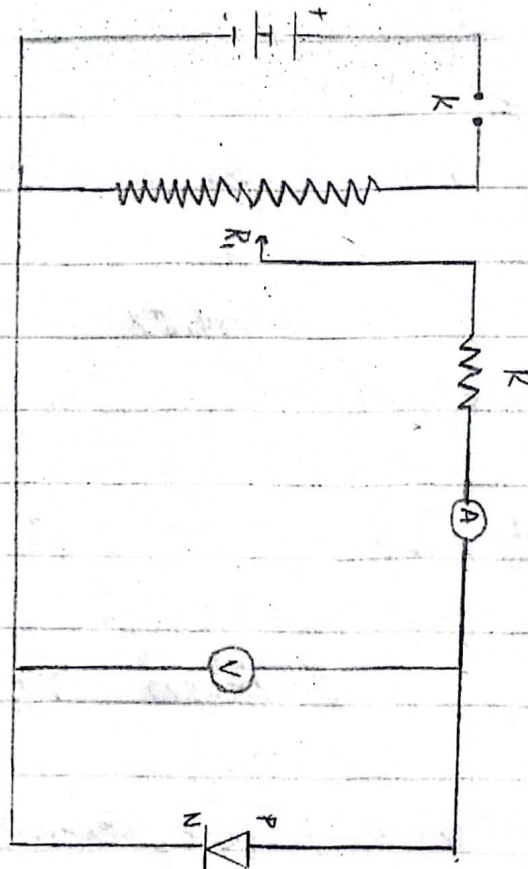
- * All connections should be clean and tight.
- * Identify anode and cathode of the diode.
- * Forward current should not exceed the break down

TO MAKE THE GRAPH USING
NOT GIVE
APPROXIMATE
voltage in order to avoid
damage of diode.

* Straight portions of characteristics
curve should be used for
finding forward resistance
and reverse resistance.

Circuit Diagram

a. Forward biased



Forward biased

Observations

No. of obs.	1	2	3	4	5	6
Forward voltage V (volt)	0.1	0.3	0.5	0.6	0.8	0.9
Forward current I (mA)	1	3	6	9.5	60	100

Calculations.

From graph, Calculation

→ Forward resistance =

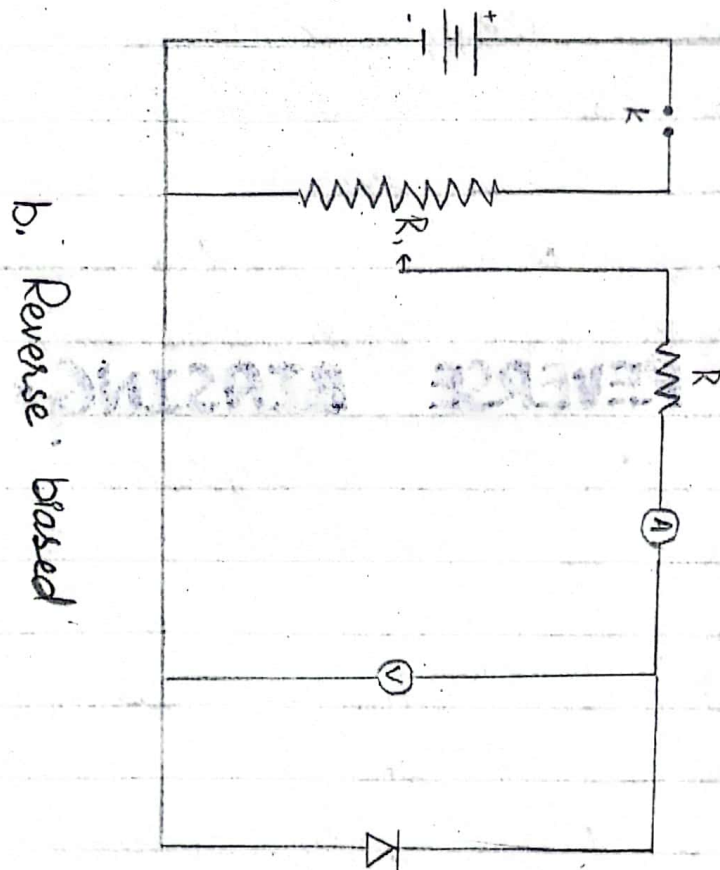
$$R_f = \frac{\Delta V}{\Delta I} = \frac{0.8}{6 \times 10^{-3}} = 13.3 \Omega$$

Reverse biased.

Observation

No. of obs	1	2	3	4	5	6	7	8
Reverse voltage V (volt)	1	2	3	4	5	6	10	12
Reverse current I (Amp)	1	1.3	1.7	2.5	3	3.7	7.5	10

Circuit Diagram



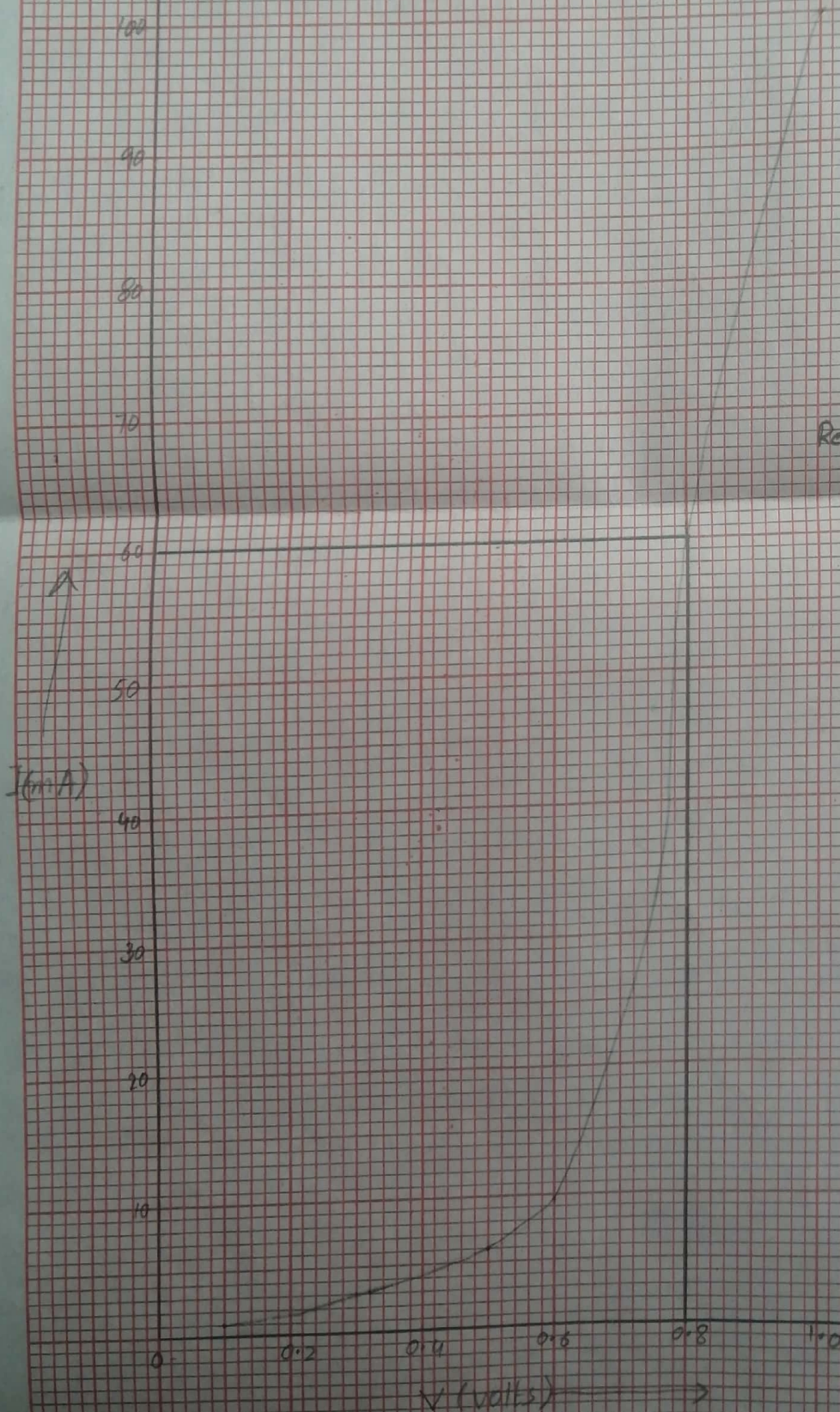
→ Reverse Resistance

$$R_r = \frac{\Delta V}{\Delta I} = \frac{V_2 - V_1}{I_2 - I_1}$$

$$R_r = \frac{3 - 2}{1.7 \times 10^{-6} - 1.3 \times 10^{-6}}$$

$$= \frac{3 - 2}{10^{-6} (1.7 - 1.3)} = 25 \times 10^6 = 2.5 \text{ M}\Omega$$

(Forward)



Scale along x-axis

1 Big Box = 0.2 V

1 Small Box = $\frac{0.2}{10} = 0.02 \text{ V}$

Scale along y-axis

1 Big Box = 10 mA

1 Small Box = $\frac{10}{10} = 1 \text{ mA}$

Resistance

$$V = IR$$

$$R = \frac{V}{I} = \frac{0.8 \text{ V}}{60 \times 10^{-3} \text{ A}} = 13.3 \Omega$$

Answer Book Number _____

Roll No. in Figure _____

Roll No in words _____

Candidate's Signature _____

Sign of Dy. Supdt. _____

Reverse

V (Volt) →

Scale along x-axis

1 Big Box = 2V

1 Small Box = $\frac{2}{10} = 0.2V$

Scale along y-axis

1 Big Box = 1mA

1 Small Box = $\frac{1}{10} = 0.1mA$

I (mA)

↓

TO STUDY A RELATIONSHIP BTW CURRENT PASSING THROUGH A TUNGSTEN FILAMENT LAMP AND V

APPARATUS:

- * 36W, 12V car bulb * Bulb holder * 12V battery
- * High resistance rheostat * voltmeter
- * Ammeter * Key and connecting wire.

PROCEDURE:

1. Draw a neat circuit diagram.
2. Clean the ends of connecting wire and arrange the apparatus
3. Connect 12 volt battery B, key K, rheostat R and ammeter A and the tungsten filament bulb in series and voltmeter V is connected in parallel with the bulb
4. Connect the terminals marked positive (+) on the voltmeter and the ammeter to or towards the positive pole of the battery and all the connections are clean and tight
5. Move the sliding contact of the rheostat to one extreme end

so that the hole of its resistance is in circuit and close the circuit by inserting the plug in the key K.

6. Adjust a rheostat slowly so as to get a small deflection in the voltmeter and the ammeter. Carefully note the reading of the voltmeter and the ammeter.

7. Increase the current passing through the circuit by adjusting the sliding contact of rheostat and again note the reading of ammeter and voltmeter.

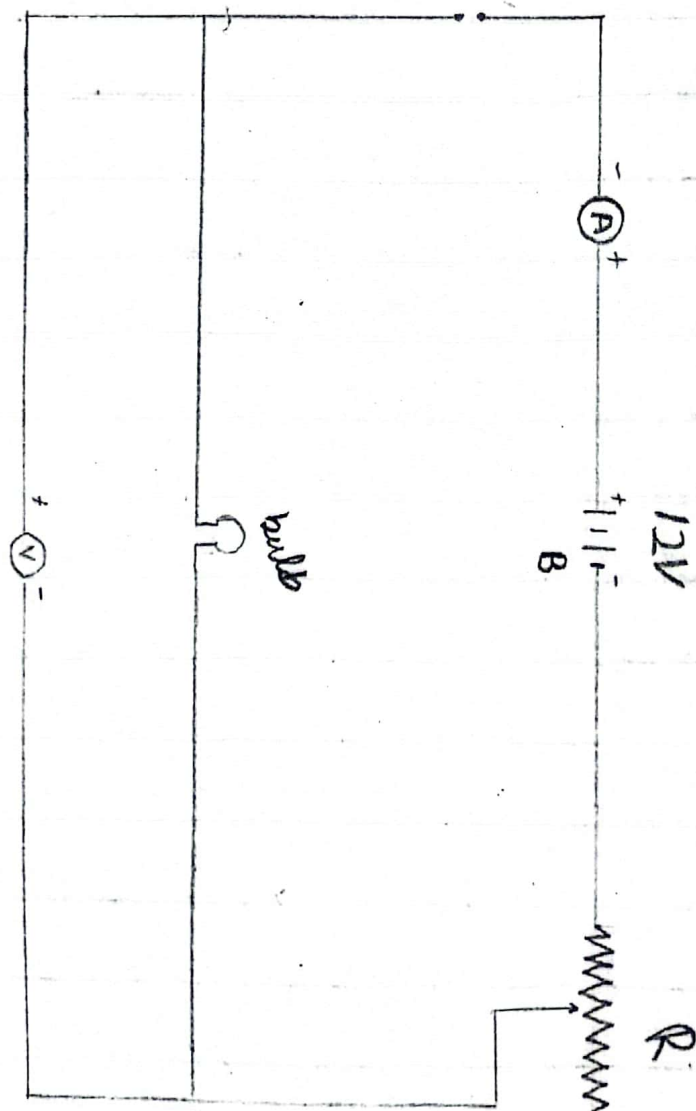
8. Similarly, take at least six observations by changing current in equal steps.

9. Plot a graph between voltmeter reading and ammeter reading.

PRECAUTIONS :

1. All the connections should be clean and tight.
2. Ammeter should be connected in series.
3. Voltmeter should be connected in parallel.
4. The terminals marked on ammeter and voltmeter should be connected to or towards the positive pole of the battery.
5. The current should be changed in equal steps.

Circuit Diagram

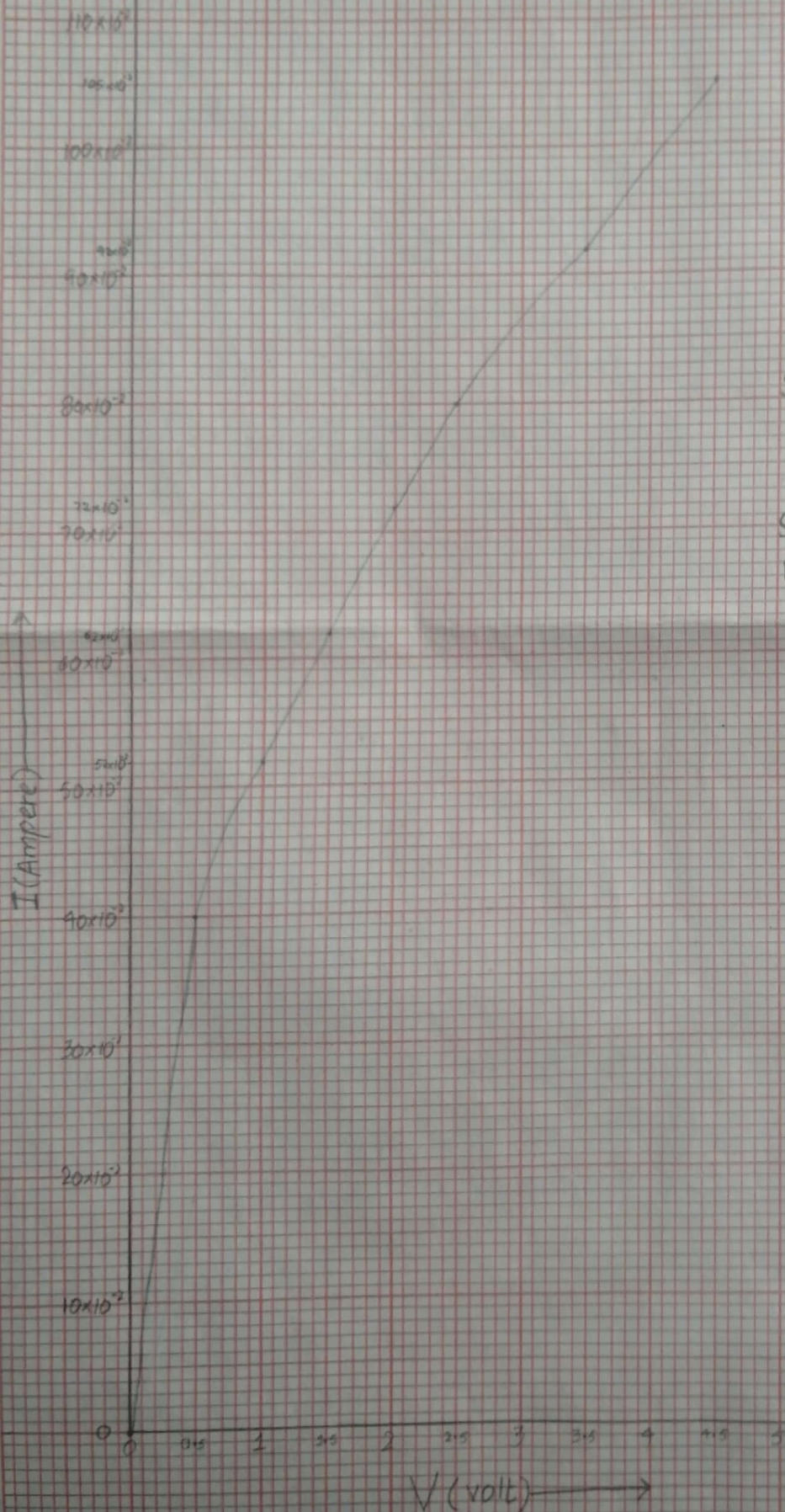


Observation and calculation

No. of obs	1	2	3	4	5	6	7	8
Voltmeter reading	0	0.5	1.0	1.5	2.0	2.5	3.5	4.5
Ammeter reading	0	0.40	0.52	0.62	0.72	0.80	0.92	1.05
Resistance of filament $R = V/I$	0	1.25	1.92	2.41	2.77	3.12	3.8	4.28

Results

The ratio V/I is not constant
 The graph between V and I is
 not a straight line, and V
 is not proportional to I and
 ohm's law is not valid



Scale along x-axis

1 Big Box = 2

1 Small Box = $\frac{2}{10} = 0.2$

Scale along y-axis

1 Big Box = 10×10^{-2}

1 Small Box = $\frac{10 \times 10^{-2}}{10} = 1 \times 10^{-2} \text{ A}$