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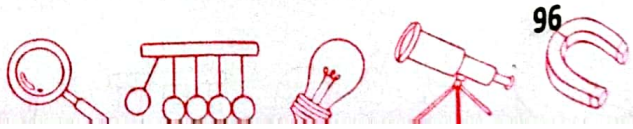
List of Practical's PHYSICS HSSC-II



Experiment 01

Determine unknown resistance by slide wire bridge.

Apparatus

Meter bridge, a sensitive galvanometer, resistances (car, a resistance box, a jockey, a rheostat, a plug key, a cell or battery eliminator, thick connecting wires and a piece of sand paper.

Circuit Diagram

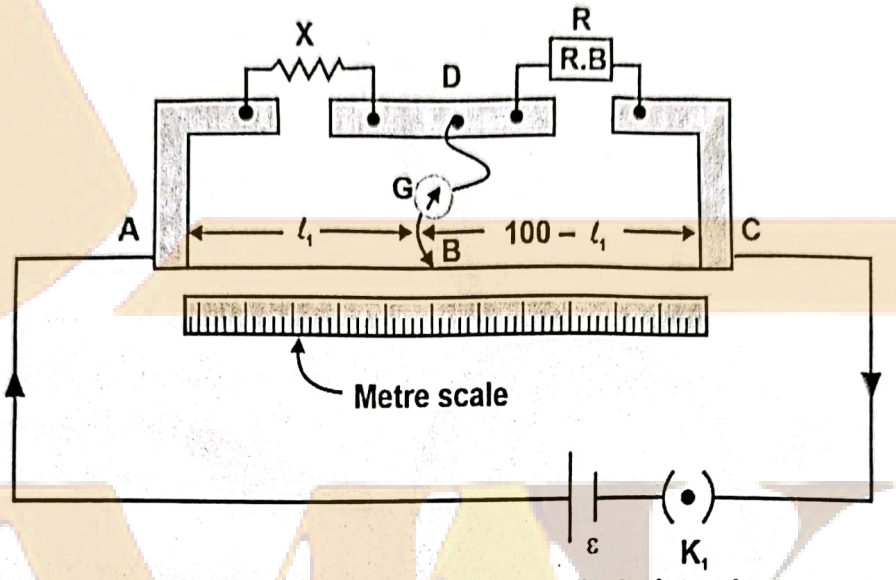


Fig. shows a slide wire bridge with 1m long wire from A to C." X is the resistance to be measured and "R" is the resistance from resistance box.

Theory

The meter bridge consists of a one-meter-long wire of uniform cross-sectional area, fixed on a wooden block A scale is attached to the block. Two gaps are formed on it by using thick metal strips in order to make the wheat stone's bridge. The terminal D between the gaps is used to connect galvanometer and jockey.

The meter bridge works on the principle of wheat stones. Here four resistors P. Q, R, and S are connected to form the network ABCD. In the balancing condition, here is no deflection on the galvanometer. Then,

$$\frac{P}{Q} = \frac{R}{S}$$

$$\frac{X}{R} = \frac{R \text{ (resistance of length } \ell_1 \text{ (AB) of the wire)}}{Q\text{(resistance of length } \ell_2 \text{ (BC) of the wire)}}$$

A resistance wire is connected in left side gap and the resistance box is in right side gap. One end of the galvanometer is connected to terminal B and its other end is connected to a jockey. As the jockey slides over the wire AC, it shows zero deflection at the balancing point (null point).

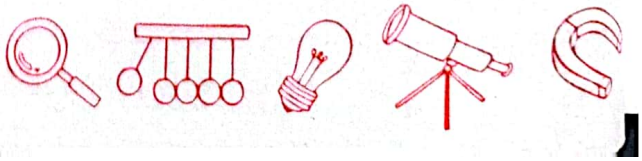
Procedure

Make connections according to circuit diagram.

Takeout 1 ohms each from resistance box. First press key K1 and find balance length ℓ_1.

Now find $\ell_2 = 100 - \ell_1$

Record three readings



Observations

Least count of the screw gauge = 0.001cm

Mean diameter = 0.030 cm

Radius of the wire = 0.015 cm

Length of the wire = 15 cm

No of observations	Resistance taken out R	AB = l_1	BC = l_2	$X = R\frac{l_1}{l_2}$
Units	Ohm	cm	cm	ohm
1	2	55	45	2.4
2	3	45	55	2.45
3	4	39	61	2.56

Mean resistance = 2.47ohm

Specific resistance = $\rho = \frac{X}{L} \times \pi r^2 = 1.16 \times 10^{-4}$ ohm cm

$\rho = 1.16 \times 10^{-6}$ ohm m

Viva & Voice

Q.1 Why is the meter bridge called so?

Ans. It is called a meter bridge because the bridges use one-meter-long `wire.

Q.2 What is the null point?

Ans. Null point is defined as the point at which a galvanometer shows zero deflection.

Q.3 Why is the bridge method better than the Ohms law of measurement?

Ans. Bridge method is better than the Ohms law of measurement because of the null method.

Q.4 What is the range of measurement of resistance using a Wheatstone bridge?

Ans. The resistance measurement range using a Wheatstone bridge is between 1Ω to a few mega ohms.

Q.5 What is the condition for balancing a Wheatstone bridge?

Ans. The resistances should be adjusted so that the potential difference across the galvanometer is zero and galvanometer give no deflection called balancing condition or null point.

Q.6 Does the null point indicate the absence of current or two equal and opposite currents in the galvanometer?

Ans. It indicates the absence of current as potential at two points become equal.

Q.7 What is the advantage of this method over others for the measurement of resistance?

Ans. The superiority of this method lies in the fact that it is a null method and not a deflection method. It is easier to see that there is no deflection than to measure a deflection accurately.

Q.8 On which principle is slide wire bridge work?

Ans. The slide wire bridge works on the principle of wheat stone bridge.

Q.9 Which rule is applied in the wheat stone bridge?

Ans. The Kirchhoff's 2nd rule is applied in wheat stone bridge which states that sum of all the potentials in a closed loop is zero.

Q.10 Why no current flows in balancing condition of wheat stone bridge?

Ans. In the balancing condition the potential of two terminal of galvanometer becomes equal and potential difference is zero so no current flows in balancing condition.

Q.11 Which type of wire is used in slide Wire Bridge?

Ans. Generally, alloys manganin/nichrome/ eureka are used in Meter Bridge, because these materials have low temperature coefficient of resistivity.

Q.12 **What is difference between resistance and resistivity?**

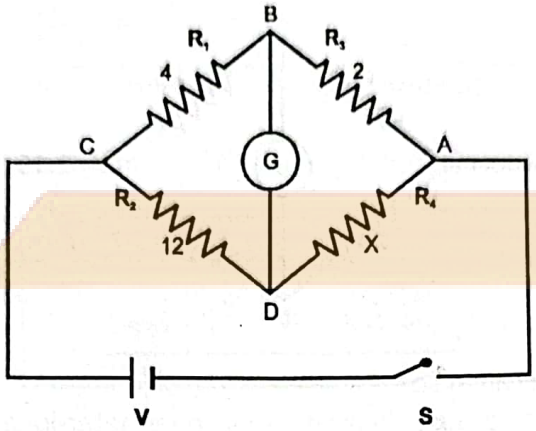
Ans. The opposition offered by the conductor to the flow of elections is called resistance.
The resistance of one meter cube substance called resistivity.
The resistance depends on length and area of conductor nature of material and temperature. Whereas resistivity is independent of length and area of conductor it purely depends upon nature of substances and its temperature.

Q.13 **What factor changes by changing the length of wire in slide wire bridge experiment?**

Ans. By changing the length of wire the resistance changes as resistance is directly proportional to length $R \propto \ell$.

Q.14 **Calculate the unknown resistance if the bridge is balanced?**

Ans. $\frac{R_1}{R_2} = \frac{R_3}{R_4}$



Let $R_1 = 4\Omega$, $R_2 = 12\Omega$, $R_3 = 2\Omega$
Then $R_4 = X = ?$

$$\frac{4}{12} = \frac{2}{X}$$

$$X = 6 \text{ ohms}$$

Q.15 **Why should the battery circuit have closed first than the galvanometer circuit?**

Ans. It can be done because to avoid the induced currents.

Q.16 **What is eureka wire?**

Ans. It has large resistance used in slide wire bridge, rheostat etc. it is an alloy of 40% nickel and 60% copper. Commonly this wire is using whose resistance is to measure. Sometimes nichrome wire also used.

Q.17 **What is principle of Wheatstone bridge?**

Ans. Its principle states as the ratio of resistances on one side of bridge become equal to the ratio of resistances on the other side of the bridge when bridge is balanced (galvanometer gives zero deflection).

Q.18 **How we can check the correctness of side wire bridge circuit?**

Ans. In order to check the correctness of circuit, check the deflection of galvanometer at opposite side by putting tapping key at opposite side of wire.

Q.19 **What is jockey?**

Ans. Jockey is sliding contact which slides over wire, of slide Wire Bridge to balance the bridge.

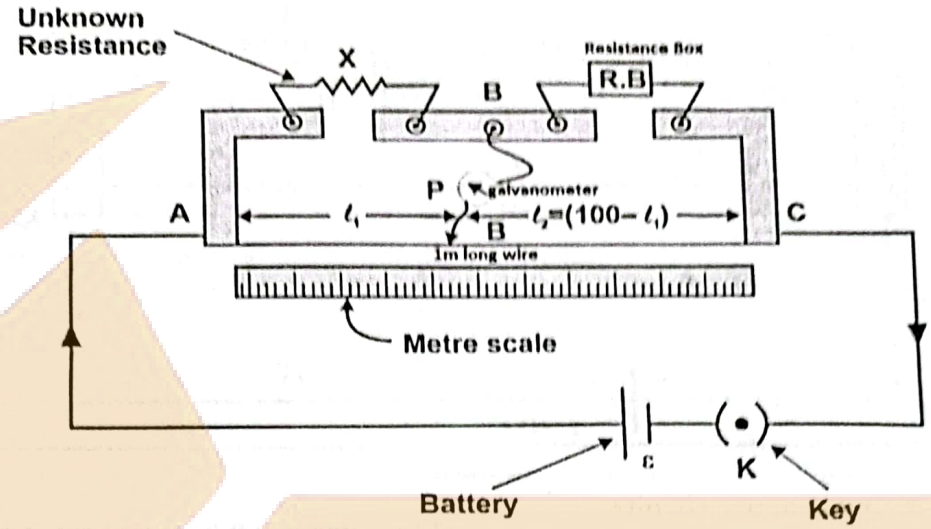
Q.20 **When the bridge is balanced?**

Ans. When no current flows through galvanometer then it will be balanced.

SOLVED WORKSHEET

Q.1 i) label the components of circuit? [1]

Ans.



ii) What is the name of above experiment? [1]

Ans. Determine the unknown resistance of a wire by slide wire bridge.

iii) What is the principle of above experiment? [1]

Ans. Its working is based on the principle of Wheatstone bridge.

iv) What is the range of measurement of resistance using a Wheatstone bridge? [1]

Ans. The resistance measurement range using a Wheatstone bridge is between 1Ω to a few mega ohms.

v) Complete the column of table? [2]

No of observations	Resistance taken out R	AB = l_1	BC = l_2	$X = R\frac{l_1}{l_2}$
Units	[ohm]	[cm]	[cm]	[ohm]
1	2	49	51	1.99
2	3	40	60	2
3	4	34	66	2.06

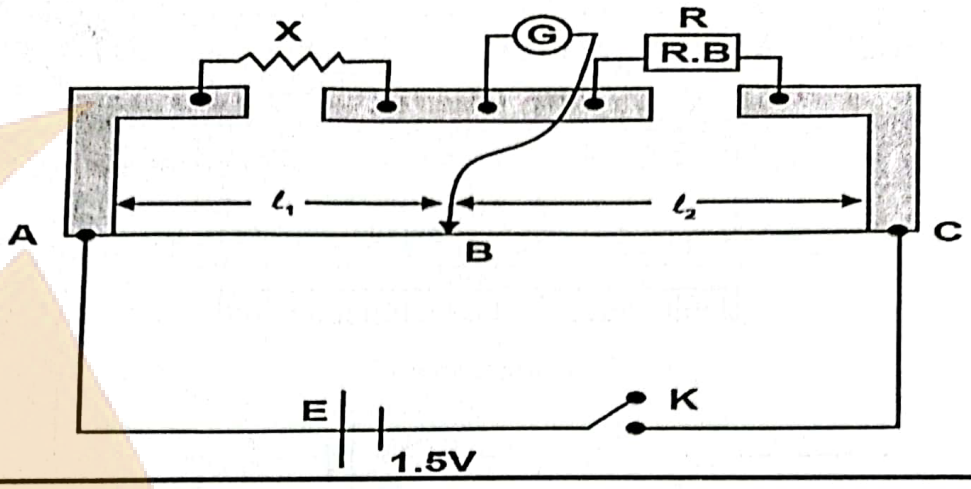
vi) Mean Resistance of wire of wire = X = ------2----------Ohm [1]

Ans. Mean Resistance = $\frac{1.99+2+2.06}{3}$ = 2 ohm

vii) If the length of wire is 12cm and diameter is nearly 0.04cm. Find resistivity of wire. If resistance is equal to 2Ω.

Ans. Specific resistance = $\rho = \frac{X}{L} \times \pi r^2 = \frac{2 \times 3.14 \times (2 \times 10^{-4})^2}{0.12} = 2.1 \times 10^{-6}$ ohm m

Q.1 A circuit diagram is shown below?



i) What is the Name of above circuit? [01]

ii) Why this circuit is used? [01]

iii) On What principle does the circuit work? [01]

iv) From above fig give the formula to find unknown resistance of wire (01)

X = ...

v) Complete the missing entries of following Table? [01+02]

No of observations	Resistance from resistance box "R"	Distance from balancing length l_1	Distance from balancing length l_2	Unknown resistance
units	ohm	cm	cm	$X=\frac{l_1}{l_2}R$
1	1	58	42	1.4
2	2	42	58	1.45
3	3	33	67	1.48

vi) Find the mean resistance=----------Ohm [1]

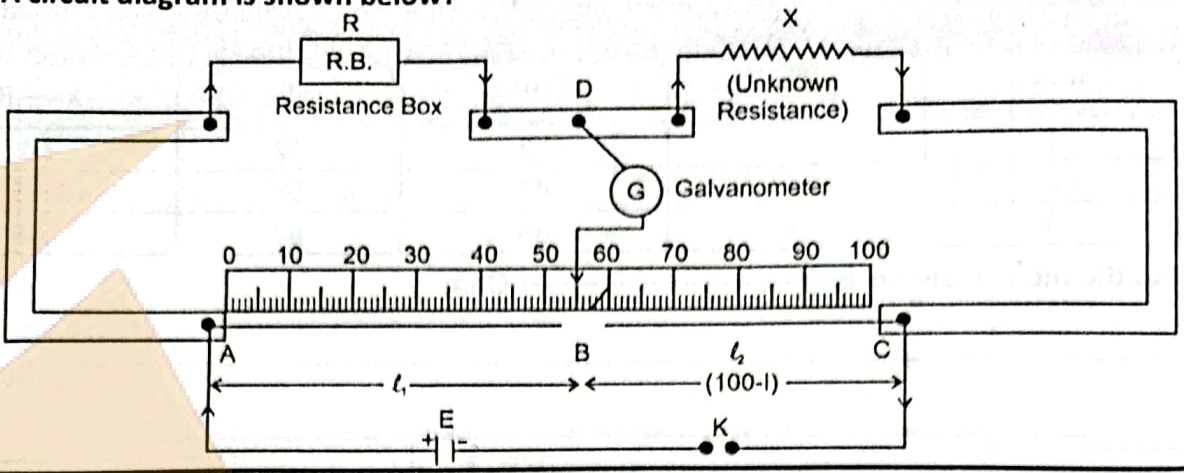
vii) Mean diameter of wire = 0.024 cm (01)

Radius of the wire = 0.012 cm

Length of the wire = 20 cm

Find resistivity of wire = ρ

Q.1 **A circuit diagram is shown below?**

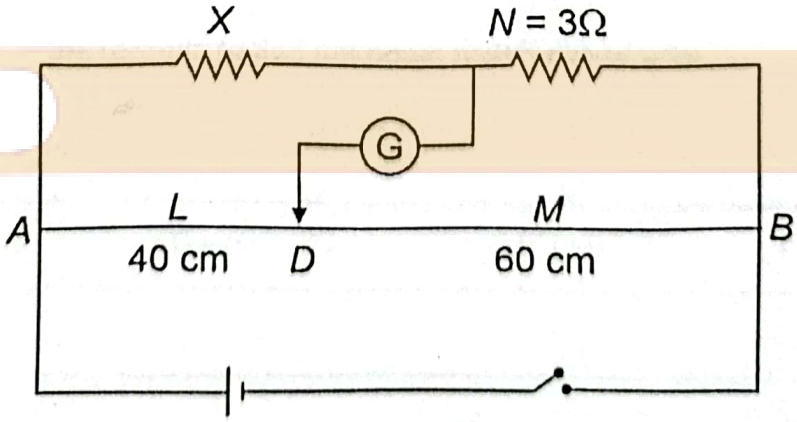


i) **Find the balancing length reading from the fig?** [01]

ii) **What should be the reading of galvanometer on the balancing point and why?** [01]

iii) **What is the mathematical expression for this circuit to measure unknown resistance?** [01]

iv) **The Wheatstone bridge shown in the figure below is balanced when the uniform slide wire AB is divided as shown Value of the resistance X is:** [02]



v) Why is the continuous flow of current through the slide wire generally discouraged? [02]

vi) Define specific resistance with formula and give its unit? [01]

Experiment 02

Determine the internal resistance of cell by using potentiometer.

Apparatus

Potentiometer, dry cell, an ammeter, one resistance box (R. BOX) (about 0-50 Ω), 2 one-way plug keys, galvanometer rheostat of about 20 Ω, jockey, lead accumulator and connecting wires.

Circuit Diagram

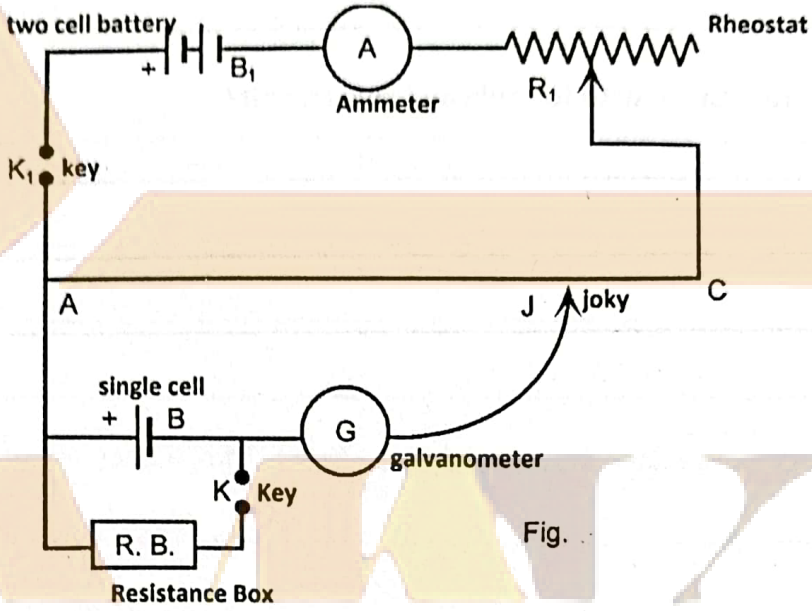


Fig.

Theory

When a resistance R is connected across a cell of emf E and internal resistance r, then the current I in the circuit is

$$\ell = \frac{E}{R+r}$$

The potential difference (V = IR) across the two terminals of the cell is

$$V = \left(\frac{E}{R+r}\right)R$$

$$\frac{R+r}{R} = \frac{E}{v}$$

$$\frac{E}{v} = 1+\frac{r}{R}$$

$$\left(\frac{E}{v}-1\right)R = r$$

E and V can be measured by balancing them on a potentiometer wire. If ℓ_1 is the length of the potentiometer wire which balances *E* and l_2 is the length of the wire which balances *V* then

$$E \propto \ell_1 \quad \text{and} \quad V \propto \ell_2 \quad \text{or} \quad \frac{E}{V} = \frac{\ell_1}{\ell_2}$$

Putting the value of E/V in Eq (iv) we have

$$r = \left(\frac{1}{2}\right)$$

$$r = \left(\frac{\ell_1}{\ell_2} - 1\right)R$$

$$= \left(\frac{\ell_1 - \ell_2}{\ell_2}\right)R$$

If ℓ_1 and ℓ are the distances of the balance null point from end A of the potentiometer for an open and a closed circuit then E is proportional to ℓ_0 and V is proportional to ℓ.

$$r = \left(\frac{\ell_1 - \ell_2}{\ell_2}\right)R$$

Procedure

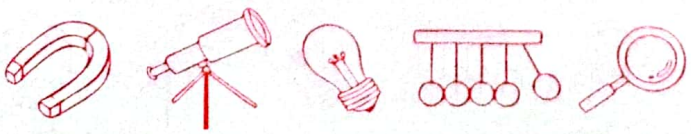
1. Draw a neat circuit diagram.
2. Connect the shunt wire across the galvanometer and introduce some resistance by the rheostat R_1 in the potentiometer circuit. Close the key K_1. Keeping the key K open press the jockey on the potentiometer wire first near its end A and then near its end C and see that the deflections of the galvanometer in these two cases are in the opposite direction. If it is not so, decrease the resistance introduced by the rheostat R_1 and get the balance point near the end C of the wire.
3. Remove the shunt and note the reading of the ammeter. Find the balance point accurately. Note the distance l_1 of the balance point from the end A of the wire.
   Introduce some suitable resistance R by the resistance box R.B. Close the keys K_1 and K and find the balance point as before. Find the distance ℓ_2 of the balance point from the end A of the wire.
   Determine the internal resistance r of the cell by the relation $r = \left(\frac{\ell_1 - \ell_2}{\ell_2}\right)R$
4. Repeat the experiment thrice by slightly changing the resistance *R* and the resistance in the battery circuit.

Observation and Calculation

ℓ_1 = ... cm (in the beginning of the experiment)

No of observation	RESITANCE R Ohm	Balancing length ℓ_1 Without resistance from R-B cm	Balancing length ℓ_2 With resistance from R-B cm	$r = \left(\frac{\ell_1 - \ell_2}{\ell_2}\right)R$ Ω
1	1	327	280	0.17
2	2	320	293	0.18
3	3	315	298	0.17

MEAN VALUE OF r = 0.173 ohm



Q.1. **What is meant by electric potential?**

Ans. The potential at a point is measured by the work done in bringing a unit positive charge from infinity to that point.

Q.2. **What is meant by short circuiting of a cell?**

Ans. When the two poles of a cell are connected by a wire of negligible resistance, the cell is said to be short circuited. This must be avoided because a very large current begins to flow and the cell is likely to be damaged.

Q.3. **Under what condition does a battery give the maximum current?**

Ans. A battery gives maximum current when the external resistance is equal to the internal resistance of the battery.

Q.4. **What is internal resistance of battery?**

Ans. The resistance of electrolyte in the flow of current is called internal resistance of battery.

Q.5. **On Which factors the internal resistance of battery depends?**

Ans.

Internal resistance 'r' of cell depends

- $r \propto \frac{1}{A}$ (A is area of plates used in cell)
- $r \propto$ distance between electrodes of battery
- $r \propto$ concentration of electrolyte.
- $r \propto \frac{1}{T}$ (r decreases with increase in temperature of electrolyte)
- $r \propto d$ (d is distance between plates)

Q.6. **The internal resistance of a battery of high voltage should be high why?**

Ans. The high voltage battery should have high internal resistance otherwise battery will be damaged due to greater flowing current.

Q.7. **The Terminal potential drops by flowing current in battery why?**

Ans. When current flows then battery began to heat. This heat energy comes from electrical energy of batter so its potential drops.

Q.8. **What are the source of emf?**

Ans. All those devices which convert non-electrical energy into electrical energy. e.g. cell batter, A.C. generator, thermo-couple, solar cell.

Q.9. **What is function of source of emf?**

Ans. It provide a permanent potential difference between two points is a electrical circuit for steady flow of current.

Q.10. **What is the difference between cell and battery?**

Ans. Cell is not rechargeable while battery (accumulates) is rechargeable.

Q.11. **What is relation between emf and terminal potential difference which one of them greater than other?**

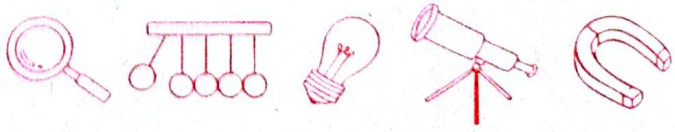
Ans. The relation between emf (E) and terminal potential difference (V_t) is

$$V_t = E - Ir$$

It shows that emf if greater them potential difference.

Q.12. **In which condition potential difference will be greater than emf?**

Ans. When battery is being charged then potential difference will be greater than emf.



SOLVED WORKSHEET

Q.1 **Write the name of above Experiment?**

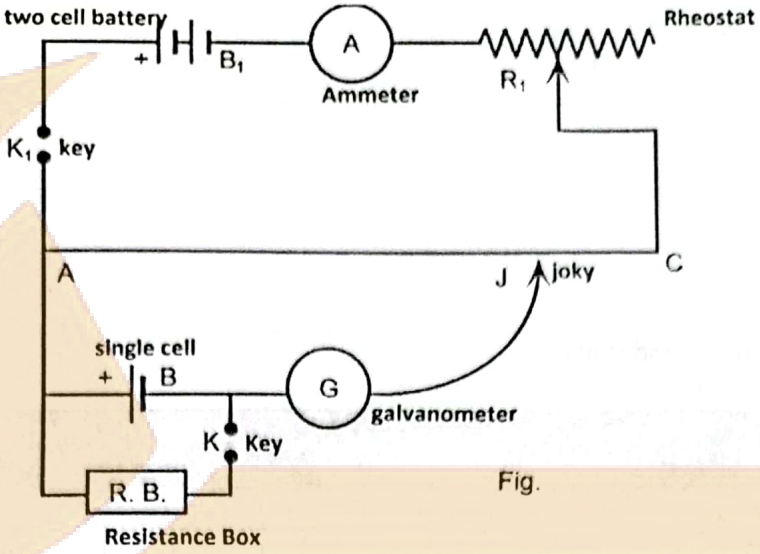


Fig.

i) **Label the diagram.** **(2)**

Ans. See above diagram

ii) **What is internal resistance of cell?** **(1)**

Ans. The resistance offered by electrolyte present between two electrodes of a cell to the flow of ions is called internal resistance of the cell.

iii) **Write the formula of internal resistance of cell?** **(1)**

Ans. $r = \left(\frac{\ell_1 - \ell_2}{\ell_2}\right)R$

iv) **Complete the table and unit?** **(2)**

No of observation	Resistance R	Balancing length ℓ_1	Balancing length ℓ_2	$r = \left(\frac{\ell_1 - \ell_2}{\ell_2}\right)R$
units	[--------]	[--------]	[--------]	[--------]
1	5	340	318	0.50
2	6	340	312	0.54
3	7	300	280	0.50

v) **Find MEAN VALUE OF r = 0.51 ohm** **(1)**

Ans. $r = \frac{0.50 + 0.54 + 0.50}{3} = 0.51$ ohm

vi) **Whether the internal resistance of cell remain constant or not?** **(1)**

Ans. The internal resistance of a cell does **not remain constant** over time. It can change due to several factors:

1. **Age of the cell**: As a cell ages, chemical reactions within it become less efficient, which increases its internal resistance.
2. **Temperature**: Higher temperatures generally reduce internal resistance, while lower temperatures increase it. However, very high temperatures can cause permanent damage, leading to higher resistance over time.

SCHOLAR WORKSHEET – 01

Q.1 i. Draw the circuit diagram of the internal resistance of cell using potentiometer? [2]

ii. Complete the table and unit? [1+1]

Use value of l_1 =290 cm

No of observation	Resistance R	Balancing length l_2	$r = \left(\frac{l_1 - l_2}{l_2}\right)R$
units	[--------]	[--------]	[--------]
1	1	271	
2	2	279	
3	3	283	

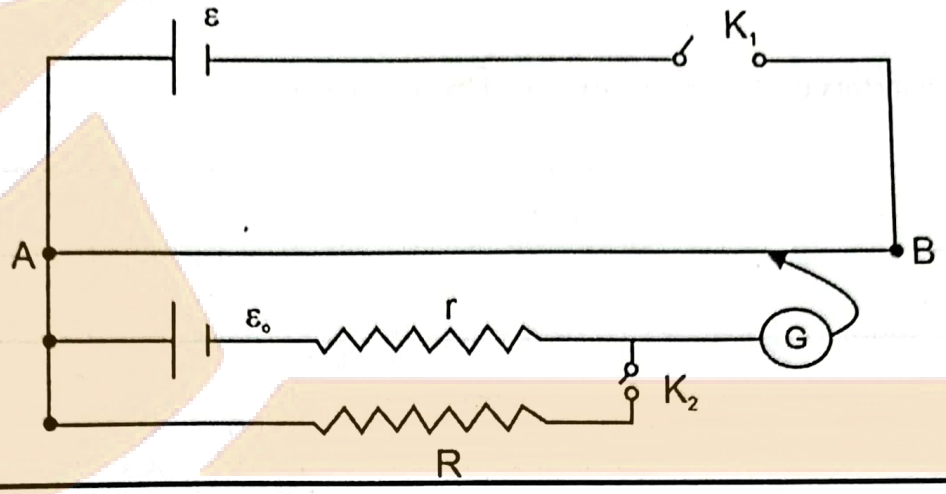
MEAN VALUE OF r = ohm

iii. A cell of emf E and internal resistance r is connected across a variable resistor R. A graph showing variation of terminal voltage V of the cell with the current I. Using the plot, show how the emf of the cell and its internal resistance can be determined. Explain the graph? [2]

iv. Plot a graph showing the variation of current I versus resistance R, connected to a cell of emf E and internal resistance r. [2]

v. Whether the internal resistance of cell remain constant or not? (1)

Q.1 The internal resistance of a cell is to be determined using a potentiometer. In an experiment, an external resistance of R = 60 Ω is used across the given cell. When the key K_1 is closed and K_2 is open, the balance point is found at a length of 72 cm. The balance length on the potentiometer is found at 60 cm when both the keys are closed. Calculate the internal resistance of the cell. [2]



i) What are ways to reduce internal resistance? [2]

ii) A 9.0 V battery has an internal resistance of 12.0 Ω. [1]

(a) What is the potential difference across its terminals when it is supplying a current of 50.0 mA?

iii) When a cell is connected directly across a high resistance voltmeter the reading is 1.50 V. When the cell is shorted through a low resistance ammeter the current is 2.5 A. What is the emf and internal resistance of the cell? [2]

iv) **Why the potentiometer is preferred to find internal resistance of cell.** [2]

v) **On Which factors the internal resistance of battery depends?** [1]

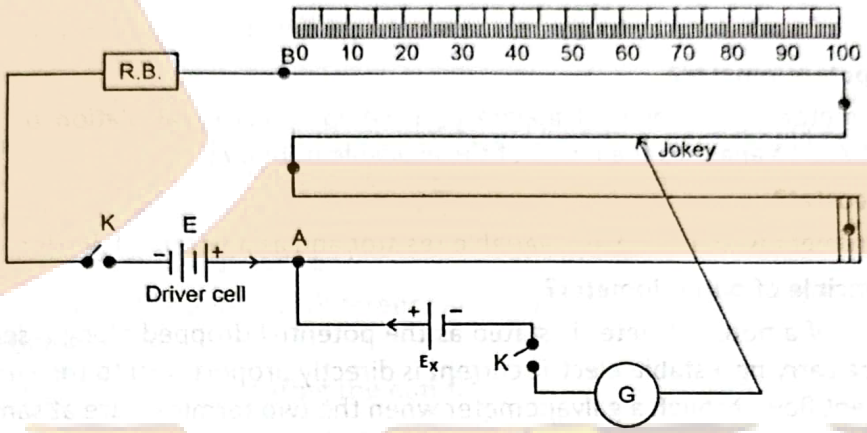
Experiment 03

Determine "Emf" of a cell using Potentiometer

Apparatus

Potentiometer, a Daniel cell, a two-way key, a resistance box, galvanometer, a voltmeter (0-3 V), a battery, a low resistance rheostat (about 20 Ω), two one-way keys, connecting wires and sand paper.

Circuit Diagram



Theory

According to the principle of potentiometer, when a steady current flows through a wire of uniform thickness and material, potential difference between any two points on it is directly proportional to the length of the wire between the points. Thus,

$$E \propto L$$

Unknown emf E_x is directly proportional to balance length

$$E_x \propto \ell$$

$$E_x = E\frac{\ell}{L}$$

Procedure

- Connect the circuit according to Fig. Total length of wire = L= 4 m
- Now close the key "K" and find the balancing length ℓ by sliding jokey on wire from A to B
- Repeat this experiment and calculate E.M.F of cell

Observation and Calculation

Emf of driving source

No of Observations	Total Length of wire L	Distance of balance point for cell of unknown emf l	$E_x = E\frac{\ell}{L}$
Units	cm	cm	volt
1	400	198	1.485
2	400	197	1.477
3	400	199	1.49

Mean E.M.F of cell = _____

Q.1. **What is advantage of this method of measuring the unknown emf of a cell?**

Ans. It is a null method and does not involve errors in measuring a deflection because it is easier to see that there is no deflection than to measure a deflection accurately.

Q.2. **Why should the current be passed for a short time just necessary for taking a reading?**

Ans. The resistance of the potentiometer wire should remain constant but it changes due to heat produced by the passage of current through it. For this reason, current should be passed for a short time just sufficient to take a reading and it should be stopped for some time before taking the next reading so that the wire may cool down to its original temperature.

Q.3. **Define emf of battery?**

Ans. The amount of work done by battery on a unit charge called emf. Its unit is volt.

Q.4. **What is a potentiometer?**

Ans. A potentiometer is an electrical apparatus used for precise calculation of minute potential differences and to analyses the e.m.f. of the available primary cells.

Q.5. **What is rheostat?**

Ans. It is an instrument which is use as a variable resistor and as a potential divider.

Q.6. **What is principle of potentiometer?**

Ans. The principle of a potentiometer is stated as the potential dropped along a section of a wire of uniform area carrying a stable electric current is directly proportional to the wire's length.
The no current flow through a galvanometer when the two terminals are at same potential.

Q.7. **What is principle of rheostat?**

Ans. The working principle of rheostat is that the resistance of the wire is directly proportional to length.

Q.8. **The potentiometer wire must be long and uniform thickness, why?**

Ans. The potentiometer will be more sensitive for increasing the length of wire and fall of potential is proportional to uniform thickness.

Q.9. **The emf of battery can be measured by voltmeter and potentiometer. Which is preferable and why?**

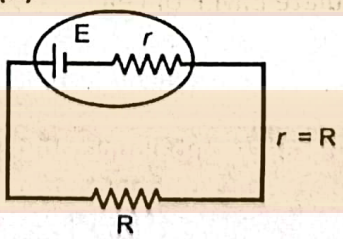
Ans. The potentiometer is preferred then voltmeter as it measures accurately.

Q.10. **What is meant by a potential gradient?**

Ans. The potential gradient is the potential variation per unit length of the given potentiometer wire.

Q.11. **How the output power of battery / cell will be maximum?**

Ans. The output power of battery / cell will be maximum when its internal resistance (r) will be equal to resistance of external circuit (R).

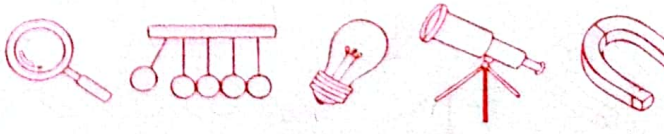


Q.12. **Write any two uses of potentiometer?**

Ans. (i) It can measure emf of battery/cell.
(ii) It can compare the emfs of two batteries.

Q.13. **Why potentiometer is as accurate voltage measuring device?**

Ans. As it draws no current while measuring voltage.



Q.14. What is the difference between emf and potential difference?

Ans.

(i)	emf = w/q	(i)	$\Delta V = w/q$
(ii)	It stands for gain in energy	(ii)	It stands for loss in energy
(ii)	Cause	(iii)	Effect
(iv)	Always present even when I = 0,	(iv)	It is zero when I = 0
(v)	It is source	(v)	It is sink

Q.15. Can a voltmeter read correct emf of cell?

Ans. Voltmeter cannot read correct emf of cell because it draws some current from cell.

Q.16. What is cell?

Ans. The device which converts chemical energy into electrical energy.

Q.17. What is difference between primary and secondary cell?

Ans. The primary cell cannot be recharged while the secondary can be recharged.

Q.18. Why is a potentiometer preferred over a voltmeter for the calculation of e.m.f?

Ans. For the purpose of measuring e.m.f accurately, no electric current should be taken from the cell. In the case of a potentiometer, the readings are noted when the electric current is zero. So the potentiometer measures the e.m.f correctly.

Q.19. What is meant by terminal voltage?

Ans. Terminal voltage is the potential difference along with a cell's terminals when the electric current is being taken from it.

Q.20. Is a voltmeter used for measuring the e.m.f.?

Ans. No, the voltmeter takes electric current from the cell.

Q.21. What is the reason behind the null point?

Ans. The null point is acquired because the cell's e.m.f. is balanced by the potential variation along a particular length of the connected potentiometer wire.

Q.22. Why does a secondary cell give more electric current than a primary cell of the identical e.m.f.?

Ans. A secondary cell gives more electric current than a primary cell because a secondary cell possesses a very low internal resistance.

Q.23. Which type of cells (primary cells or secondary cells) is employed in automobiles?

Ans. Secondary cells are typically used in automobiles because they provide the needed large beginning current due to this cell's relatively low internal resistance.

Q.24. How is the potentiometer's sensitivity affected by the length of the wire?

Ans. The sensitivity of the potentiometer rises with the increase in the increase in wire's length.

Q.25. What will result if the cross-section area of the potentiometer wire is non-uniform?

Ans. The potential difference across the wire will not be proportional to its length.

Q.26. What can be the reason for one-sided deflection in galvanometers?

Ans. (a) The primary cell's e.m.f. may surpass that of the main circuit cell.
(b) Circuit connections may be incorrect or loose.

Q.1 **Label the name of component of circuit?** **(2)**

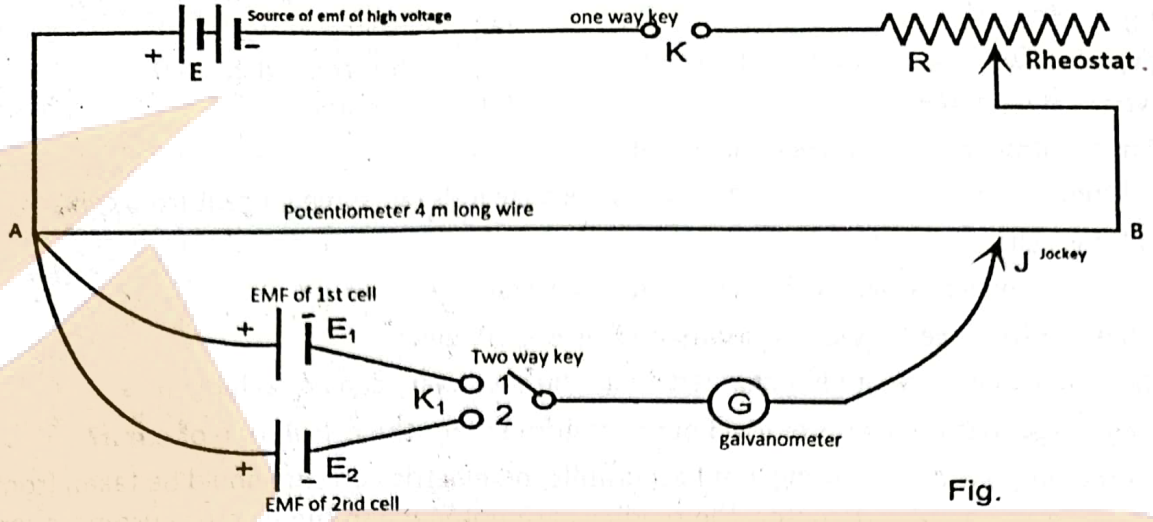


Fig.

i) **Write the name of above Experiment?** **(1)**

Ans. Compare "Emf" of two cell using Potentiometer

ii) **What is E.M.F of cell?** **(1)**

Ans. Emf is the energy supplied by the battery per unit charge.

EMF of a cell represents the maximum potential difference between its electrodes, determining the cell's ability to generate electrical energy

iii) **Why potentiometer is an accurate device for measuring for potential difference?** **(2)**

Ans. A potentiometer is an accurate and versatile device to make electrical measurements of emf because the method involves a condition of no current flow through the galvanometer, the device can be used to measure potential difference, internal resistance of a cell and compare emf's of two sources

iv) **Complete the table and unit?** **(2)**

No Of Observation	Blancing Length For Cell E_X ℓ_1	Blancing Length For Cell E ℓ_2	$\frac{E_1}{E_2} = \frac{l_1}{l_2}$
units	cm	cm	
1	271	275	0.985
2	280	283	0.989
3	285	289	0.986
4	289	292	0989

(v) **Name some source of electromotive force?**

Ans. Devices that can provide emf include electrochemical cells, thermoelectric devices, solar cells, photodiodes, electrical generators.

SCHOLAR WORKSHEET – 01

Q.1 **DRAW the circuit diagram to find "Emf" of a cell using Potentiometer?** **[2]**

i) **Complete the table and unit?** **[2]**

Use values E= 3V

$E_2 = 1.5\ V$

No Of Observation	Blancing Length For Cell E_1 l_1	Blancing Length For Cell E_2 l_2	$E_1 = E_2 \frac{l_1}{l_2}$
units	[----------]	[----------]	[----------]
1	284	290	
2	294	300	
3	304	311	

MEAN VALUE OF E_x =_____ [1]

ii) **Why potentiometer is better device than voltmeter for measuring potential difference** **[1]**

_____

_____

_____

iii) **What is the reason behind the null point?** **[1]**

_____

_____

_____

iv) **What will result if the cross-section area of the potentiometer wire is non-uniform?** **[1]**

_____

_____

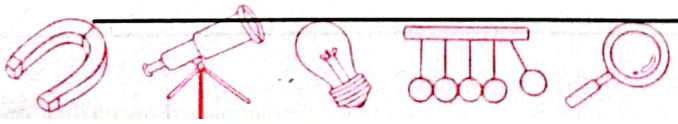
_____

v) **Draw a circuit which can give continuously varying potential. Give formula to find P-D between point A and jokey position.** **[2]**

_____

_____

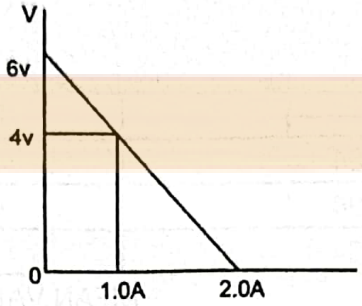
_____



SCHOLAR WORKSHEET – 02

Q.1 In a potentiometer circuit, a cell of EMF 1.5V gives the balance point at 36 cm length of wire. If another cell of EMF 2.5V replaces the first cell, then at what length of the wire, the balance point occurs? [2]

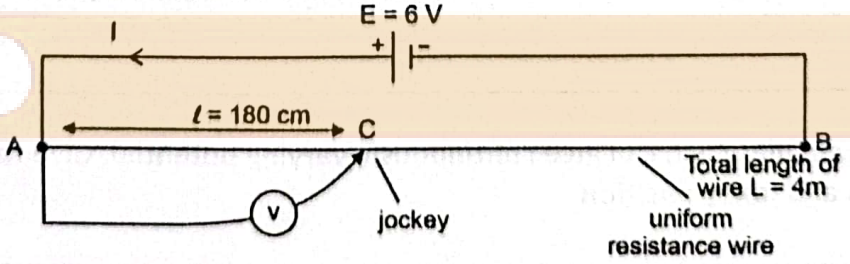
i) The figure shows a plot of terminal voltage 'V' versus the current 'I' of a given cell. Calculate from the graph (a) emf of the cell. [2]



ii) Why is a potentiometer preferred over a voltmeter for the calculation of e.m.f? (2)

iii) Why does a secondary cell give more electric current than a primary cell of the identical e.m.f.? (1)

iv) From fig find potential difference between A and C. (2)



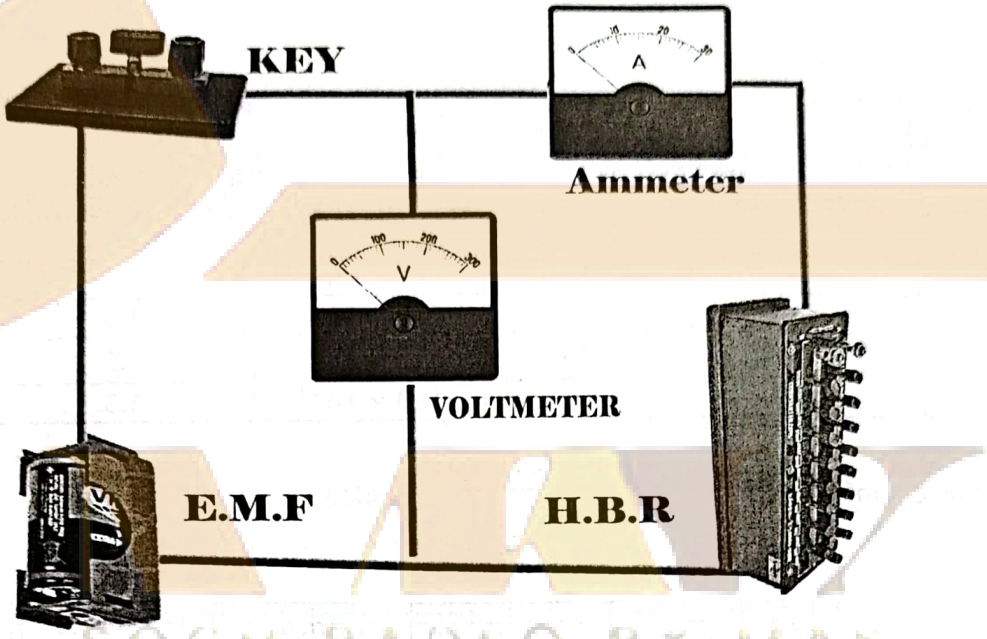
Experiment 04

Determine the E.m.f. and internal resistance of cell by plotting V against I graph

Apparatus

Apparatus High resistance box, milliammeter, Voltmeter, cell, connecting wires, key, sand paper

Diagram



Theory

The cell is connected to external Resistance R, the current I is flowing from its positive to negative terminal. The internal resistance behave as if it is in series to the cell. The total resistance of the circuit becomes R + r.

If emf of the cell will be ε, then from the Ohm's law

$$\varepsilon = I(R + r)$$

$$\varepsilon = IR + Ir \qquad ...(1)$$

IR = The voltage drop across External resistance and which is parallel to cell

$$IR = V$$

By putting i

$$\varepsilon = V + Ir \qquad ...(2)$$

External resistance R = ∞, Then I = 0

$$\varepsilon = V + 0$$

Emf of cell = terminal voltage of cell

From Equation (2)

$$Ir = \varepsilon - V$$

$$r = \frac{\varepsilon - V}{I}$$

Procedure

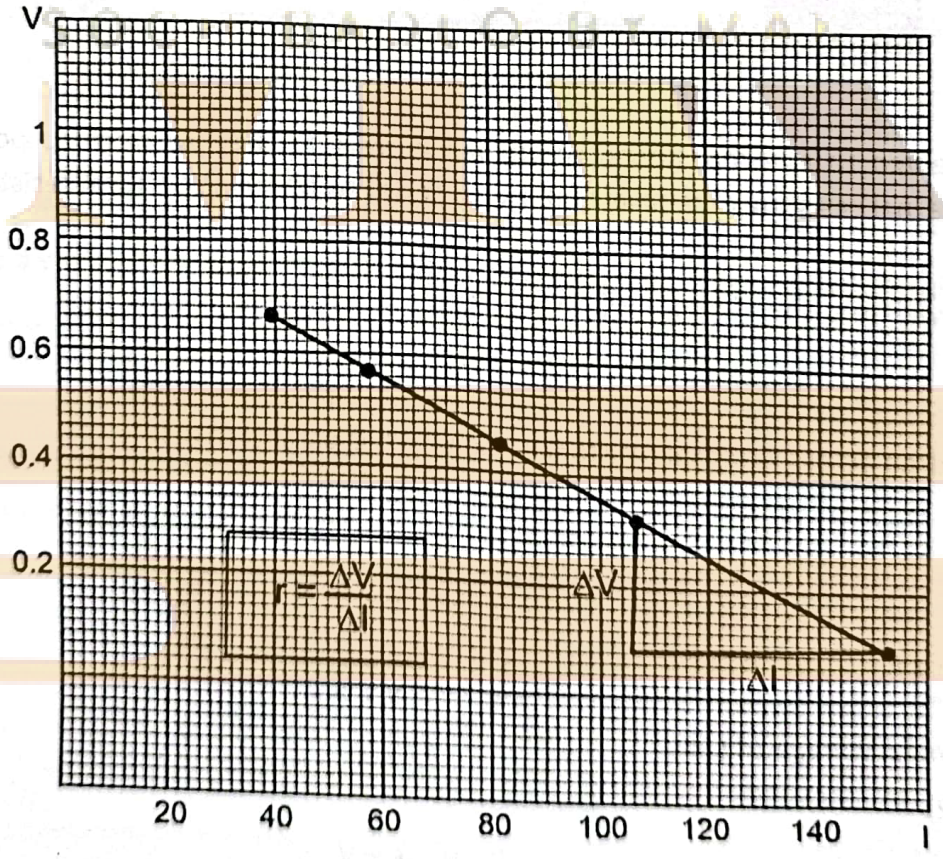
- Make the connections according to circuit diagram.
- By closing key and take out infinite resistance from H.B.R.
- The milliammeter will show zero reading and voltmeter then show Emf of cell.
- Now plug the infinity key and take out resistance from resistance box milliammeter will show reading.
- Record the reading of voltmeter and milliammeter for different values of resistance taken out from resistance box.
- Draw the graph between I and terminal voltage V which is straight line.
- The slope of line $\frac{\Delta v}{\Delta I}$ will give internal resistance r

Observation and Calculations

S.no	Resistance R	Voltmeter reading V	Ammeter reading I	Emf ε	$r = \frac{\varepsilon - V}{I}$
1	1	0.9	350×10^{-3}	1.5	3.28
2	2	1	280×10^{-3}	1.5	3.35
3	3	1.10	240×10^{-3}	1.5	3.25
4	4	1.15	200×10^{-3}	1.5	3.50
5	5	1.2	180×10^{-3}	1.5	3.33

Mean value of emf = $\frac{3.28 + 3.35 + 3.25 + 3.52 + 3.33}{5} = 3.42\Omega$

Graph



Viva & Voice

Q.1 **Define internal resistance?**

Ans. A cell can be thought of as a source of e.m.f. with a resistor connected in series. When current flows through the cell a voltage develops across the internal.

Q.2 **Whether the internal resistance of cell remain constant or not?**

Ans. The internal resistance of a cell can increase over time due to chemical changes within the cell. This can lead to a decrease in the cell's performance, even if the cell is not being used.

Q.3 **What is the E.M.F of the cell?**

Ans. It is the Potential difference across the terminal of cell when it is not delivering the current, i.e., the cell is in open Circuit.

Describe the condition for maximum power output delivered to the load resistance by a battery.

Maximum Power Output:

- In many electronic circuits and systems it is important to have maximum transfer of power from the source to the load. For example, we want maximum power transfer from amplifier to speaker system. This is accomplished by proper matching of load resistance R and source resistance r.
- The power output will be maximum when load resistance R becomes equal to internal resistance r of battery.

If V is P-D across R then power delivered to R is

$$P_{out} = I^2R$$

$$P_{out} = \left[\frac{\varepsilon^2}{(R+r)^2}\right] R \quad \left[\because \quad I = \frac{\varepsilon}{R+r}\right]$$

$$P_{out} = \frac{\varepsilon^2 R}{(R-r)^2+4Rr}$$

When R = r, then denominator becomes minimum.

Hence, value of power output becomes maximum. Thus

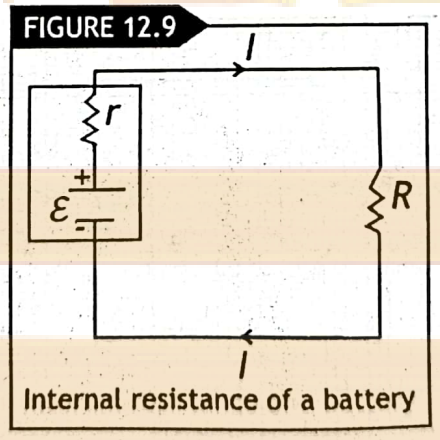
$$(P_{out})_{max} = \frac{\varepsilon^2 r}{(r-r)^2+4r\,r}$$

$$(P_{out})_{max} = \frac{\varepsilon^2 r}{0+4r\,r}$$

$$(P_{out})_{max} = \frac{\varepsilon^2}{4r}$$

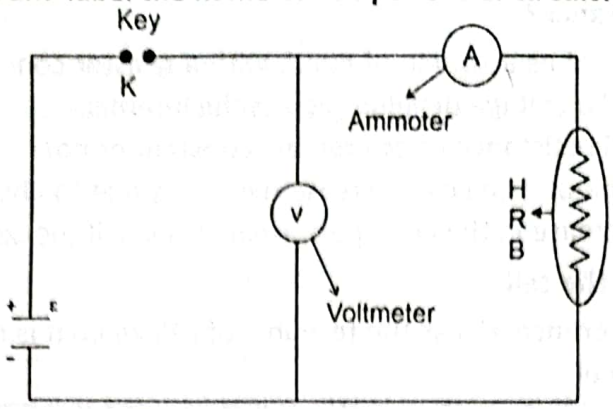
- This is the expression for maximum output power delivered to a load resistance.

FIGURE 12.9



Internal resistance of a battery

Q.1 Draw circuit diagram and label the name of component of circuit? **(2)**



i) Define internal resistance? **[1]**

Ans. A cell can be thought of as a source of e.m.f. with a resistor connected in series. When current flows through the cell a voltage develops across the internal.

ii) What is the E.M.F of the cell? **[1]**

Ans. It is the Potential difference across the terminal of cell when it is not delivering the current, i.e,. the cell is in open Circuit.

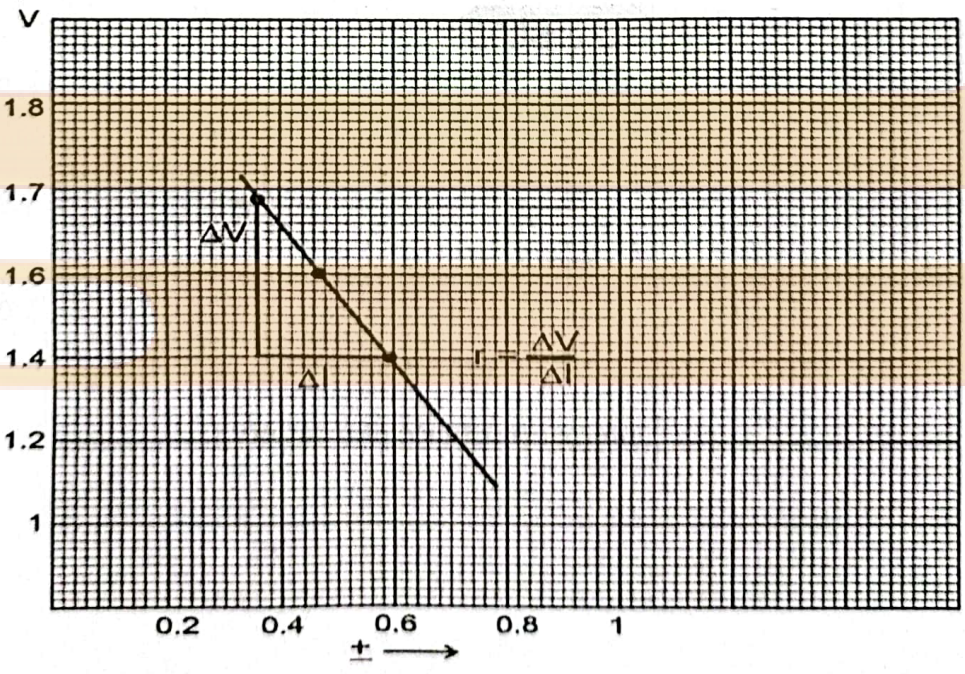
iii) Why does on sided deflection of galvanometer indicates? **[1]**

Ans. The E.M.F of driver cell is smaller than the E.M.F of any of these two cells

iv) Complete the table and unit? **[2]**

S.no	Resistance R	Voltmeter reading V	Ammeter reading I	Emf ε	$r = \frac{\varepsilon - V}{I}$
units	ohm	voltage	Ampere	volt	ohm
1	1	1.4	0.6	2.5	2.76
2	2	1.6	0.5	2.5	3.4
3	3	1.7	0.4	2.5	4.55

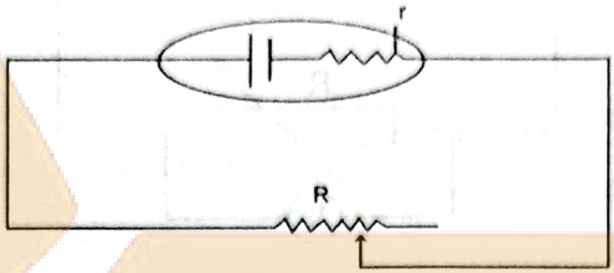
v) Draw graph from given data. **(2)**



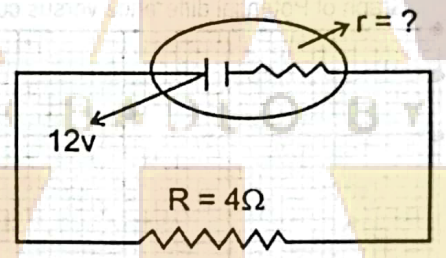
SCHOLAR WORKSHEET – 01

Q.1 i) **Give the formula to find the internal resistance of cell.** **(2)**

ii) **Draw a circuit in which a battery of emf E and internal resistance r is connected to a variable resistor R and explain it.** **[2]**



iii) **Consider the circuit given here with the following parameters E M F. of the cell = 12 V. When current in circuit 2 A. Find the Internal resistance of the cell. When external Resistance R = 4 ohm.** **[2]**

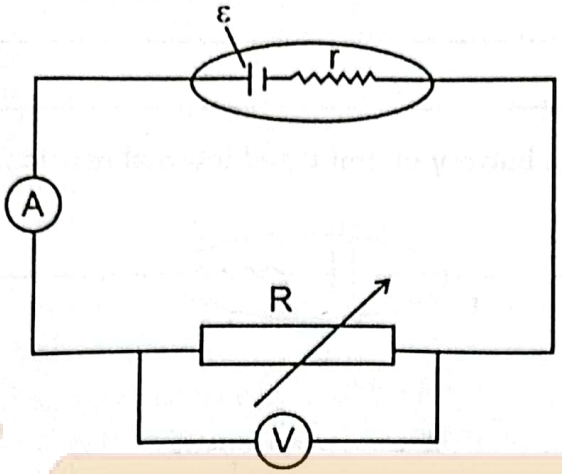


iv) **Complete the table and unit?** **[3]**

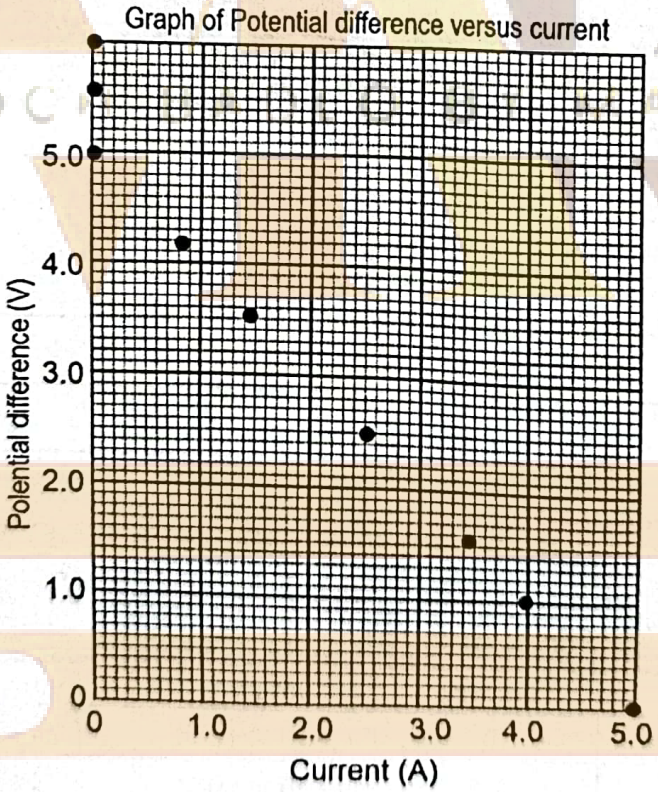
S.no	Resistance R	Voltmeter reading V	Ammeter reading I	Emf ε	$r = \frac{\varepsilon - V}{I}$
units	ohm	voltage	ampere	volt	ohm
1	3	1	300×10^{-3}	3	
2	4	1.5	290×10^{-3}	3	
3	5	1.10	280×10^{-3}	3	
4	6	1.15	260×10^{-3}	3	
5	7	2	240×10^{-3}	3	

Q.1 The emf and internal resistance of a certain battery were determined experimentally. The circuit used to experiment is shown in the diagram below:

i) State relation of internal resistance and emf of cell? [2]



ii) The data obtained from the experiment is plotted on the graph as given below? Draw the line of best fit through the plotted points. Ensure that the line cut the both axes. (2)



iii) **Using above graph write the value of emf of the battery?** **[1]**

iv) **Determine the internal resistance of the battery?** **[2]**

v) **Differentiate between emf and P.D?** **[2]**

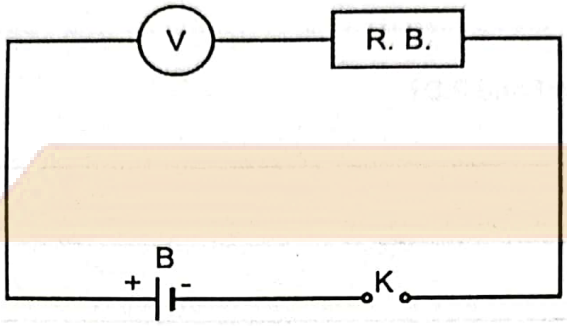
Experiment 05

Determine Resistance Of Voltmeter By Drawing Graph between R and 1/V

Apparatus

A voltmeter whose resistance is be determined, battery to provide maximum voltmeter reading resistance, a switch, and enough suitable connectors.

Diagram



Theory

If V is the potential across the voltmeter and the resistance the voltmeter is R then we can have

$$\frac{E}{R + R_v} = \frac{V}{R_v}$$

This above equation gives

$$V = \frac{ER_v}{R + R_v}$$

Taking reciprocal of both sides

$$\frac{1}{V} = \frac{R}{E\,R_v} + \frac{R_v}{E\,R_v}$$

This can be written in the form straight line equation ($y = mx + c$)

$$\frac{1}{V} = \frac{R}{ER_v} + \frac{1}{E}$$

Procedure

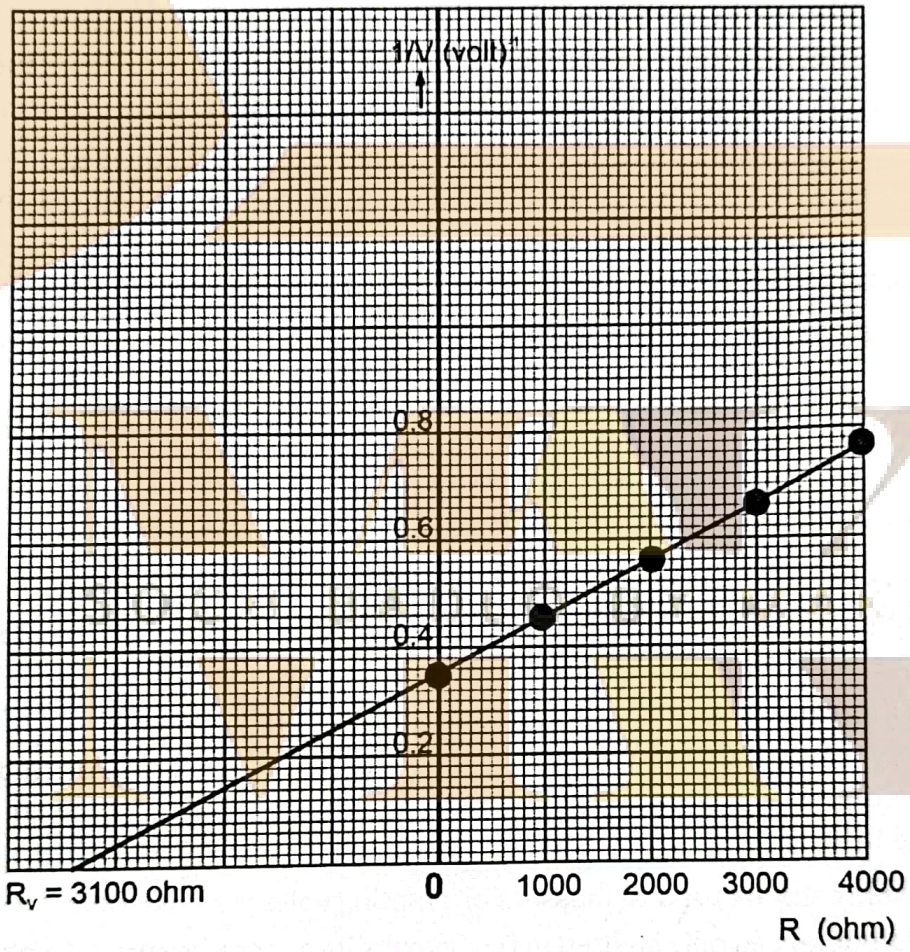
- Connect the circuit diagram as shown inFigure1.
- Close the circuit by inserting the circuit switch. Note first reading of voltmeter when resistance from resistance from resistance box is zero.
- Take out resistance of 1000 ohm and note the reading of voltmeter increase the resistance taken out from the resistance box in steps and note the reading of voltmeter each time. Taking as many reading as possible and complete in table below.

Observation

No of readings	Resistance R	Voltmeter reading	1/V
unit	ohm	volts	
1	0	3	033
2	1000	2.4	0.41
3	2000	1.85	0.52
4	3000	1.5	0.66
5	4000	1.25	0.769

Graph

Plot a graph 1/v against R and get the best fit straight line. The intercept on the x-axis will give R_v and intercept on y-axis gives 1/E.



Viva & Voice

Q.1 What is voltmeter?

Ans. It is an instrument used to measure the potential difference between two points directly in volts, when connected across those points.

Q.2 Why resistance of voltmeter should be high?

Ans. A voltmeter is connected in parallel combination to measure the potential difference. In order to read actual potential difference between two points in a circuit, it is essential that negligible current should be drawn through it. For this, the resistance of voltmeter should be high so that potential difference can be measured accurately.

Q.3 How can you change the range of voltmeter?

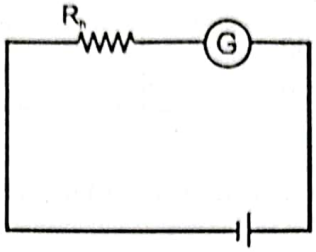
Ans. We can increase the range of voltmeter by increasing the series high resistance.

Q.4 **What is milli voltmeter? How can a voltmeter be changed to millivoltmeter?**

Ans. It is a low range voltmeter. A voltmeter can be changed to milli voltmeter by decreasing its series resistance because milli voltmeter has comparatively low resistance with voltmeter.

Q.5 **How can an ordinary galvanometer be converted into a voltmeter?**

Ans. Galvanometer can be converted into a voltmeter by connecting a suitable high resistance in series with the galvanometer.



Q.6 **Can an AC voltmeter be used in a DC circuit?**

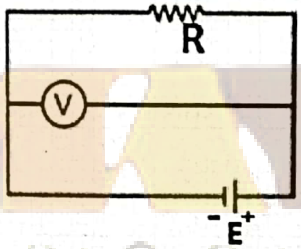
Ans. A pure AC voltmeter cannot be used in a DC circuit because it will measure the overage zero

Q.7 **Why a high resistance is connected in galvanometer to convert into volt meter?**

Ans. The resistance of galvanometer is very low. A high resistance is connected in series to maximize the resistance so that it cannot draw any current, so the circuit current will not change.

Q.8 **How the voltmeter is connected in the circuit?**

Ans. The voltmeter is always connected in parallel of the circuit.



Q.9 **Define the unit of potential difference?**

Ans. S.I unit of potential difference is volt. If energy of one joule is given to move a charge of one coulomb between two points, then P-D between two points is 1 V.

Q.10 **What is difference between galvanometer, ammeter and voltmeter?**

Ans. Galvanometer only detect the presence of current in circuit, so it is connected in series. Ammeter measure current it is also connected in series in the circuit. Voltmeter measure potential difference between two terminals it is always connected in parallel.

Q.11 **Can D.C. voltmeter be used to measure alternating voltage?**

Ans. No D.C. voltmeter can only be used in D.C. circuits.it cannot measure A.C voltage.

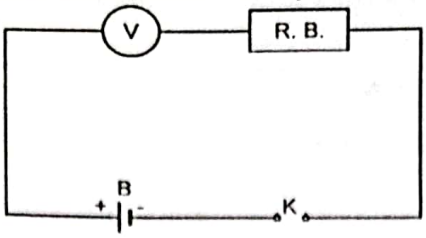
Q.12 **What should be the characteristics of a good voltmeter?**

Ans. Best voltmeter draws very small current through it that produce deflection only.

Q.13 **What is meant by ideal voltmeter?**

Ans. Ideal voltmeter draws zero current through it (i.e., its resistance is infinite) and measure accurate voltage.

Q.1 **Draw circuit diagram and label the name of component of circuit?** **(2)**



i) **Why is voltmeter so commonly used to measure potential difference?** **(1)**

Ans.
- Voltmeters are easy to connect in parallel to the component or section of the circuit where the potential difference is to be measured.
- They can measure voltages across a broad range of devices and circuits, from small electronic components to high-voltage systems.

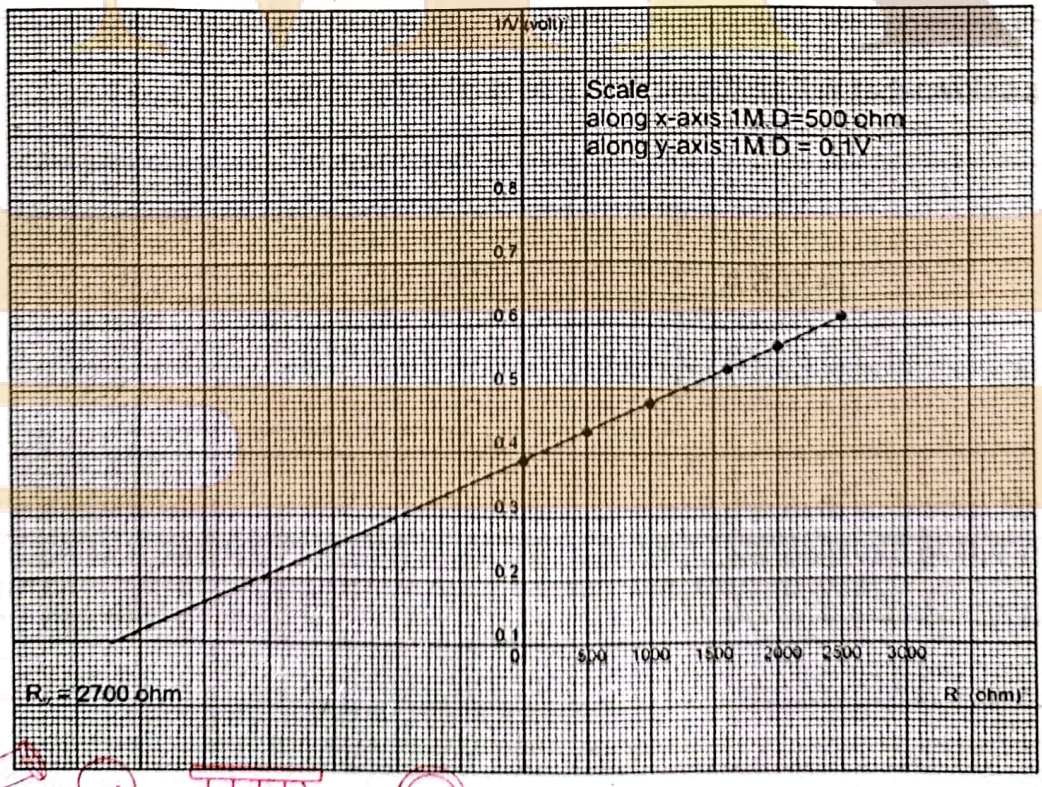
ii) **Why voltmeter should have a high resistance?** **(2)**

Ans. A voltmeter is connected in parallel combination to measure the potential difference. In order to read actual potential difference between two points in a circuit, it is essential that negligible current should be drawn through it. For this, the resistance of voltmeter should be high so that potential difference can be measured accurately.

iii) **Complete the table and unit?** **[2]**

No of readings	Resistance R	Voltmeter reading V	1/V
unit	Ω	volt	$(volt)^{-1}$
1	0	3	0.33
2	500	2.6	0.385
3	1000	2.3	0.435
4	1500	2	0.5
5	2000	1.8	0.56
6	2500	1.6	0.625

iv) **Draw graph from given data.** **(2)**



SCHOLAR WORKSHEET – 01

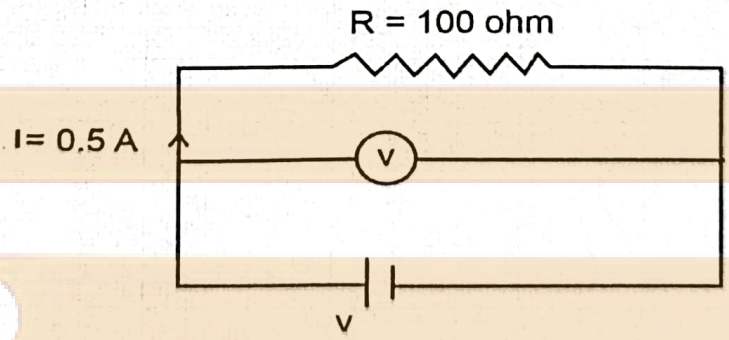
Q.1 Draw circuit diagram and label the name of component of circuit? **(2)**

i) Give the formula to find high resistance to convert galvanometer in to voltmeter. **(1)**

ii) Full scale deflection current of galvanometer is 5 mA and its resistance is 100 ohms. Find the value of high resistance to convert it in to voltmeter of range of 20 V. **(2)**

iii) What are the characteristics of good voltmeter? **(1)**

iv) In fig below what will be thew reading of ideal voltmeter. **(1)**



v) Write the unit and complete the last column in the following measurement. (2)

No of readings	Resistance R	Voltmeter reading V	1/V
unit	....	.....	....
1	0	3	
2	500	2.7	
3	1000	2.4	
4	1500	2.1	
5	2000	1.85	
6	2500	1.65	

SCHOLAR WORKSHEET – 02

Q.1 Complete the table given below. (2)

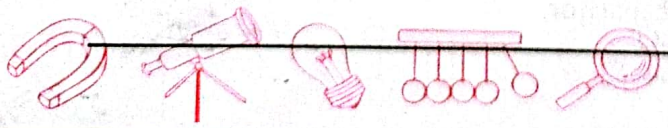
No of readings	Resistance R	Voltmeter reading	1/V
unit	unit....	Unit	Unit ....
1	0	3	
2	1000	2.3	
3	2000	1.8	
4	3000	1.5	
5	4000	1.3	

i) Plot graph between 1/V and R from above data. (2)

ii) What is milli voltmeter? How can a voltmeter be changed to millivoltmeter? (2)

iii) Can D.C. voltmeter be used to measure alternating voltage? (1)

iv) If resistance of galvanometer is 100 Ω. To convert galvanometer in to voltmeter high resistance R_h of 100000 Ω is connected with galvanometer. In which combination R_h is connected with galvanometer. Find total resistance of galvanometer and draw diagram. (2)



SCHOLAR WORKSHEET – 01

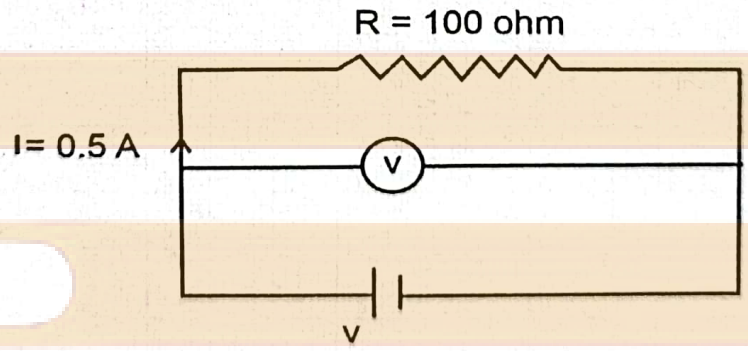
Q.1 Draw circuit diagram and label the name of component of circuit? **(2)**

i) Give the formula to find high resistance to convert galvanometer in to voltmeter. **(1)**

ii) Full scale deflection current of galvanometer is 5 mA and its resistance is 100 ohms. Find the value of high resistance to convert it in to voltmeter of range of 20 V. **(2)**

iii) What are the characteristics of good voltmeter? **(1)**

iv) In fig below what will be thew reading of ideal voltmeter. **(1)**



v) Write the unit and complete the last column in the following measurement. (2)

No of readings	Resistance R	Voltmeter reading V	1/V
unit	....	.....	....
1	0	3	
2	500	2.7	
3	1000	2.4	
4	1500	2.1	
5	2000	1.85	
6	2500	1.65	

SCHOLAR WORKSHEET – 02

Q.1 Complete the table given below. (2)

No of readings	Resistance R	Voltmeter reading	1/V
unit	unit....	Unit	Unit ....
1	0	3	
2	1000	2.3	
3	2000	1.8	
4	3000	1.5	
5	4000	1.3	

i) Plot graph between 1/V and R from above data. (2)

ii) What is milli voltmeter? How can a voltmeter be changed to millivoltmeter? (2)

iii) Can D.C. voltmeter be used to measure alternating voltage? (1)

iv) If resistance of galvanometer is 100 Ω. To convert galvanometer in to voltmeter high resistance R_h of 100000 Ω is connected with galvanometer. In which combination R_h is connected with galvanometer. Find total resistance of galvanometer and draw diagram. (2)

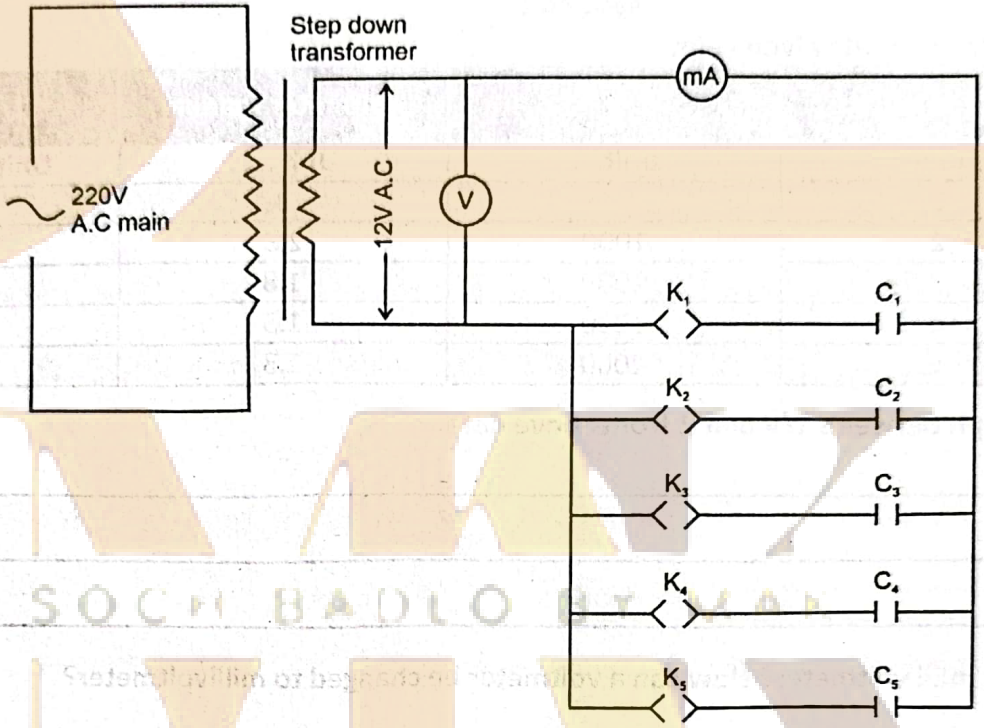
Experiment 06

Determine the relation between current and capacitance when different capacitors areused in AC circuit using different series and parallel combinations of capacitors.

Apparatus

AC milli ammeter, AC voltmeter, capacitors of different capacitances, step-down transformer, sand paper, connecting wires.

Circuit Diagram



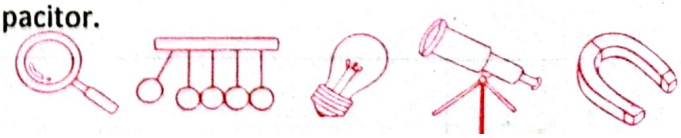
Theory

A capacitor charges up when the AC reaches its peak in an AC circuit and releases the charge when the AC decreases. This behaviour allows the capacitor to act like temporary storage that causes the current to lead voltage by 90 degrees.

Electrical engineers use capacitors to improve the power factor in an AC circuit.

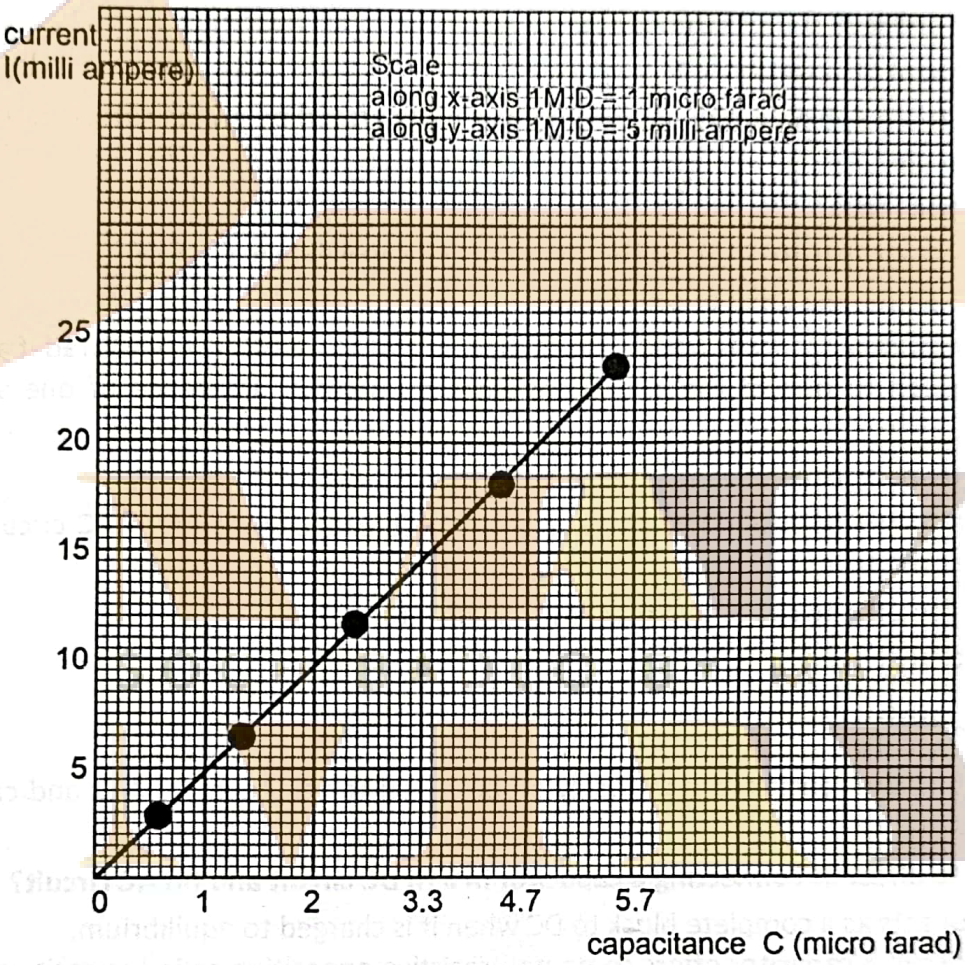
Procedure

1. Draw the circuit diagram and make the connections according to the circuit diagram.
2. Connect the primary coil of the transformer with A.C. mains and note the voltmeter reading
3. Now insert the plug into the key 1 to put capacitor C1 in the circuit. Note the reading of milli-ammeter and capacitance of the capacitor used.
4. Similarly insert key 2 for capacitor C2 and repeat this for other capacitors for reading Note the corresponding reading of milli-ammeter.
5. Calculate the ratio of current to capacitance, i.e .I/C, in each case. The ratio remains constant.
6. Plot a graph between capacitance C and current I taking C along X-axis and I along Y-axis. It will be a straight line passing through the origin as shown in figure verifying the fact that current is directly proportional to the capacitance of a capacitor.



Observations And Calculations

S No	Capacitance (C)		CURRENT (I)		$\frac{I}{C} = constant$
	μF	farad	mA	ampere	A/F
1	1	1×10^{-6}	4	4×10^{-3}	4000
2	2	2×10^{-6}	8	8×10^{-3}	4000
3	3.3	3.3×10^{-6}	13	13×10^{-3}	3939
4	4.7	4.7×10^{-6}	19	19×10^{-3}	4042
5	5.7	5.7×10^{-6}	23	23×10^{-3}	4035



Viva & Voice

Q.1 What is a variable capacitor?

Ans. A variable capacitor is a capacitor whose capacitance can be varied to a certain range of values based on necessity. The two plates of the variable capacitor are made of metals where one of the plates is fixed, and the other is movable. Their main function is to fix the resonant frequency in the LC circuit. There are two types of variable frequency and they are; *tunning capacitors* and *trimming capacitors*.

Q.2 How does the shape of the capacitor affect its capacitance?

Ans. Capacitance when air or vacuum between the plates: $C_{vac} = \frac{A\varepsilon_o}{d}$

Capacitance with dielectric as the medium between two plates of capacitor.

$$C_{med} = \varepsilon_r \left(\frac{A\varepsilon_o}{d}\right)$$

Capacitance of parallel plate capacitor depends upon

- Area of plates $[C \propto A]$
- Distance between two plates $[C \propto \frac{1}{d}]$
- Medium between two plates $[C_{med} = \varepsilon_r C_{vac}]$

Q.3 How long does a capacitor last?

Ans. Capacitors have a limited life span. Most capacitors are designed to last approximately 5 to 20 yea

Q.4 What kind of energy is stored in a capacitor?

Ans. Energy stored in a capacitor is electrical potential energy in the electric field between two pla of charged capacitor.

Q.5 Why isn't water used as a dielectric in a capacitor?

Ans. Water has a high dielectric constant but a very low dielectric strength, hence it would act as a conductor and leak charges through it.

Q.6 What is meant by a capacitor?

Ans. Capacitor is a combination of conducting plates separated by an insulator and is used to sto electric charge.

Q.7 Define capacitance?

Ans. The ability of a capacitor to store the charge called capacitance. C = Q/V

Q.8 Name and define the units of capacitance?

Ans. The SI unit of capacitance is *farad*. The capacitance of a capacitor is one farad if a charge of on *coulomb* given to one of the plates produces a potential difference of one volt across th capacitor.

Q.9 What is meant by capacitive reactance?

Ans. The non-resistive opposition to the current due to capacitance in an AC circuit is called the capacitive reactance.

Q.10 On which factors the capacitive reactance depends?

Ans. The Capacitance reactance is

$$X_c = \frac{1}{2\pi fC}$$

It shows that the reactance is inversely proportional to frequency of A.C. and capacitance of a capacitor.

Q.11 What is the effect of connecting a capacitor in a (i) DC circuit and (ii) AC circuit?

Ans. A capacitor acts as a complete block to DC when it is charged to equilibrium.
In an AC circuit a capacitor offers some non-resistive opposition called capacitive reactance and allows some current to flow through the circuit.

Q.12 What you infer that the graph between capacitance and current is a straight line?

Ans. When the graph between "C" and "I" is straight line then it means that for a constant applied voltage, the current is proportional to capacitance.

Q.13 The Capacitor has insulator between its plates then does it conduct?

Ans. A Capacitor conducts alternating current by charging and discharging during each cycle.

Q.14 What is the effect of dielectric in a Capacitor?

Ans. The Dielectric increases the Capacitance of a Capacitor.

Q.15 What is Dielectric?

Ans. The insulator between the plates of a capacitor called Dielectric. It may be rubber, paper, and oil

Q.16. How capacitance of a capacitor can be increased?

Ans. Capacitance of a capacitor can be increased by:

$$C_{med} = \frac{A \varepsilon_0 \varepsilon_r}{\quad}$$

(i) By increasing the area of plates.
(ii) By decreasing separation between the plates.
(iii) By placing dielectric between the plates.

Q.17 **What is dipole?**

Ans. Two equal and opposite charges separated by a small distance are called dipole.

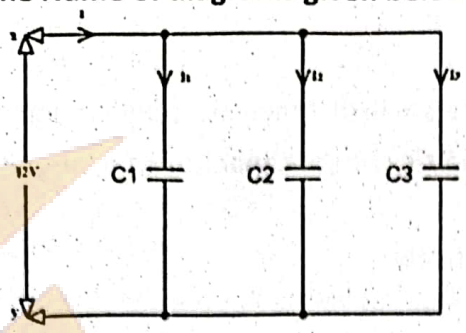
Q.18 **What is the effect of polarization of dielectric when capacitor is charged and battery is disconnected?**

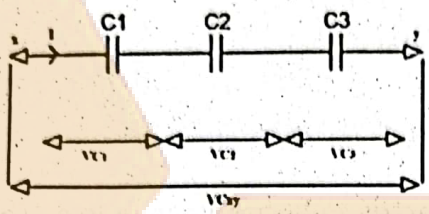
Ans.
(i) Decrease surface charge density effectively.
(ii) Decrease $\vec{E}$ electric field.
(iii) Decrease $\vec{V}$ potential difference.
(iv) Increase C, capacitance of capacitor.
(v) Q = Constant (no effect on total charge).

Q.19 **What is polarization?**

Ans. Molecules of dielectric under the action of electric field becomes dipole. This effect is called polarization.

i) **What is the Name of diagrams given below?** **[1]**





Ans. **Capacitor Circuits:** Capacitor in Series, Parallel & AC Circuits

ii) **How can we connect a Capacitor in Electronic Circuit?** **[2]**

Ans. Capacitor in Series
Capacitor in Parallel
Capacitor in AC Circuit

iii) **Discuss the Function of a Capacitor in an AC Circuit.** **(2)**

Ans. Capacitors are passive electronic components that provide energy storage in the form of an electrostatic field. A capacitor charges up when the AC reaches its peak in an AC circuit and releases the charge when the AC decreases. This behaviour allows the capacitor to act like temporary storage that causes the current to lead voltage by 90 degrees.

iv) **On which factors capacitance of parallel plates capacitor depends and give its formula.** **(2)**

Ans. $C_{med} = \frac{A\varepsilon_o \varepsilon_r}{d}$

Capacitance of parallel plate capacitor depends upon

- Area of plates $[C \propto A]$
- Distance between two plates $[C \propto \frac{1}{d}]$
- Medium between two plates $[C_{med} = \varepsilon_r C_{vac}]$

v) **Calculate the equivalent capacitance for three capacitors connected in series, given their individual Capacitances are 2 μF, 4 μF, and 8 μF.** **(2)**

Ans.

$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$

$$= \frac{1}{2} + \frac{1}{4} + \frac{1}{8}$$

$$\frac{1}{C_{eq}} = \frac{4+2+1}{8} = \frac{7}{8}$$

$$\frac{1}{C_{eq}} = \frac{8}{7} = 1.143\ \mu F$$

SCHOLAR WORKSHEET – 01

Q.1 A student performed and experiment by using different capacitors with A.C circuit to find the relation between capacitance and current?

Capacity (F)	0.01	0.02	0.03	0.04	0.05	0.06
Current (A)	4	8	12	16	20	24
I/C (A/F)						

i) Complete the table? [2]

ii) Plot a graph between capacity and current A-C circuit using different capacitors. Taking the capacity C along X-axis and current along y-axis? [2]

Capacity (F)	0.01	0.02	0.03	0.04	0.05	0.06
Current (A)	4	8	12	16	20	24

iii) What does the shape of graph represent? [1]

iv) Find the slope of graph? [2]

v) If capacitance of capacitor is 1 micro farad and capacitive reactance is 3185 Ω. Find the frequency of A.C. [2]

SCHOLAR WORKSHEET – 02

Q.1 A student performed and experiment by using different capacitors with A.C circuit to find the relation between capacity and current?

Capacity (farad)	0.001	0.002	0.003	0.004	0.005	0.006
Current (ampere)	0.5	1	1.5	2	2.5	3
I/C (A/F)						

i) Complete the table. [1]

ii) Plot a graph between capacitance and current in A-C circuit using different capacitors from above table. [2]

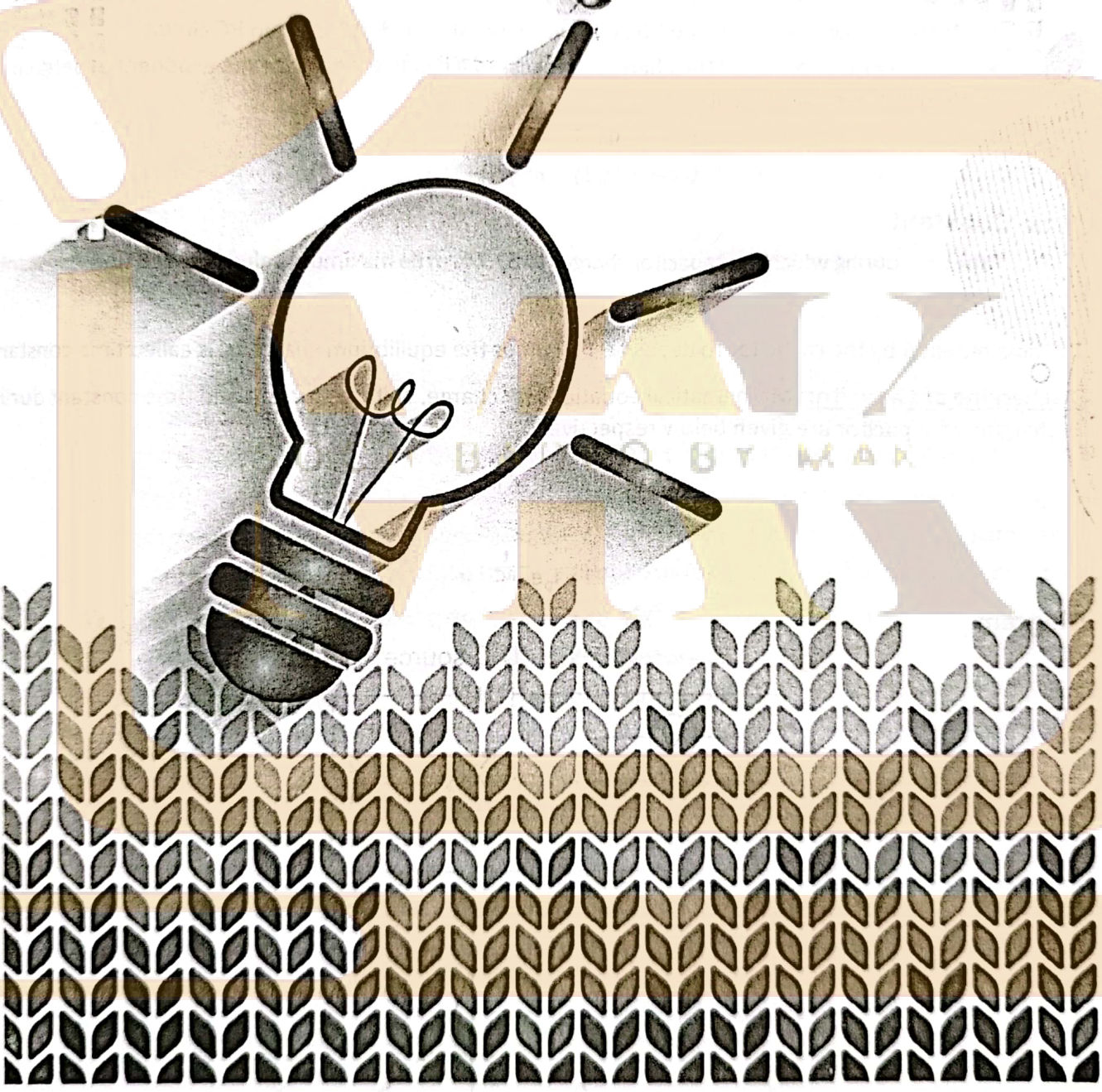
iii) What you infer from the graph? [1]

iv) When capacitors are connected in series which quantity remains same and which quantities change? [1]

v) Why capacitors are connected in ceiling fan? [2]

vi) Give the unit and dimensions of capacitance. [2]

SECTION - II



Experiment 01

Determine time constant by charging and discharging a capacitor through a resistor.

Material Required (Apparatus)

- Capacitor (100 μF)
- power supply (12 V DC)
- connecting wires
- resistor (100 K)
- stop watch
- voltmeter
- two-way key

Theoretical Base

- A capacitor stores charge and electrical potential energy.
- When capacitor is in series with an external resistance R, it forms an RC circuit.
- Experiments shows that the charging process of a capacitor exhibits the exponential behaviour therefore we can write its Eq: as

$$q = q_o (1 - e^{-t/RC})$$

$$V = V_o (1 - e^{-t/RC})$$

Time Constant

"The time during which the capacitor charges to 63.2 % of its maximum value, is called time constant"

OR

The time required by the capacitor to deposit 0.632 times the equilibrium charge q_o is called time constant

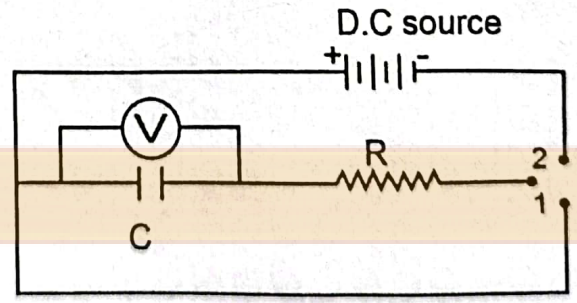
Discharging of Capacitor: Mathematical equations for charge, voltage, current and time constant during discharging of capacitor are given below respectively:

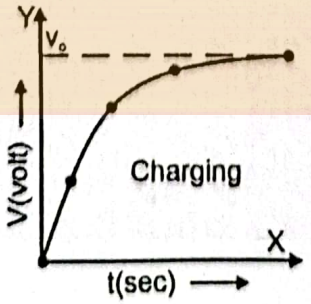
$$q = q_o e^{-\frac{t}{RC}}$$

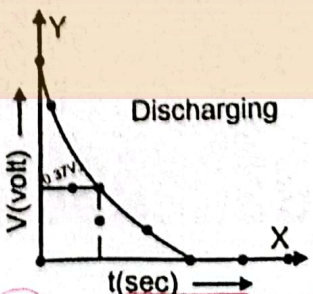
$$V = V_o e^{-\frac{t}{RC}}$$

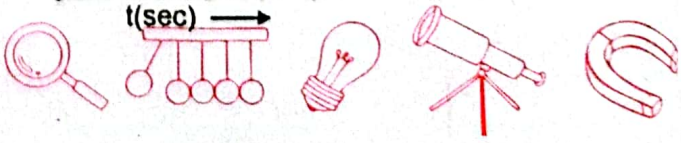
$$I = I_o e^{-\frac{t}{RC}}$$

Diagram

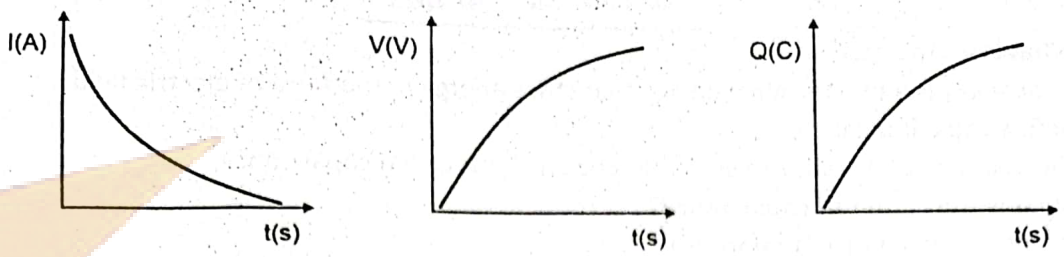




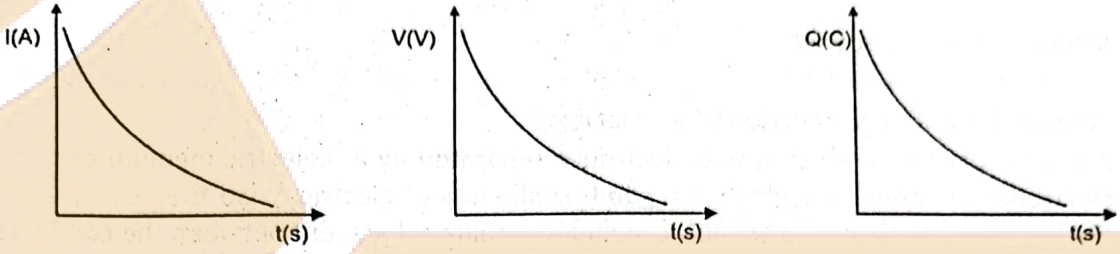




Charging Graphs



Discharging Graphs

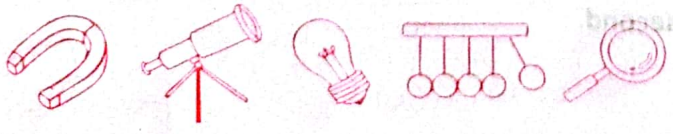


Procedure

1) Arrange the apparatus as shown in the figure. Keep the power supply off till you start taking the readings.
2) Close key K of position 1 so that the capacitor is completely discharged and the ammeter shows zero reading.
3) Turn ON the voltage supply.
4) Connect key K to position 2 and simultaneously start stop watch. Note first reading at zero time corresponding to max, charging current. Take further readings after every 10 seconds. Allow the capacitor to be charged further till the deflection of the voltmeter stop at a maximum position.
5) Reset the stop watch to zero reading. Shift key K to position 1 and simultaneously start the stopwatch. Again, take observations of voltage during discharging of a capacitor after equal interval of time. Keep on taking these readings of voltage till the voltage falls to very small value.
6) Plot two graphs for charging and discharging of the capacitor as shown in figure.
7) Find time constants, against the voltage during charging V = 0.632
   And during discharging V = 0.37Vo and fill up all the lines.

Observations

Obs.	Charging		Discharging	
	Time (t)	Voltage (V)	Time (t)	Voltage (V)
1	0	0	0	11.9
2	10	7.6	10	4.4
3	20	10.4	20	1.7
4	30	11.4	30	0.6
5	40	11.8	40	0.22
6	50	11.9	50	0.1



Viva & Voice

Q.1. What is a capacitor?

Ans. A capacitor is a two terminal device that store energy in the form of electric field.

Q.2. Define capacitance.

Ans. The ability of a capacitor to store electric charge is called capacitance.

Q.3. What is the SI unit of capacitance?

Ans. SI unit of capacitance is farads (F)

$$1 \text{ farad} = \frac{1 \text{ coulomb}}{1 \text{ volt}}$$

Q.4. Who invented capacitor?

Ans. Ewald Georg von Kleist

Q.5. What is the basic construction of a capacitor?

Ans. A basic capacitor is made of two electrodes separated by a dielectric medium or material. The electrodes or conductive plates are good conductors of electricity. So they easily allow electric current through them. The dielectric medium or material present between the conductive plates is poor conductor of electricity. So it does not allow electric current through it.

The electric charges that try to move from one plate to another plate will be trapped within the electrode or plate because of the strong opposition from the dielectric.

As a result, electric charge is builds up on the electrodes.

Q.6. When capacitor starts charging?

Ans. When voltage is applied to the capacitor, it starts charging.

Q.8. When capacitor starts discharging?

Ans. When capacitor is connected to any device such as electric bulb, it starts discharging.

Q.9. Why does the experimental and calculated values of the time constant differ a little?

Ans. It is due to the fact that the resistance of the connecting wire, the internal resistance of the battery, the resistance of dirty and loose connections and the applied resistor are all included in the resistance *R*. Therefore the experimental value of the time constant is always a little greater than its calculated value.

Q.12. Why is the discharging current maximum initially?

Ans. Because full capacitor voltage is applied across the resistor R.

Q.13. What type of decrease is that of discharge current?

Ans. It is the exponential decrease.

Q.14. What is the unit of time constant?

Ans. The unit of time constant is second or ohm-farad.

Q.15. If charging time of a capacitor is large, what is its discharging time?

Ans. Its discharging time will also be large and vice versa.

Q.16. Is the charging rate of the capacitor constant?

Ans. No, because the charging process of capacitor is exponential.

Q.17. How will you define time constant of RC series circuit?

Ans. The time taken by the capacitor to charge up to 63.2% of its final value. Or the time taken by capacitor to discharge to 36.8% of its initial value.

Q.18. Name some smaller units of capacitance.

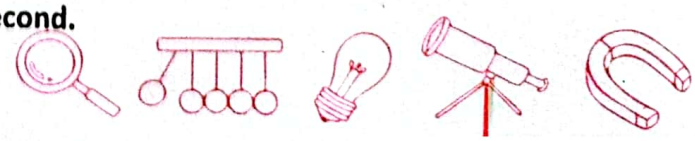
Ans. (i) millifarad (ii) microfarad (iii) picofarad

Q.19. How much time does the capacitor take to charge 100%?

Ans. It will take an infinite time.

Q.20. Show that unit of time constant (T = RC) is second.

Ans. We know that,



$$C = \frac{Q}{V}$$

$$\text{Unit farad} = \frac{C}{V}$$

$$R = \frac{V}{I}$$

$$\Omega = \frac{V}{A}$$

$$\Omega F = \frac{V}{A}\left(\frac{C}{V}\right) = \frac{C}{A} = \frac{A\,s}{A} = s$$

Q.21. What is relative permittivity or dielectric constant?

Ans. $\varepsilon_r = \frac{C_{med.}}{C_{vac.}}$

Relative permittivity is the ratio of capacitance of parallel plate capacitor with medium between plates to the capacitance with vacuum between two plates of capacitor.

Q.22. What is unit of relative permittivity?

Ans. Relative permittivity have no unit because it the ratio of similar quantities.

Q.23. What is the formula for energy stored in a capacitance?

Ans.

$U = \frac{1}{2}QV$

$U = \frac{1}{2}CV^2$

$U = \frac{1}{2}\frac{Q^2}{C}$

$U = \frac{1}{2}\varepsilon_o\varepsilon_r E^2 Ad$

Q = Charge
V = Potential difference
C = Capacitance
E = Electric field
A = Area of plates
d = distance between two plates

Q.24. Upon what factors the speed of charging and discharging of a capacitor depends?

Ans. The speed of charging and discharging of a capacitor depends upon RC of the circuit.

Q.25. Upon which factors capacitance of parallel plate capacitor depends?

Ans. As $C = \frac{A\varepsilon_o\varepsilon_r}{d}$ it depends upon

(i) Area of each plate of capacitor
(ii) Distance between the plates of capacitor
(iii) Medium between the plates of capacitor

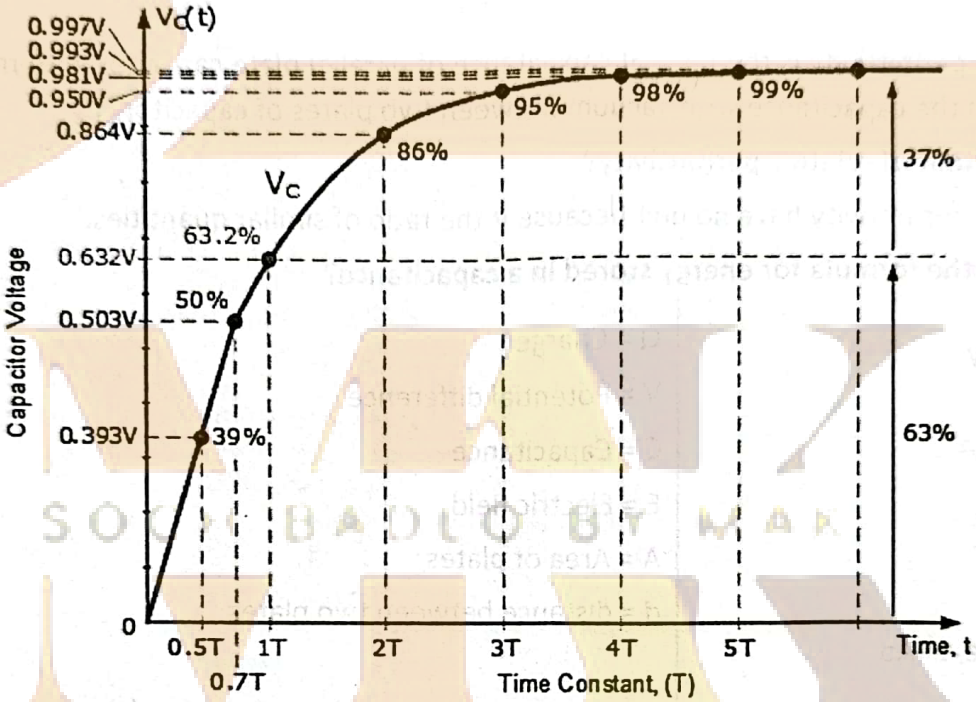
Q.26 Write the use of charging, discharging of a capacitor?

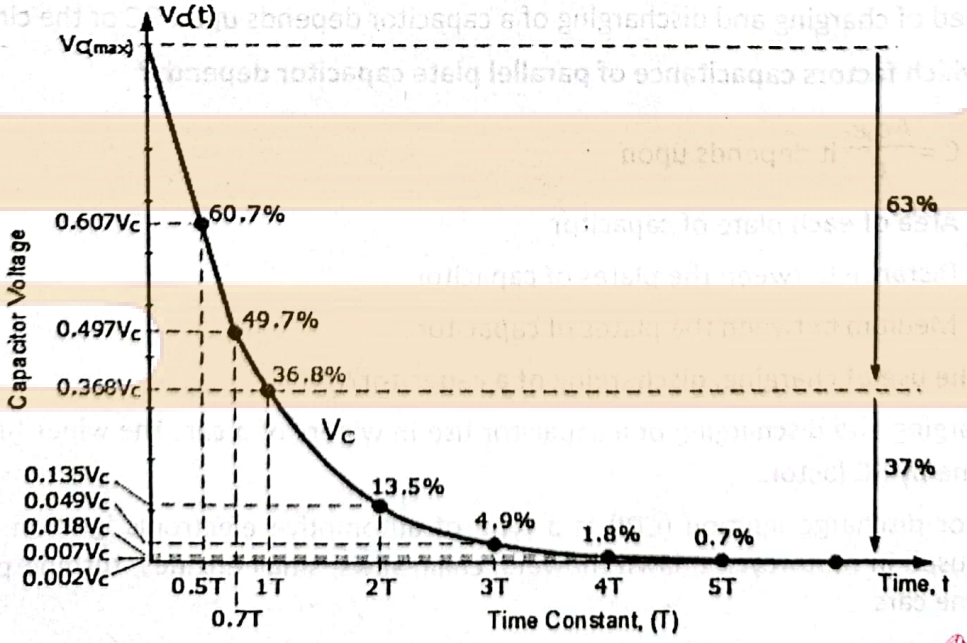
Ans. The charging and discharging of a capacitor use in wipers of a car. The wiper timing for ON and OFF done by RC factor.

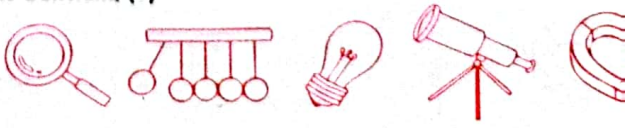
Capacitor discharge ignition (CDI) is a type of automotive electronic ignition system which is widely used in motorcycles, lawn mowers, chain saws, small engines, turbine powered aircraft, and some cars.

RC Charging Table

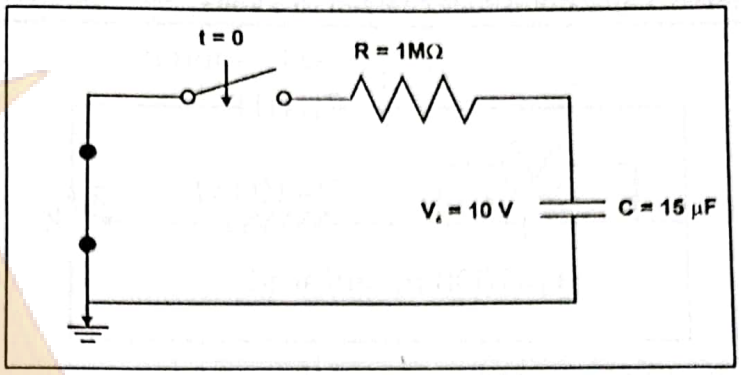
Time Constant	RC Value	Percentage of Maximum	
		Voltage and charge	Current
0.5 time constant	0.5T = 0.5RC	39.3%	60.7%
0.7 time constant	0.7T = 0.7RC	50.3%	49.7%
1.0 time constant	1T = 1RC	63.2%	36.8%
2.0 time constant	2T = 2RC	86.5%	13.5%
3.0 time constant	3T = 3RC	95.0%	5.0%
4.0 time constant	4T = 4RC	98.2%	1.8%
5.0 time constant	5T = 5RC	99.3%	0.7%







Q.2 **A student used the following RC discharging circuit to calculate the RC time constant when the switch is first closed. Capacitor is fully charged to 10 volts.**



Calculations

(i) **What value will be the voltage across the capacitor at 0.5 time the time constant during discharging of capacitor?** **[2]**

Ans. $V = V_o (e^{-t/RC})$ ... (1)

$\Rightarrow$ As $t = 0.5\ RC$ and $V_o = 10\ V$ (Given)

$\Rightarrow$ Eq.1 becomes $V \Rightarrow V_o (e^{-0.5\ RC/RC}) = 10 (e^{-0.5}) = 10 (0.6065)$

$\Rightarrow$ $V = 6.06\ V$

(ii) **What value will be the voltage across the capacitor at 1 time constant?** **[1]**

Ans. $V = V_o (e^{-t/RC})$ ... (1)

$\Rightarrow$ As $t = 1\ RC$ and $V_o = 10\ V$ (given)

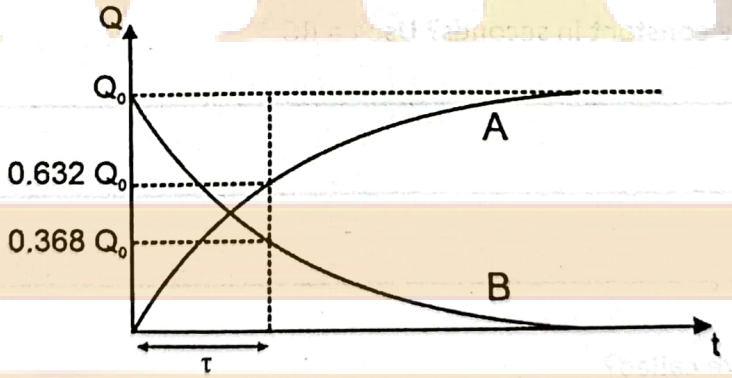
$\Rightarrow$ Eq.1 becomes $V \Rightarrow V_o (e^{-RC/RC}) = 10 (e^{-1})$

$\Rightarrow$ $V = 10 (0.368) = 3.68\ V$

(iii) **How long will it take for the capacitor to fully discharge? Use $t = 5\ RC$.** **[1]**

Ans. $t = 5 (1 \times 10^6 \times 15 \times 10^{-6} = 75\ s$

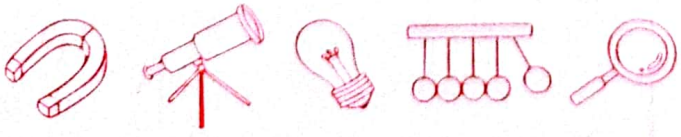
(iv) **Analyze the following graphs and identify which of the following curves represents charging and discharging of the capacitor.** **[1]**



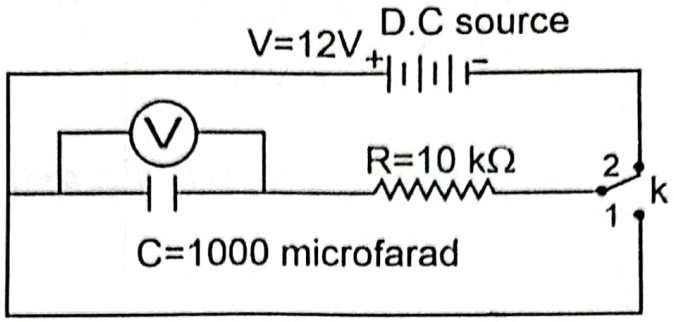
Ans. Curve – A shows charging and Curve – B shows discharging.

(v) **Referring to the figure above what can be said about the charging current as the time increases, will it increase or decrease?** **[1]**

Ans. It will decrease. As, the graph has a gradient or slope which tends to move away from y-axis.



Q.2 **A student used the following RC discharging circuit to calculate the RC time constant when the switch is first closed. Capacitor is fully charged to 3 volts.**



C = 1000 μF, R = 10 kΩ and $V_o' = 12$ V

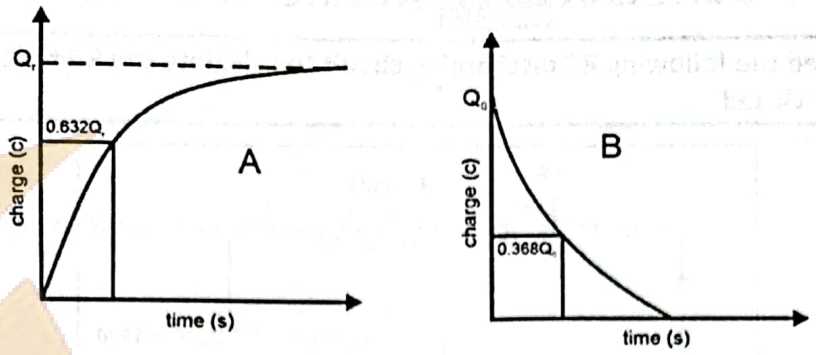
(i) **What value will be the charge on the capacitor after 1 time constant during charging?** **[2]**

(ii) **What value will be the voltage across the capacitor after 2 time constants during discharging?** **[1]**

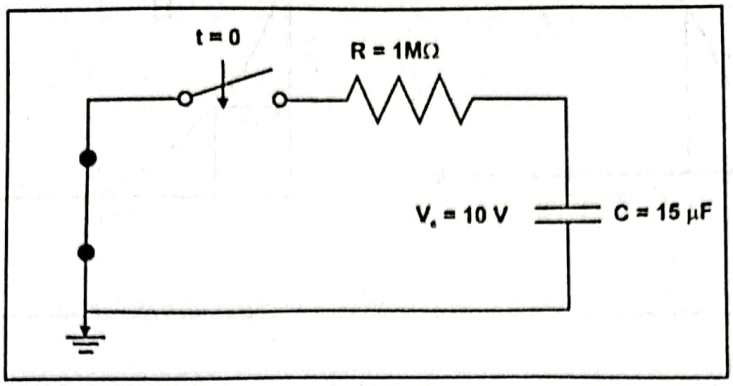
(iii) **What is the time constant in seconds? Use t = RC** **[1]**

(iv) **What is this curve called?** **[1]**

(v) **Is the slope increasing or decreasing for the curve A?** **[1]**



Q.2 **A student used the following RC discharging circuit to calculate the RC time constant when the switch is first closed.**

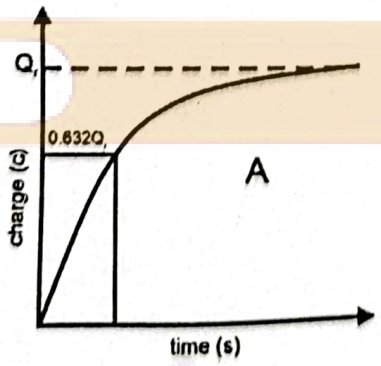


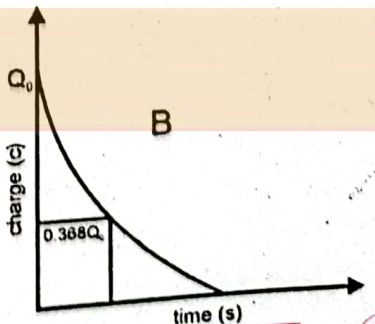
(i) **What is the value of maximum voltage on the capacitor?** [1]

(ii) **What value will be the P.D across capacitor after 3-time constants during discharging?** [2]

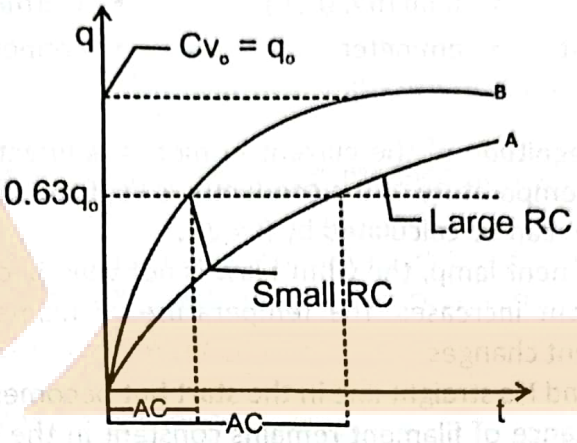
(iii) **What is the time constant in seconds? Use t = RC** [1]

(iv) **Which process curve B depicts?** [1]





(v) **Which graph shows faster charging?** [1]



Experiment 02

Investigate the relationship between current passing through a tungsten filament lamp and the potential applied across it.

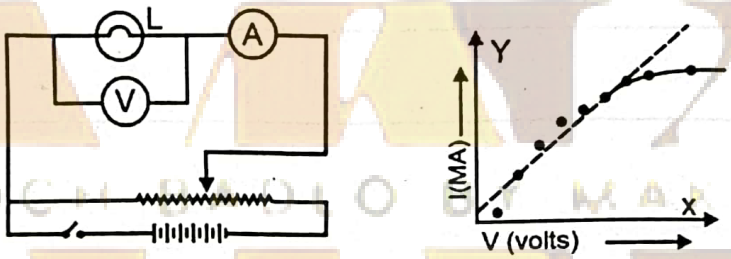
Material Required (Apparatus)

- 12 volt battery
- high resistance rheostat
- bulb (6V, 0.5A)
- ammeter
- voltmeter
- connecting wires

Theoretical Base

- By Ohm's law, 'the magnitude of the current in metals is directly proportional to the applied voltage as long as the temperature of the conductor is kept the same'.
- Resistance of conductor can be calculated by R = V/I.
- In case of tungsten filament lamp, the Ohm's law is not valid because as the amount of current passing through filament increases, the temperature of filament is also increases. And the resistance of the filament changes.
- The graph between V and I is straight line in the start but becomes a curve in the end.
- It shows that the resistance of filament remains constant in the beginning but increases at the end. So that Ohm's law is not valid in this case.

Diagram and Graph



Procedure

1) Make the connections according to the circuit diagram. The Rheostat and ammeter are connected in series, but the voltmeter is connected in parallel with the bulb
2) Adjust the sliding contact to apply a small voltage, so that the ammeter and voltmeter give small initial readings. Note these readings.
3) Take the readings of ammeter and voltmeter in regular steps by changing the resistance of rheostat.
4) Complete the table. Plot a graph between V and I, which is not a straight line.

Observations & Calculations

Obs.	Ammeter reading I	Voltmeter V	Voltage to current ratio V/I
1	0	0	0
2	0.18	2	11.11
3	0.28	4	14.28
4	0.35	6	17.14
5	0..4	8	20
6	0.43	10	23.3

Viva & Voice

Q.1 Define Ohm's law.

Ans. The current that flows through metallic conductors is directly proportional to the voltage applied provided all physical conditions and temperatures remain constant.

Q.2 What is the formula of Ohm's law?

Ans. Ohm's law is given by the formula: V = IR
Where, I = current, V = voltage, and R = Resistance.

Q.3 What is specific resistance?

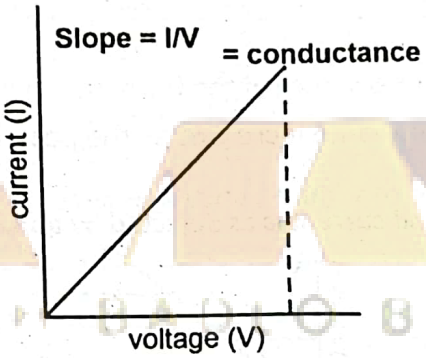
Ans. The resistance offered per unit length and unit cross-sectional area is known as the specific resistance.

Q.4 What are the factors on which the heat energy produced in a conductor depends when a current is passed through it?

Ans. The heat energy produced in a conductor is equal to *VIt* i.e., it depends on the potential difference *V*, the current *I* passing through it and time *t* for which the current is passed.

Q.5 Which quantity gives the slope of I-V graph?

Ans. slope of I-V graph $= \frac{1}{V}$ = G=conductance



Q.6 What is the unit of resistance?

Ans. The unit of the electrical resistance is Ohms.

Q.7 Does the resistance of conductor depend on the temperature?

Ans. Yes, the resistance of conductor depends on the temperature. With rise in temperature, amplitude of vibration of atoms increases, the number of collisions of electron with the atoms increases, resistance increases therefore the current decreases.

Q.8 What is electrical conductivity?

Ans. It is the measure of the ability of the material to allow the electric current to pass through it.

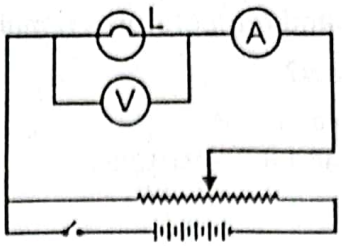
Q.9 Does the resistance depend on the dimensions of the conductor?

Ans. Yes, the resistance depends on the dimensions of the conductor. Resistance of conductor is directly proportional to length of conductor and inversely proportional to area of cross-section.

Q.10 What will happen to internal resistance of battery if we increase the temperature?

Ans. The internal resistance of the battery will decrease with increase in temperature.

Q.2 Following is the diagram for tungsten filament experiment. Voltage is applied across the filament and the readings of current as measured by ammeter are enlisted in the table below.



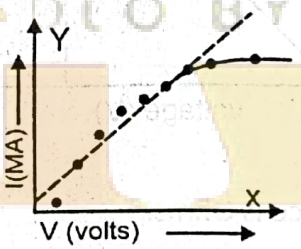
Calculations

S. No.	Voltmeter Reading 'V' (volts)	Ammeter Reading 'I' (A)	Resistance of Lamp $R = \frac{V}{I}$ (Ω)
1	0.5	0.4	1.25
2	1	0.5	2
3	1.5	0.6	2.5
4	2	0.7	2.85
5	2.5	0.8	3.12
6	3	0.9	3.33

(i) **What can be said about the resistance of the filament?** [1]

Ans. The resistance of a filament lamp increases as the potential difference increases because the filament becomes hot.

(ii) **If graph between voltage and current is as depicted by above readings is given below.**



Does this graph obey Ohm's law? Give reasons. [1]

Ans. No, its doesn't because tungsten is a non-ohmic device therefore the slope is not constant and voltage-current no longer maintain proportionality.

(iii) **In the circuit diagram in which combination the ammeter is connected, series or parallel and why?** [1]

Ans. Ammeter is always connected in series so that current reading is same as that of the device.

(iv) **In this experiment enlist any two possible errors.** [2]

Ans. (1) If connections are not properly made and are loose then readings may be wrong.
(2) Connections of voltmeter and ammeter should be connected in proper combination of parallel and series respectively.
(3) Least count of voltmeter and ammeter should be of smaller least count to get correct readings.

Q.2 A student investigates the relationship between current passing through a tungsten filament lamp and the potential applied across it.

(i) Write down the apparatus needed for this investigation. [01]

(ii) The student record reading of voltmeter and ammeter are given in table. Complete last column. [01]

No. of Obs.	Ammeter Reading I (ampere)	Voltmeter Reading V (volt)	R= V/I
1	0	0	
2	0.23	03	
3	0.42	06	
4	0.53	09	
5	0.65	12	
6	0.71	15	

(iii) Tell which physical quantity is dependent variable and which one is independent variable. [01]

(iv) Plot the graph between current (I) and potential difference (V). [02]

(v) Discuss the behavior of tungsten that can be deduced from the graph. [01]

Q.2 A student investigates the relationship between current passing through a tungsten filament lamp and the potential applied across it. The student record reading of voltmeter and ammeter are given in table.

No. of Obs.	Ammeter Reading I (ampere)	Voltmeter Reading V (volt)	R= V/I
1	0	0	
2	0.33	04	
3	0.47	08	
4	0.59	12	
5	0.70	16	
6	0.79	20	

(i) Complete the last column of the above table. (02)

(ii) What can be said about the resistance as the above-mentioned readings are considered? Is it constant? [1]

(iii) In which category filament bulb will fall. Ohmic or non Ohmic. Give answer on the basis of above readings of the table. [1]

(iv) Plot the graph between current (I) and potential (V). [02]

Experiment 03

Draw characteristics of semiconductor diode and calculate forward and reverse current resistances.

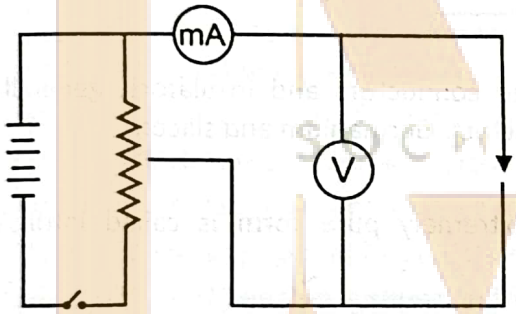
Material Required (Apparatus)

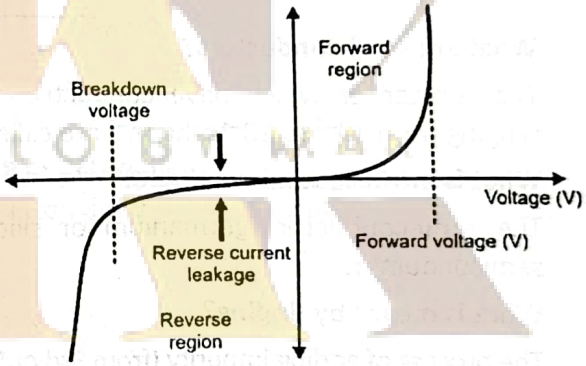
- A semi-conductor diode
- milliammeter
- voltmeter
- rheostat
- key
- battery
- connecting wires

Theoretical Base

- Semiconductors have small amounts of impurity atoms have been added to them.
- The resistivity of semiconductors is intermediate between those of conductors and insulators.
- A junction between p and n type of materials forms a semiconductor diode.
- It is unidirectional device in the sense that it allows charge carriers to flow only in one direction.
- If the positive terminal of a battery is connected with p-type and negative terminal with n-type of diode then the semiconductor diode is called forward biased.
- If the negative terminal of the battery is connected with p-type and positive terminal with n-type, then the semiconductor diode is called reverse biased.

Diagram and graph





Procedure

1) Make electrical connections according to the components as shown in the circuit diagram. For forward characteristics connect the positive of the diode to the negative of ammeter.
2) Plug in the key K1 and adjust the rheostat so that the voltmeter reads 0.1 volts. Close the key K2 and take the milli-ammeter reading.
3) Increase the applied voltage in steps of 0.1 volts interval and note both voltmeter and milli-ammeter readings.
4) Reverse the connections of the diode for reverse characteristics. Take the readings as before at least 2-volt interval up to 20 volts.
5) Plot a graph by taking voltage along X-axis and current along Y-axis. Use the same graph for forward and reverse characteristics.

Observations and Calculations

Sr.No.	Forward Voltage (V)	Forward Current (mA)
1	0	0
2	0.2	0
3	0.4	0
4	0.6	0
5	0.8	6
6	1	20

Sr.No.	Reverse Voltage (V)	Forward Current (μA)
1	0	0
2	5	2
3	10	5
4	15	10
5	20	50
6	25	150

Viva & Voice

Q.1 What are semi-conductors?

Ans. The substances which have conductivities in between conductors and insulators, generally ranging from 10^{-6} to 10^{-4} mho m^{-1} are called semiconductors. Germanium and silicon.

Q.2 What is intrinsic semi-conductor?

Ans. The semi-conductor (germanium or silicon) in its extremely pure form is called intrinsic semiconductor.

Q.3 What is meant by doping?

Ans. The process of adding impurity (from 3rd or 5th group) to pure germanium or silicon is called doping.

Q.4 What is extrinsic semi-conductor?

Ans. The doped semi-conducting material is called an extrinsic semi-conductor.

Q.5 What is the number of atoms added as impurity in the intrinsic semiconductor?

Ans. The number of atoms added as impurity are in the ratio of $1 : 10^6$

Q.6 How does the resistivity of a conductor and a semi-conductor vary with temperature?

Ans. The resistivity of a conductor increases linearly with temperature while that of semi-conductor decreases exponentially with temperature. The reverse is the case with their conductivity.

Q.7 What is P-type substance?

Ans. When impurity from 3rd group e.g., aluminium gallium indium and boron etc.) is added to pure semi-conductance, the resultant substance is called P-type substance.

Q.8 What is N-type substance?

Ans. When impurity from 5th group e.g., arsenic, antimony or phosphorous etc.) is added to pure semi-conductor the resultant substance is called N-type substance.

Q.9 **What do you mean by donor impurities.**

Ans. When impurity from 5th group which donate free electrons to the crystal of germanium or silicon are called donor impurities.

Q.10 **What do you mean by acceptor impurities?**

Ans. The impurities (from 3rd group) which provide holes (can accept free electrons) to the crystal of germanium or silicon are called acceptor impurities.

Q.11 **What is meant by unbiased junction?**

Ans. When no external voltage is applied to a P-N junction, it is said to be un-biased.

Q.12 **What is potential barrier of PN-junction?**

Ans. When the PN junction is formed, a potential difference is developed across the depletion region which stops further diffusion of electrons into the p-region and is called a potential barrier.

Q.13 **What is the value of potential barrier for Ge and Si?**

Ans. The value of potential barrier for Ge is 0.3 volt and for Si is 0.7 volt at room temperature.

Q.14 **Why does the conductivity of a semi-conductor increase with temperature?**

Ans. As when the temperature is increased, then due to thermal agitation the bonds are broken and we get more free electrons and holes. Therefore, conductivity of semiconductor increases with rise in temperature.

Q.15 **What is effect of temperature on the potential barrier?**

Ans. Potential barrier decreases with the rise of temperature at the rate of 2.5 mV per Kelvin.

Q.16 **What is depletion region or zone?**

Ans. In semiconductor physics, the depletion region, also called depletion layer, depletion zone, junction region or the space charge region, is small region around the P.N junction in which free charge carriers are not present. Its thickness is of the order of 1 micron.

Q.17 **What is the use of P.N junction diode?**

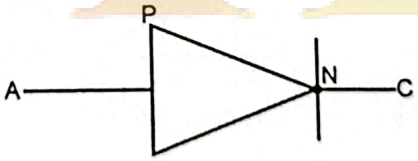
Ans. It is used as a rectifier (i.e. to convert AC to DC)

Q.18 **Which is more temperature resistant, silicon or germanium?**

Ans. Germanium devices work up to 80°C, while silicon devices can work upto 200°C.

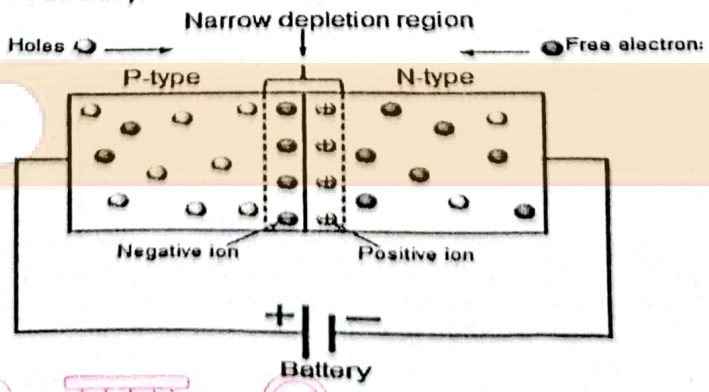
Q.19 **What is symbol of P.N junction?**

Ans. The P-N junction is shown in the circuit as



Q.20 **When is a P.N Junction forward biased?**

Ans. It is forward biased when P-type side is connected to +ve terminal and N-type side is connected to –ve terminal of the battery.



Q.21 **When is a P.N junction reverse biased?**

Ans. It is reverse biased when P-type side is connected to –ve terminal and N-type side is connected to +ve terminal of the battery.

Q.22 **What is break down voltage of a diode?**

Ans. It is the maximum voltage up to which a diode can withstand when it is reverse biased.

Q.23 **What is meant by forward resistance of a P.N junction?**

Ans. If forward bias voltage is increased by ΔV_f, the current increases by ΔI_f. The ratio $\frac{\Delta V_f}{\Delta I_f}$ is known as forward resistance of the P.N junction, i.e. $r_f = \frac{\Delta V_f}{\Delta I_f}$. The value of r_f is only a few ohms.

Q.24 **Is N-type substance electrically neutral?**

Ans. Yes, as the doping does not add or subtract charges.

Q.25 **What is meant by reverse or leakage current?**

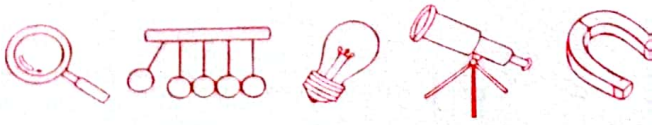
Ans. Under reverse biased condition a very small current flows across the P.N junction due to the flow of minority charge carriers. This current is known as reverse or leakage current.

Q.26 **Name two most commonly used diodes.**

Ans. (i) Light emitting diode (LED) is used for displaying digits etc. in electronic devices.
(ii) Photo diode is used for the detection of light.

Q.27 **What is an ideal semi-conductor diode?**

Ans. An ideal semi-conductor diode behaves like a perfect conductor (zero resistance) when forward biased and a perfect insulator when reverse biased.

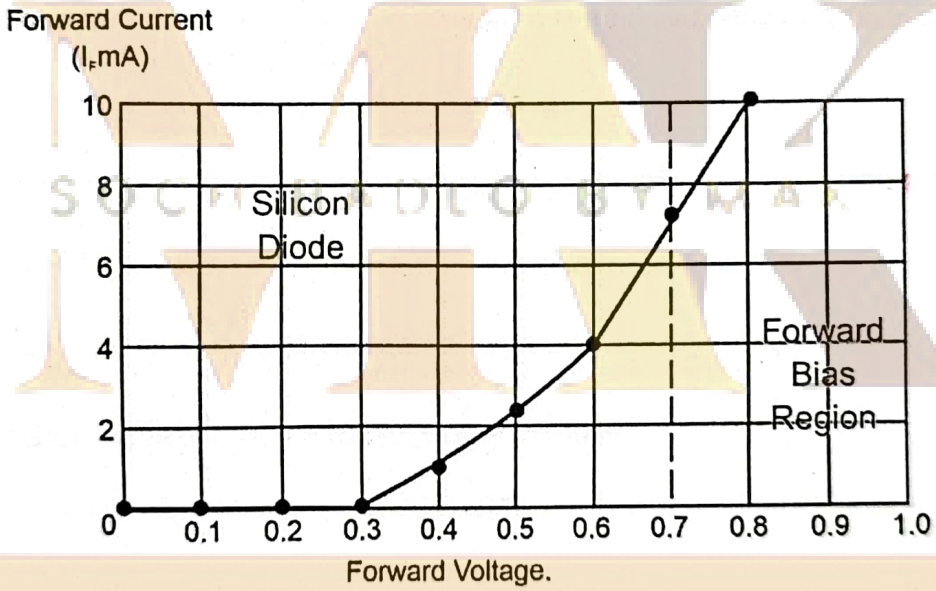


Q.2 (i) **Following are the measured values of forward characteristics and reverse characteristics. Draw the graphs in both cases.** **[3]**

Ans.

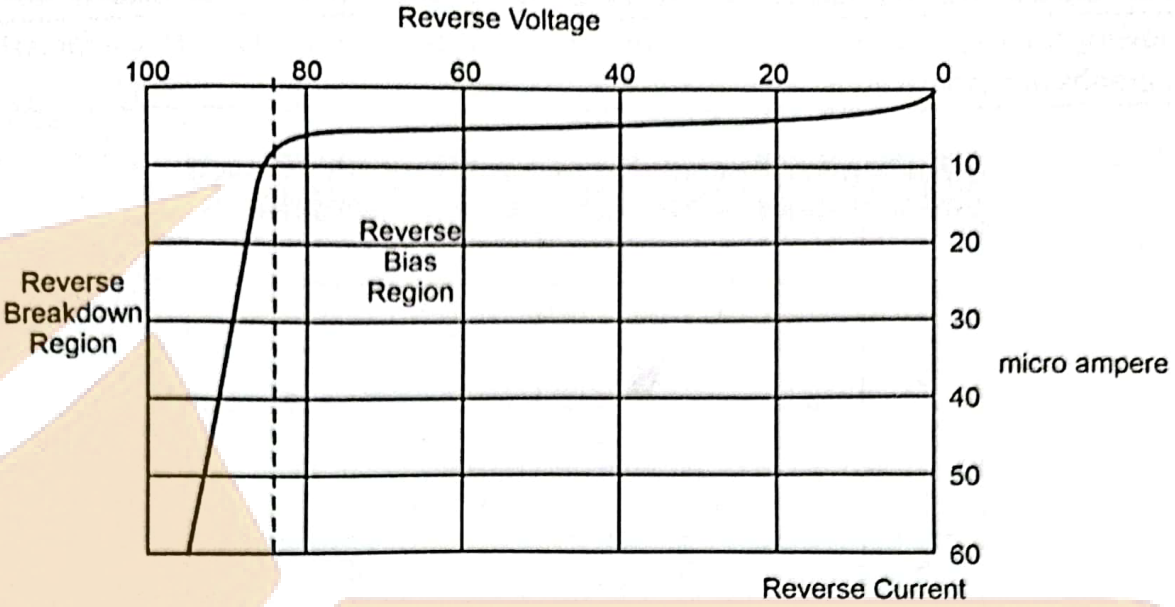
Sr.no.	Forward Voltage (V)	Forward Current (mA)
1	0	0
2	0.1	0
3	0.2	0
4	0.3	0
5	0.4	1
6	0.5	2.5
7	0.6	4.5
8	0.7	7
9	0.8	10

Forward Characteristics Curve for a Junction Diode



Sr. No.	Reverse Voltage (V)	Reverse Current (μA)
1	0	0
2	20	5
3	40	5
4	60	6
5	80	7
6	90	50

Reverse Characteristics Curve for a Junction Diode



ii. **Is the slope of the graph constant or variable?** [1]

Ans. Graph's slope is variable.

iii. **Why reverse current is small?** [1]

Ans. Because reverse current is due to minority charge carriers.

iv. **Why initially the forward current is negligible?** [1]

Ans. Potential barrier prevents the charges to flow.

Q.2 i. Following are the measured values of forward characteristics and reverse characteristics. Draw the graphs in both cases. [3]

Sr.No.	Forward Voltage (v)	Forward Current (mA)
1	0	0
2	0.4	0
3	0.8	2
4	1.2	6
5	1.6	20
6	2.0	50

Sr.No.	Reverse Voltage (V)	Reverse Current (μA)
1	0	0
2	10	2
3	20	2
4	30	4
5	40	10
6	50	60

ii. Does the resistance decrease in reverse biasing? [1]

iii. Why forward current is larger than reverse current? [1]

iv. Why reverse current is saturated? [1]

SCHOLAR WORKSHEET – 02

Q.2 i. While performing this experiment, what is the apparatus required for it. [1]

ii. Draw circuit diagram of forward bias and reverse bias of PN-junction diode. [1+1]

iii. Which charge carriers are responsible in forward current? [1]

iv. Why reverse current is less than forward current? [1]

v. Is diode an ohmic device? [1]

Experiment 04

Study of the variation of electric current with intensity of light using a photocell.

Material Required (Apparatus)

Photo-electric cell, microammeter or sensitive galvanometer, battery, rheostat, Key, scale, electric bulb.

Theoretical Base

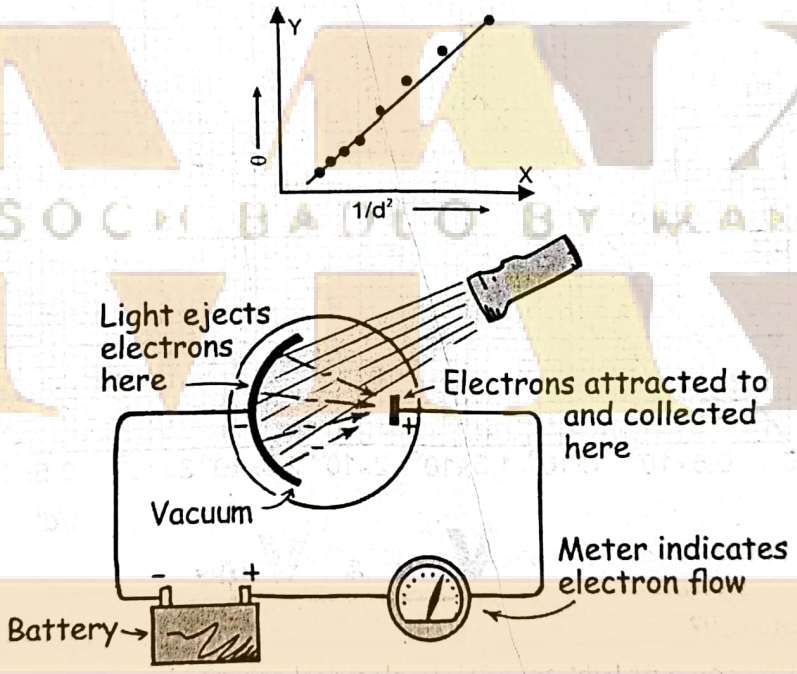
Photocell is a device working on the principle of photoelectric effect for converting light energy into electrical energy.

It consists of an anode and a photosensitive cathode, from which photoelectrons are emitted when light falls on it.

According to inverse square law, 'the intensity of light from a point source varies inversely as the square of the distance from the source, i.e., $I \propto \frac{1}{d^2}$

Graph between photoelectric current or deflection "Θ" and "$\frac{1}{d^2}$" will be a straight line

Diagram and Graph

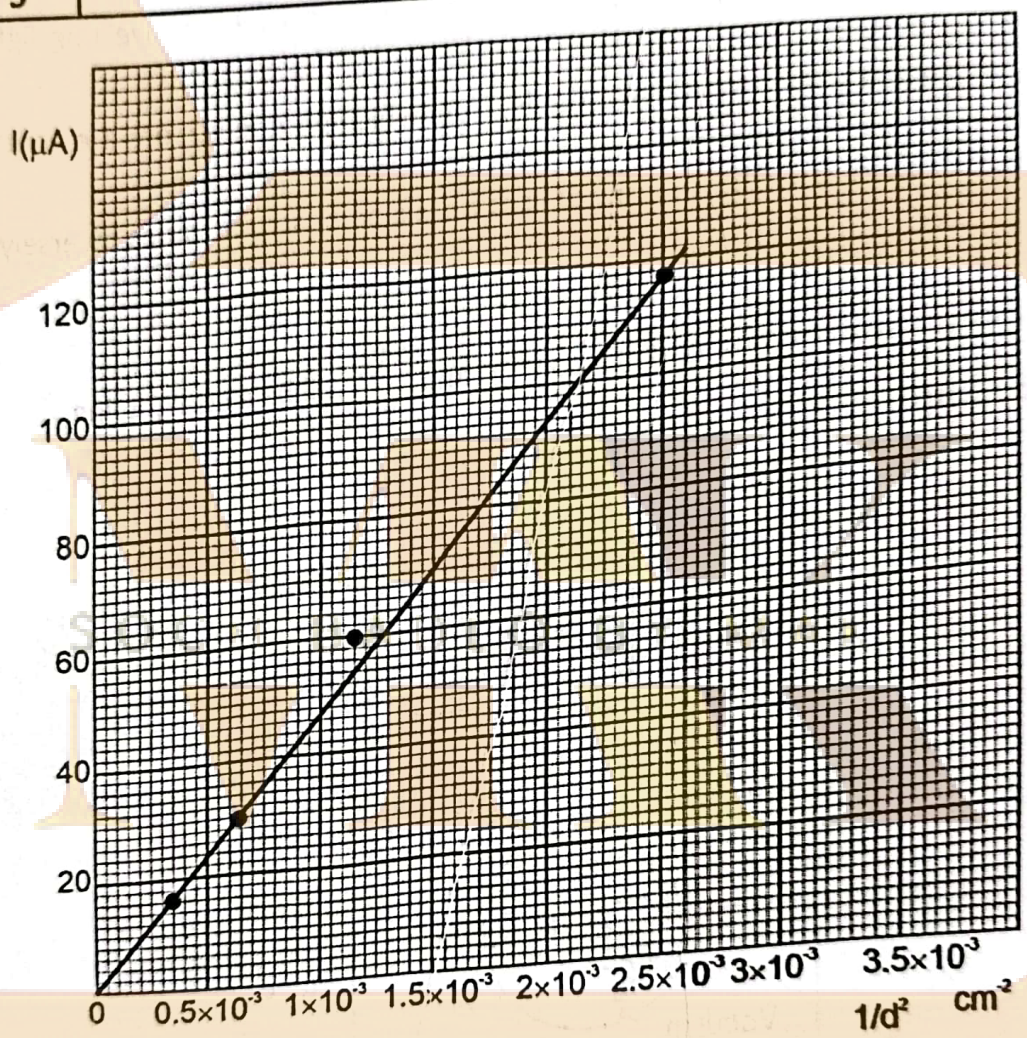


Procedure

1) Set up the apparatus as shown in the figure. All the components are in series. The bulb should be selected and fixed in such a way that its light falls on the photo- cell.
2) Turn on the lamp. Adjust the suitable deflection in the galvanometer.
3) Note the deflection, in the galvanometer (or micro-ammeter) and the corresponding distance, d of the photo-cell from the lamp. Change the distance d in regular steps and note the deflection in the galvanometer.
4) Draw a graph between "$\frac{1}{d^2}$" verses. It will be a straight line.

Observations & Calculations

No of Obs.	Distance of the bulb from cathode "d" (cm)	Photoelectric current μA	Intensity of light $I \alpha \frac{1}{d^2}$ (cm^{-2})
1	50	15	0.4×10^{-3}
2	40	25	0.625×10^{-3}
3	30	60	1.11×10^{-3}
4	20	115	2.5×10^{-3}
5	10	240	10×10^{-3}



Viva & Voice

Q.1 What is a photo cell?

Ans. It is a device that converts light energy into electrical energy.

Q.2 State inverse square law.

Ans. It states that the intensity of light is inversely proportional to the square of distance from the source of light.

Q.3 Define intensity of light.

Ans. The light energy falling normally per second per unit area is called intensity of light.

Q.4 What is S.I. unit of intensity?

Ans. The S.I. unit of intensity is watt m^2

Q.5 **What is photon?**

Ans. A photon is a discrete bundle of electromagnetic energy. A beam of light consists of a stream of energy corpuscles. These corpuscles are called photons.

Q.6 **What is photoelectric effect?**

Ans. When light of suitable frequency falls on a certain metal surface electrons are emitted. This phenomenon is called photoelectric effect.

Q.7 **What are photoelectrons?**

Ans. When light of suitable frequency falls on a certain metal surface electrons are emitted. These electrons are called photoelectrons.

Q.8 **What is photoelectric current?**

Ans. The current produced due to photoelectrons is called photoelectric current.

Q.9 **Upon what factors, the emission of photoelectrons from a metal surface depends?**

Ans. The emission of photoelectrons from metal surface depends upon the following factors.
(i) Frequency of incidence light (ii) Nature of metal surface

Q.10 **What is maximum K.E of the photoelectrons?**

Ans. The maximum K.E of photoelectrons is given by the relation.

$K.E_{max}$ of electron = eV_0

or $K.E_{max}$ of electron = hf – hf_0 = hf – ϕ_0

Q.11 **Does the maximum K.E of photoelectrons depend upon intensity of light used?**

Ans. No, maximum K.E of photoelectrons depends upon frequency of light used and nature of metal surface.

Q.12 **Does photoelectric current depends upon the intensity of light?**

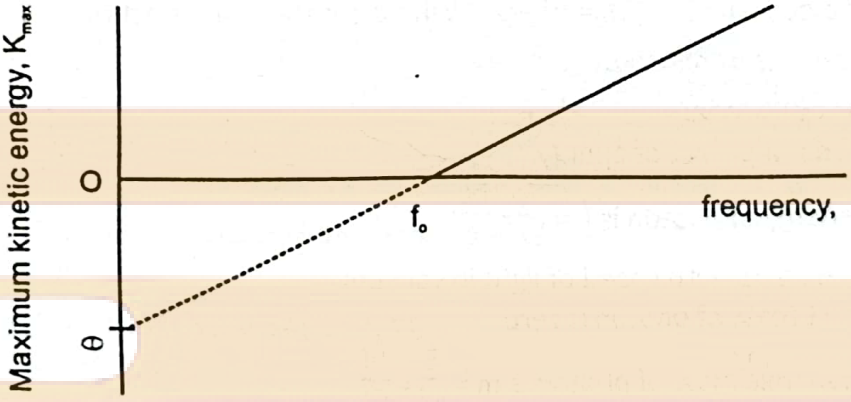
Ans. Yes, photoelectric current is directly proportional to intensity of incident light.

Q.13 **What is the shape of graph between $K.E_{max}$ of photoelectrons and frequency of incident light?**

Ans. It is a straight line.

Q.14 **What is threshold frequency?**

Ans. **Threshold Frequency (f_0):** The minimum value of frequency of incident light, required to eject electron from metal surface, is called threshold frequency. Threshold frequency varies from metal to metal.



Q.15 **What is cut off wavelength in photoelectric effect?**

Ans. The cutoff wavelength in the photoelectric effect is the maximum wavelength of light that can still cause the ejection of electrons from a metal. If wavelength of light is longer than cutoff wavelength, no photoemission occurs.

Q.16 **Does the threshold/critical frequency depends upon nature of metal surface?**

Ans. Yes, threshold frequency depends upon the nature of metal surface.

Q.17 **What is stopping potential?**

Ans. The value of reverse potential at which photoelectric current becomes zero is called stopping potential.

Q.18 **Write down uses of photocell.**

Ans. (i) Counting systems (ii) Automatic door system
(iii) Automatic Street lighting (iv) Security systems

Q.19 **What is the shape of graph between intensity of light and the photoelectric current?**

Ans. The graph is a straight line as shown in the fig.

Q.20 **Why photoelectric effect can't take place if the frequency of the radiation is less than threshold frequency?**

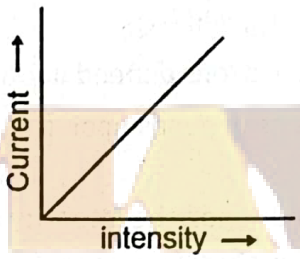
Ans. It is because energy of photon is less than the work function and photon cannot eject electron from metal surface.

Q.21 **Is the phenomenon of photoelectric effect is instantaneous or not?**

Ans. photoelectric effect is instantaneous phenomenon.

Q.22 **What is work function?**

Ans. The minimum energy required to eject an electron from a certain metal surface is called work function.



Q.23 **Why ordinary light can cause photoelectric emission in alkali metals?**

Ans. Ordinary light can cause photoelectric emission in alkali metals because they possess low work function.

Q.24 **How does the energy of photoelectron vary with the intensity of light?**

Ans. Energy of photoelectron is not affected by the variation in the intensity of light.

Q.25 **Write down Einstein's famous equation of photoelectric effect.**

Ans. $(K.E)_{max}$ of electron = $hf - hf_0 = hf - \phi$, Where ϕ is the work function.

Q.26 **Give characteristics of photon.**

Ans. **Characteristic of Photon:**

(i) Photon is a packet of energy.

(ii) The energy of photon is $E = hf = \frac{hc}{\lambda}$

(iii) Photon travel with speed of light in vacuum.

(iv) The rest mass of photon is zero.

(v) The dynamic mass of photon is $m = \frac{E}{C^2} = \frac{hf}{C^2}$

(vi) The momentum of photon is $P = \frac{E}{C} = \frac{hf}{C} = \frac{h}{\lambda}$

(vii) Photon is neutral.

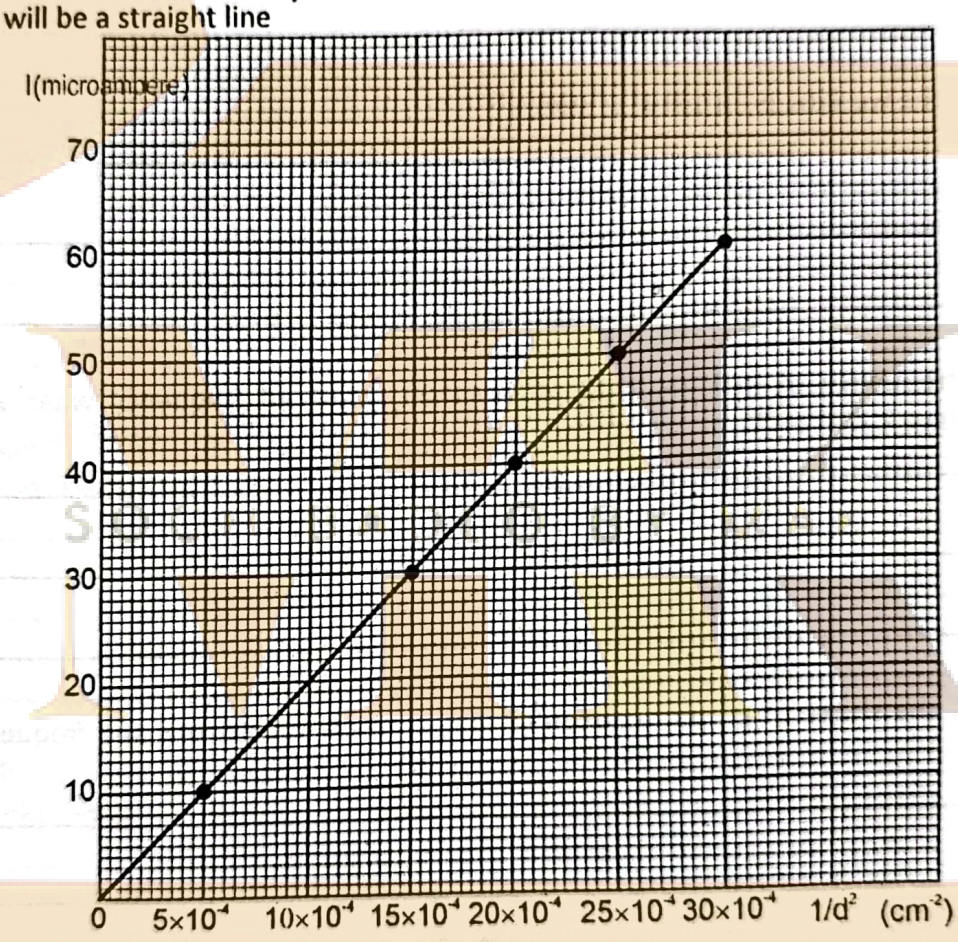
(viii) Photons are not deflected by electric and magnetic field.

Data Table Shows the Values of the Distance of Lamp from Photo Cell, Measured and the Deflection of Galvanometer.

No of obs.	Distance of the bulb from cathode "d" (cm)	Photoelectric current or deflection μA	Intensity of light $I \alpha \frac{1}{d^2}$ (cm^{-2})
1	40	11	6.25×10^{-4}
2	25	30	16×10^{-4}
3	22.5	40	19.75×10^{-4}
4	20.5	50	23.8×10^{-4}
5	18.5	60	29.2×10^{-4}

Q.2 i) What will be the graphical analysis of this experiment? **[1]**

Ans. Graph will be a straight line



ii) Which phenomenon is involved in this experiment? **[1]**

Ans. Photoelectric effect.

iii) What will be the units of intensity of light? **[1]**

Ans. Watt per square metre

iv) Can the light of any frequency will cause current to flow? **[1]**

Ans. No, suitable frequency of light i.e. above threshold frequency of metal can eject electron.

v) What is the source of electrons in this case? **[1]**

Ans. Cathode material

vi) If the light beam is interrupted by some obstacle, will current flow? **[1]**

Ans. No, current will not flow.

Q.2 i Write down the apparatus required in photo electric effect experiment. [1]

ii. Will the graph have a constant slope? [1]

iii. What is the working principle of photocell? [1]

iv. If the frequency of incident light is less than threshold frequency what will happen to photoelectric current? [1]

v. What is the shape of graph between $(K.E)_{max}$ of photoelectrons and frequency of incident light? [1]

Q.2 i. Write down the apparatus required to perform this experiment. [1]

ii. What is the relation between the photoelectric current and intensity of light? Explain with graph. [2]

iii. Why micro-Ammeter is connected in series? [1]

iv. If the frequency of incident light is greater than threshold frequency of metal what will happen to photoelectric current? [1]

v. What is the effect on microammeter reading if the distance is increased between the source of light and photocell?

Experiment 05

Analyze the variation of resistance of thermistor with temperature.

Material Required (Apparatus)

- Thermistor unit
- iron stand
- multi-meter (ohms range)
- beaker
- spirit lamp
- thermometer

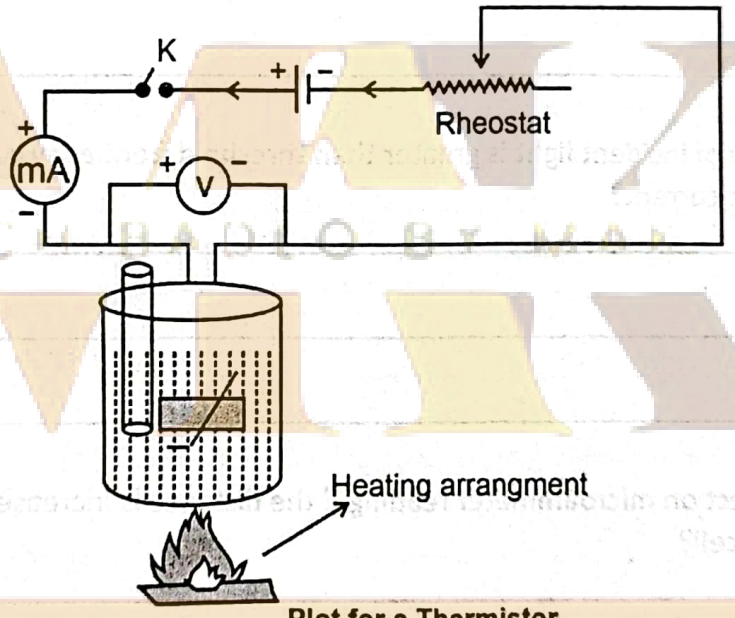
Theoretical Base

A thermistor is a temperature sensitive device.

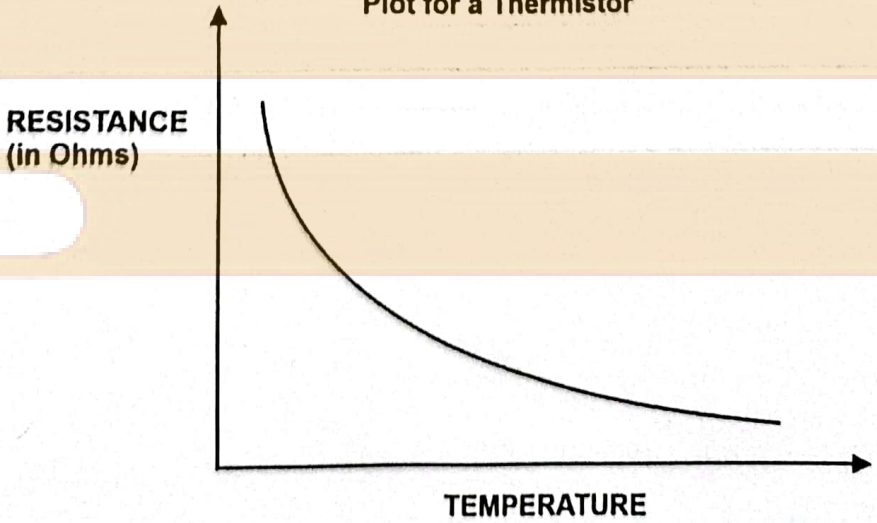
The word thermistor is derived from 'thermal resistor'.

- Depending upon their composition the thermistor can have either a positive temperatur coefficient PTC (i.e., 'the fractional change in the resistance of a thermistor per degree centigrad rise in temperature'). Their resistance increases with rise in temperature.
- Thermistor with negative temperature coefficient NTC. Their resistance decreases with rise i temperature.

Diagram and Graph



Plot for a Thermistor



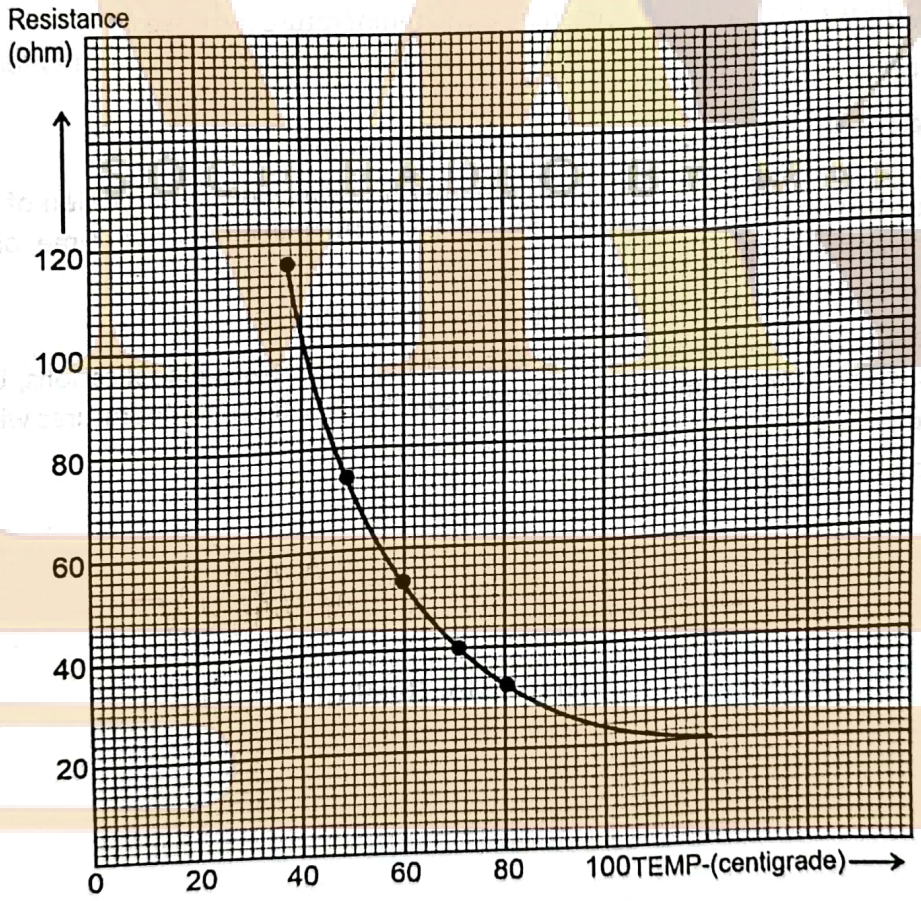
Procedure

1) Connect the apparatus according to circuit diagram as shown in the figure.
2) Fill the water in the beaker. Thermistor should be mounted above the base of the beaker, and as well a thermometer in order to read measurements.
3) Supply heat, mix the water in beaker well with a stirrer and note down the readings of temperature on thermometer and current from milliammeter at different temperatures.
4) Complete all the columns of the table.
5) Plot graph between resistance of thermistor and the temperature. The curve is not a straight line. Find the slope of this curve

Observations

Applied voltage = 3V

No of Obs.	Ammeter Reading (mA)	Temperature °C	Resistance of R = V/I Ω
1	26	40	115.4
2	40	50	75
3	56	60	54
4	76	70	39
5	100	80	30



Viva & Voice

Q.1 What is a thermistor?

Ans. A thermistor is a heat sensitive resistor. Its resistance changes with change in temperature. The word thermistor is derived from 'thermal resistor'.

Q.2 What do you mean by temperature coefficient of resistance?

Ans. Temperature coefficient of resistance is the fractional change in resistance per Kelvin change in temperature.

Q.3 Can a thermistor have positive temperature coefficient?

Ans. Yes, thermistors with positive temperature coefficient (PTC) are also available. Their resistance increases with rise in temperature.

Q.4 What are the two primary types of thermistors?

Ans. The two primary types of thermistors are negative temperature coefficient (NTC) thermistors and positive temperature coefficient (PTC) thermistors.

Q.5 What is the characteristic of an NTC thermistor?

Ans. An NTC thermistor decreases its resistance as the temperature increases.
At the heart of the NTC Thermistor is a polycrystalline semiconductor ceramic material with a spinel structure mainly composed of metal oxides such as manganese, nickel, cobalt, iron, and copper. This type of thermistor is commonly used for temperature measurement and control.

Q.6 What is the characteristic of a PTC thermistor?

Ans. A PTC thermistor increases its resistance as the temperature increases.
These are often used for circuit protection as they can limit current in response to increased temperatures.

Q.7 What factors can influence the accuracy of a thermistor?

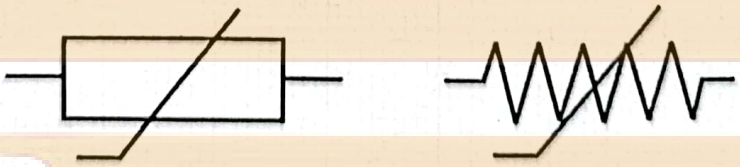
Ans. Factors that can influence the accuracy of a thermistor include the precision of the thermistor's resistance-temperature relationship, the stability of the thermistor over time, and the quality of the thermistor's construction.

Q.8 Can thermistors be used for high-temperature applications?

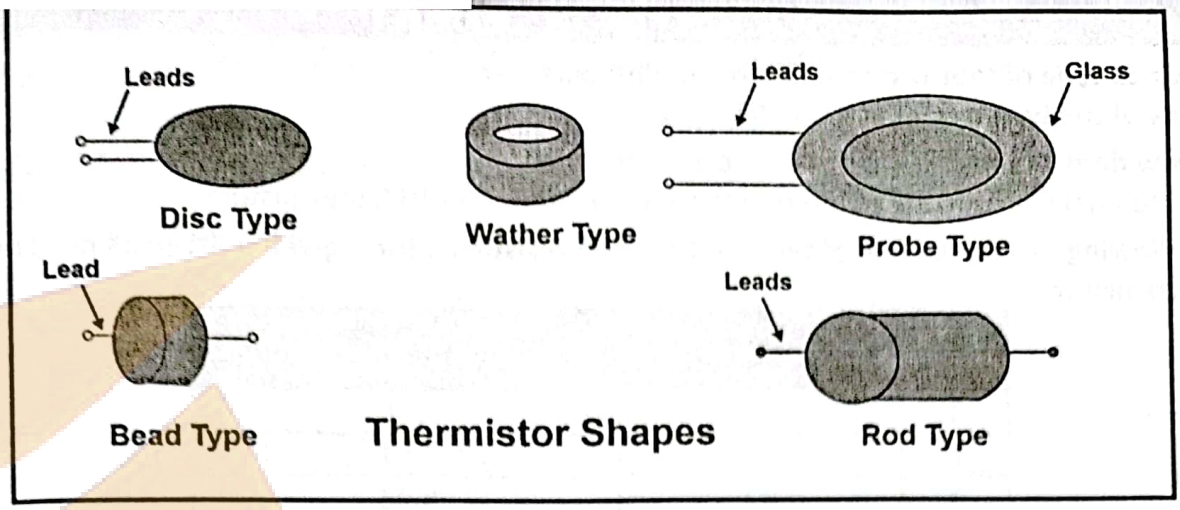
Ans. Yes, special types of thermistors can be used for high-temperature applications, but the materials used to construct the thermistor must be able to withstand these temperatures without degrading.

Q.9 What are different shapes and symbols for thermistor?

Ans. Rod, disc and bead-shape.



Thermistor Symbol



Q.10 What are the uses of thermistor?

Ans. They are used for temperature control and measurements.

A thermistor with positive temperature co-efficient of resistance (PTC) generally used for fuse purpose.

- One of the properties of the (PTC) is that when excessively large current flows, they generate heat and becomes highly resistive. Due to this property, they are used as overcurrent protection devices.
- Positive temperature coefficient thermistor (PTC) used as heater in automobile industry to provide additional heat inside cabin with diesel engine or to heat diesel in cold climatic condition before engine injection.

  NTC are used in Modern appliances, communication tools and accessories like mobile phones, computers, LCD displays, CPUs, rechargeable batteries, and medical and patient monitoring equipment.
- A thermistor with a negative temperature co-efficient (NTC) can be used to start an alarm when temperature of winding of motors, transformers and generators increases.
- Refrigerators and freezers, as well as small appliances like hair dryers, curling irons, ovens, toasters, thermostats, air conditioners and fire alarms also have NTCs for temperature control.
- A thermistor with a negative temperature co-efficient (NTC) is used to low-temperature measurements of the order of 10 K.

Q.2 i) **Which type of thermistor is suitable in this experiment?** [1]

Ans. Any of the type can be used i.e. NTC or PTC

ii) **How does the resistance of PTC thermistor vary?** [1]

Ans. As temperature increases the resistance will increase for PTC thermistors.

iii) **Following are the values of temperature and resistance for a given voltage as measured for a thermistor.**

No of Obs.	Temperature in °C	Resistance of thermistor kΩ
1	21	2.3
2	27	4.51
3	32	5.93
4	38	6.7
5	43	7.77
6	49	8.14
7	54	9.49
8	60	10.97

(a) **What can be analysed about the type of thermistor used in this experiment on the basis of the measured values?** [1]

Ans. As resistance is increasing with rise in temperature so it is the PTC thermistor.

(b) **Will the graph have a constant slope as predicted by the above values?** [1]

Ans. No, the slope will be variable.

iv) **What is a possible source of error in this experiment?** [1]

Ans. Personal error, improper intervals to measure these values, poor calibration of instrument.

v) **Is PTC thermistor an ohmic device?** [1]

Ans. No, it's a non-ohmic device. Because its resistance is not constant.

Q.2 i. What is the apparatus required to perform this experiment? [1]

ii. How does the resistance of thermistor vary with change in temperature? [1]

iii. Following are the values of temperature and resistance for a given voltage as measured for a thermistor.

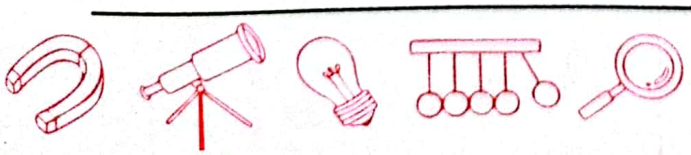
No of obs.	Temperature in °C	Temperature in kelvin	Resistance of Thermistor kΩ
1	30	303	4.02
2	40	313	2.74
3	50	323	1.99
4	60	333	1.43
5	70	343	1.07
6	80	353	0.82
7	90	363	0.63

(a) What can be analysed about the type of thermistor used in this experiment on the basis of the measured values? [1]

(b) Draw a graph as predicted by the above values (not to the scale). [1]

iv. What is a possible source if heating in this experiment? [1]

v. Is thermistor an ohmic device? [1]



Q.2 i. Is thermistor an example of fixed resistor? [1]

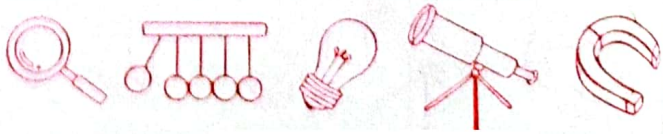
ii. How does the resistance of PTC thermistor vary? [1]

iii. Following are the values of voltages and currents as measured for a thermistor whose temperature co-efficient is positive.

No of Obs.	Temperature in °C (volt)	Temperature in K	Resistance of thermistor kΩ
1	20		2
2	30		4.4
3	40		6.8
4	50		9.4
5	60		12.8

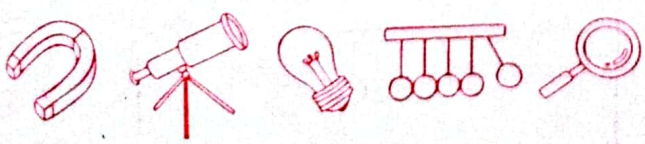
(a) Draw graph between resistance and temperature of a thermistor, what can be analysed about the slope of the graph? [2]

iv. Give some uses of thermistors. [2]



SOLUTION

SECTION - I



EXP-1 Determine Unknown Resistance by Slide Wire Bridge

SOLUTION WORKSHEET – 01

i) To measure the unknown resistance of a wire by slide wire bridge

ii) The slide wire bridge was the only practical way to make resistance measurements for years. It is a really good example of clever design where a circuit configuration overcomes error.

iii) Its working is based on the principle of Wheatstone bridge. When the bridge is balanced

$$\frac{P}{Q} = \frac{R}{S}$$

iv) $X = \frac{l_1}{l_2} R$

v)

No of observations	Resistance from resistance box "R"	Distance from balancing length l_1	Distance from balancing length l_2	Un-known resistance $X = \frac{l_1}{l_2} R$
units	ohm	cm	cm	ohm
1	1	58	42	1.4
2	2	42	58	1.45
3	3	33	67	1.48

vi) $\text{Resistance} = \frac{1.4 + 1.45 + 1.48}{3} = 1.44 \text{ Ohm}$

vii) Radius of the wire = 0.012 cm= 1.2×10^{-4} m

Length of the wire = 20 cm = 0.20 m

Find resistivity of wire = ρ

$$\text{Specific resistance} = \rho = \frac{X}{L} \times \pi r^2 = \frac{1.44 \times 3.14 \times (1.2 \times 10^{-4})^2}{0.20} = 3.2 \times 10^{-7} \text{ ohm m}$$

SOLUTION WORKSHEET – 02

i) Balancing length on the scale is 55 cm

ii) When slide wire bridge circuit is balanced then two terminals of galvanometer are at same potential. Potential difference between the terminal of galvanometer is zero, so no current flows through the galvanometer. The reading of the galvanometer in Wheatstone Bridge at balance condition is zero.

iii) $X = R\frac{l_2}{l_1}$

iv) The value of X is

$$\frac{P}{Q} = \frac{R}{S}$$

$$\frac{X}{3} = \frac{40}{60}$$

$$X = \frac{120}{60} = 2\ \Omega$$

v) When a current pass through the wire for long time, heating effect occurs i.e. temperature of the wire gets increased due to which resistance of the wire get increased.

vi) Resistance of one meter cube of substance called resistivity.

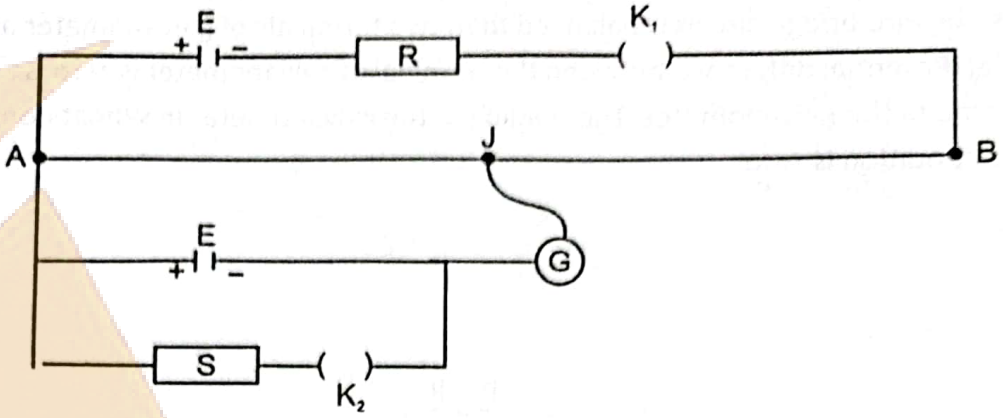
$$\rho = \frac{RA}{L}$$

Unit of resistivity Ω m

EXP-2 Determine the internal resistance of cell by using potentiometer

SOLUTION WORKSHEET – 01

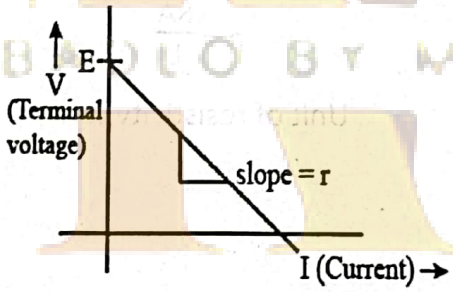
i)



ii) Use value of l_1 = 290 cm

No of observation	Resistance R	Balancing length l_2	$r = \left(\frac{l_1 - l_2}{l_2}\right)R$
units	ohm	cm	ohm
1	1	271	0.07
2	2	279	0.078
3	3	283	0.074

iii) Emf of the cell = Intercept on V axis.
Internal resistance = slope of the line

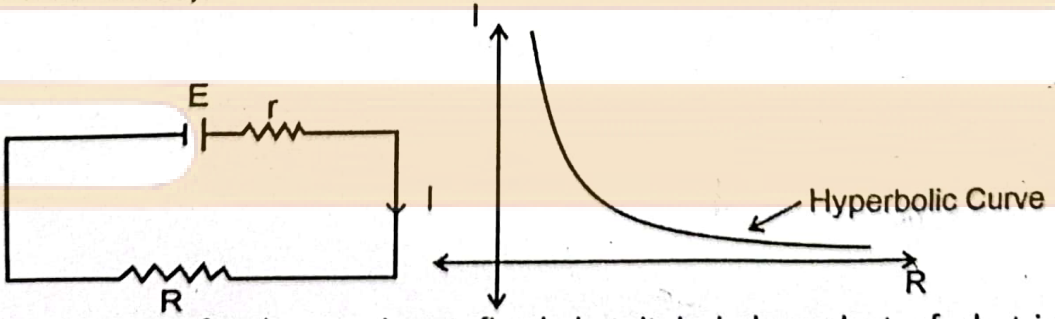


iv) According to the question

$E = I(R + r)$

$I = \frac{E}{R + r}$

As graphic is I Vs R so,



v) Internal resistance of a battery is not fixed, but it is independent of electrical load connected with it. If a battery is fully charged, it offers a very low internal resistance. But, as the battery discharges, the internal increases with age of battery.

SOLUTION WORKSHEET – 02

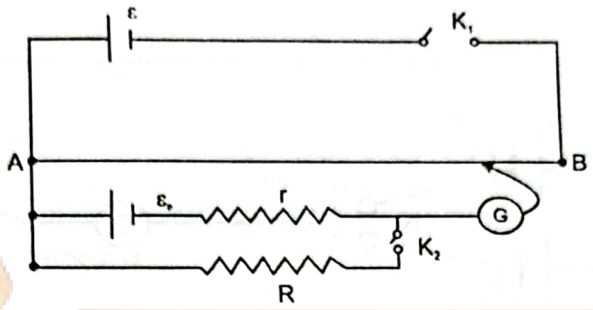
Q.1

$$r = R\left(\frac{l_1}{l_2} - 1\right)$$

Here, $l_1 = 72\ cm$; $l_2 = 60\ cm$ and $R = 60\ \Omega$

$$r = (60)\left(\frac{72}{60} - 1\right)$$

$$r = 2\ \Omega$$



i)

- Use highly conductive materials with increased surface area (e.g., copper, aluminium,).
- Improve Electrolyte Conductivity
- Minimize the distance between electrodes and use high-quality separators for better ion flow.
- Keep cells within the ideal temperature and voltage ranges to avoid degradation.
- Apply precise manufacturing and improve conductivity.

ii)

$$V_{internal} = 0.05 \times 12 = 0.6V$$

$$V_{terminal} = V_{battery} - V_{internal}$$

$$= 9 - 0.6 = 8.4\ V$$

iii)

$$E = 1.50\ V \quad , \ I = 2.5\ A$$

$$r = \frac{E}{I} = \frac{1.50}{2.5} = 0.6\ \Omega$$

iv)

- The potentiometer is preferred for measuring the internal resistance of a cell because it allows for accurate EMF measurement without drawing current from the cell.
- It uses a zero-current method, ensuring no voltage drop due to internal resistance, provides high precision, avoids heating effects, and enables direct calculation of internal resistance.

v)

Internal resistance 'r' of cell depends

- $r \propto \frac{1}{A}$ (A is area of plates used in cell)
- $r \propto$ distance between electrodes of battery
- $r \propto$ concentration of electrolyte.
- $r \propto \frac{1}{T}$ (r decreases with increase in temperature of electroly
- $r \propto d$ (d is distance between plates)

SOLUTION WORKSHEET – 01

Q.1

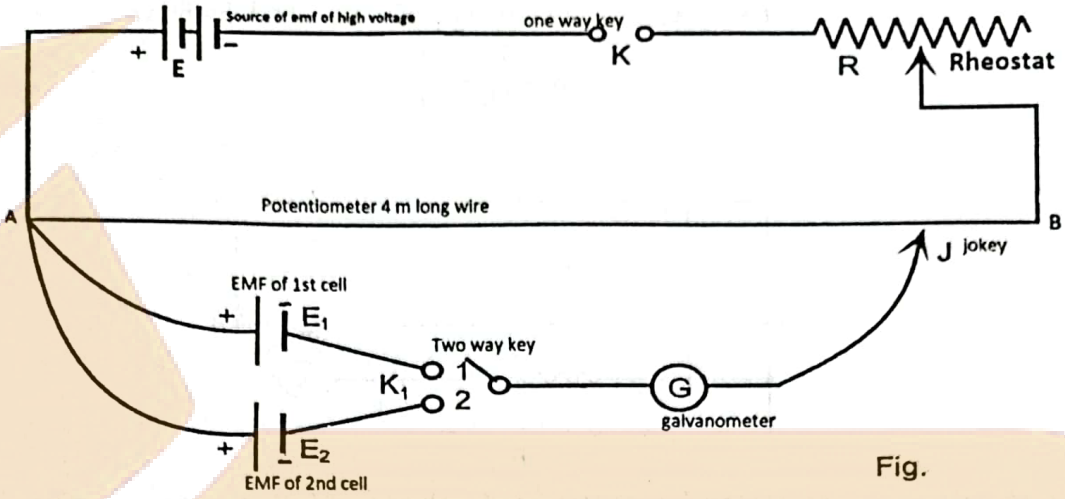


Fig.

i) Use values E= 3V

$E_2 = 1.5\ V$

No Of Observation	Blancing Length For Cell E l_1	Blancing Length For Cell E l_2	$E_1 = E_2 \frac{l_1}{l_2}$
units	cm	cm	ohm
1	284	290	1.47
2	294	300	1.47
3	304	311	1.466

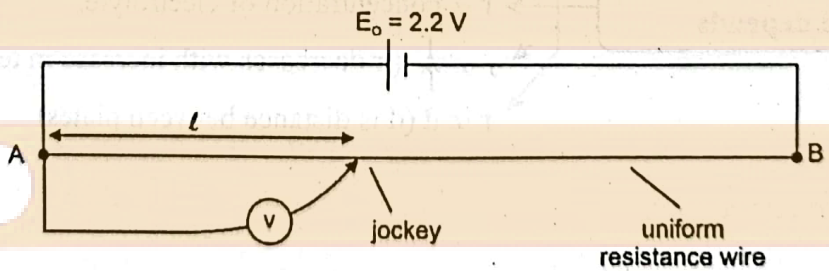
MEAN VALUE OF $E_1 = \frac{1.47+1.47+1.466}{3} = 1.47\ V$

ii) Potentiometer measures the potential difference more accurately than a voltmeter, because the potentiometer does not draw current from external circuit.

iii) The null point indicates that the voltage across the potentiometer wire is equal to the voltage of the unknown or reference emf being measured. When this happens, the circuit is balanced, and no current flows through the galvanometer.

iv) Area of the cross-section of the meter bridge wire should be uniform because if we suppose it is not having a uniform cross-section then the value of the resistance per unit length will be having different values over a different length of Meter Bridge.

v)



Formula $V = \left(\frac{E_0}{L}\right) \ell$

SOLUTION WORKSHEET – 02

Q.1

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

$$l_2 = l_1\left(\frac{E_2}{E_1}\right)$$

$$l_2 = 36\left(\frac{2.5}{1.5}\right) = 60 \text{ cm}$$

i) For emf of the cell, current I = 0
Then T.P.D. = 6V (Maximum)
called emf of the cell so emf = 6V

ii) For the purpose of measuring e.m.f accurately, no electric current should be taken from the cell. In the case of a potentiometer, the readings are noted when the electric current is zero. So the potentiometer measures the e.m.f correctly.

iii) A secondary cell gives more electric current than a primary cell because a secondary cell possesses a very low internal resistance.

iv) $V = \left(\frac{E}{L}\right)\ell$

$V = \left(\frac{6}{4}\right) 1.8 = 2.7$ V

EXP-4 Determine the E.m.f. and internal resistance of cell by plotting V against I graph

SOLUTION WORKSHEET – 01

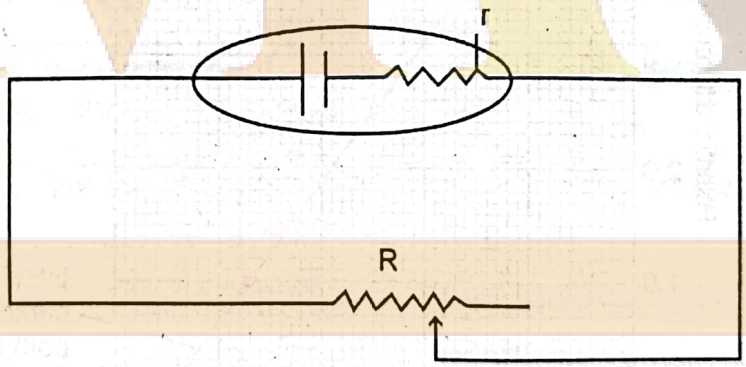
Q.1 (i) If emf of the cell will be ε, then from the Ohm's law

$$\varepsilon = I(R + r)$$

So formula of internal resistance will be

$$r = \frac{\varepsilon - V}{I}$$

ii)



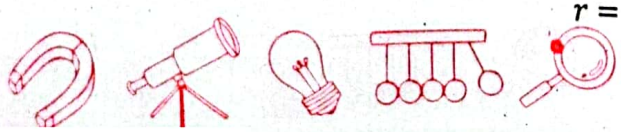
When battery and internal resistance connected to the variable resistor. Resistance R can be adjusted to any value greater than or equal to zero. Which can help us to draw a graph help in understanding relation b/w these quantities. It can also explain changing terminal potential difference by changing resistance of circuit.

iii) So formula of internal resistance will be

$$r = \frac{\varepsilon - IR}{I}$$

$$r = \frac{12 - (2)(4)}{2}$$

$$r = 2\ ohm$$



iv)

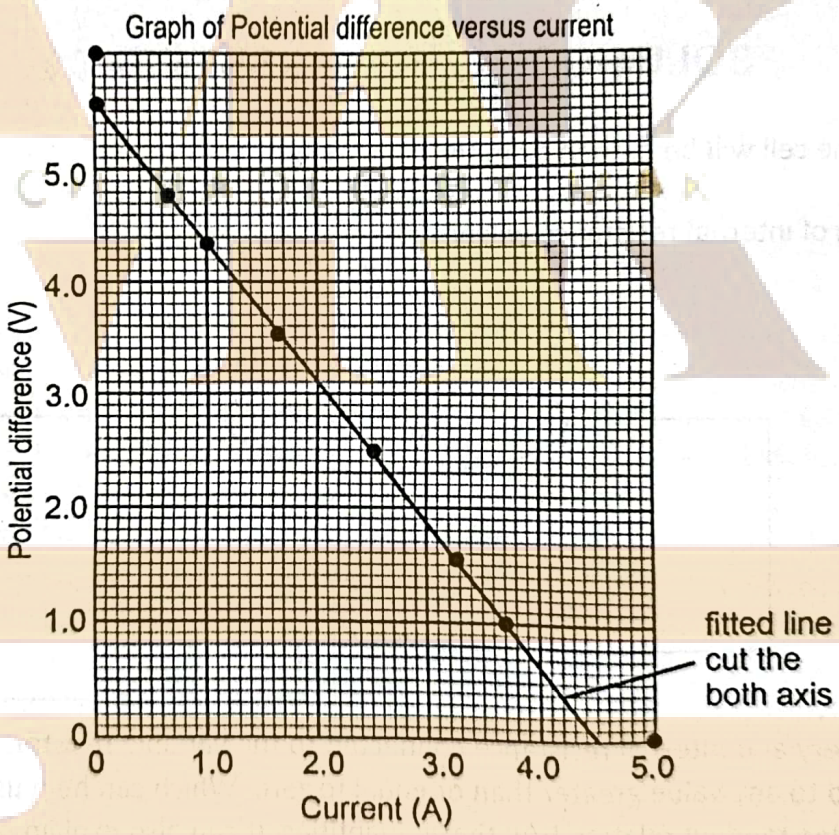
S.no	Resistance R	Voltmeter reading V	Ammeter reading I	Emf ε	$r = \frac{\varepsilon - V}{I}$
units	ohm	1	Ampere	volt	ohm
1	3	1	300×10^{-3}	3	3.6
2	4	1.5	290×10^{-3}	3	2.8
3	5	1.10	280×10^{-3}	3	2.14
4	6	1.15	260×10^{-3}	3	1.69
5	7	2	240×10^{-3}	3	1.33

SOLUTION WORKSHEET – 02

Q.1 i) The cell is connected to external Resistance R, the current I is flowing from its positive to negative terminal. The internal resistance behaves as if it is in series to the cell. The total resistance of the circuit becomes (R + r)
If emf of the cell will be ε, then from the Ohm's law

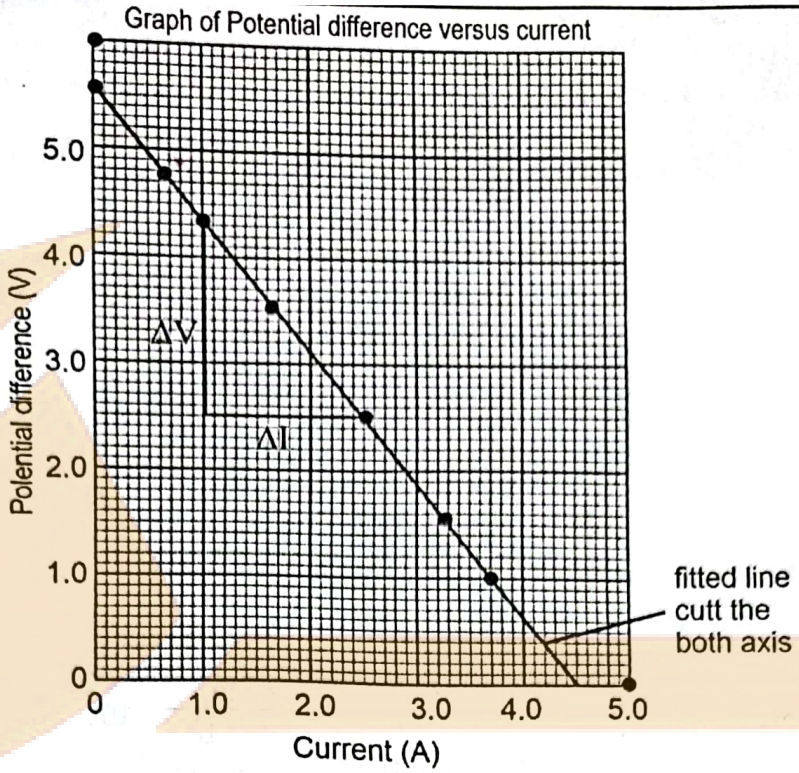
$$\varepsilon = I(R + r)$$

ii)



iii) From the y-axis the reading of emf is greater then 5.5 volt

iv)



$$r = \frac{\Delta V}{\Delta I}$$

$$r = \frac{4.3 - 3.5}{2.5 - 1}$$

$$r = 0.53\ ohm$$

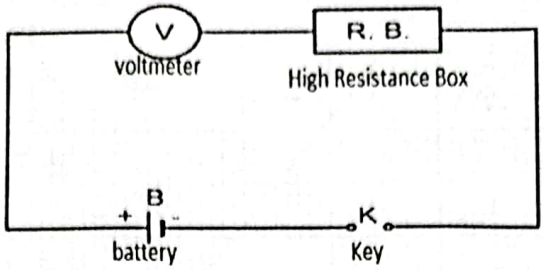
v)

EMF	Terminal potential difference
$E.M.F$ is the energy supplied to the unit charge by the cell. $E = \frac{W}{q}$	It is the work done in bringing the unit positive from positive to negative terminal with in the circuit $\Delta V = \frac{W}{q}$
It is the cause.	It is the effect.
It is always present even though no current is flowing through the circuit.	It becomes zero when no current is flowing through the circuit.
Generally, emf is greater than terminal P. D	Generally terminal P.D is less than the emf of the source
It remains constant.	It does not remain constant.
It does not depend on circuit resistance	It directly depends on the resistance between two points of measurement.

EXP-5 Determine Resistance Of Voltmeter By Drawing Graph between R and 1/V

SOLUTION WORKSHEET – 01

Q.1



i) $R_h = \frac{V}{I_g} - R_g$

ii) $R_h = \frac{V}{I_g} - R_g$

Putting values:

$$R_h = \frac{20}{5 \times 10^{-3}} - 100$$

$$R_h = 3900\ \Omega$$

iii) It must have high resistance, more precise, high accuracy and high resolution.

iv) V = IR = 0.5 x 100 = 50 V

v)

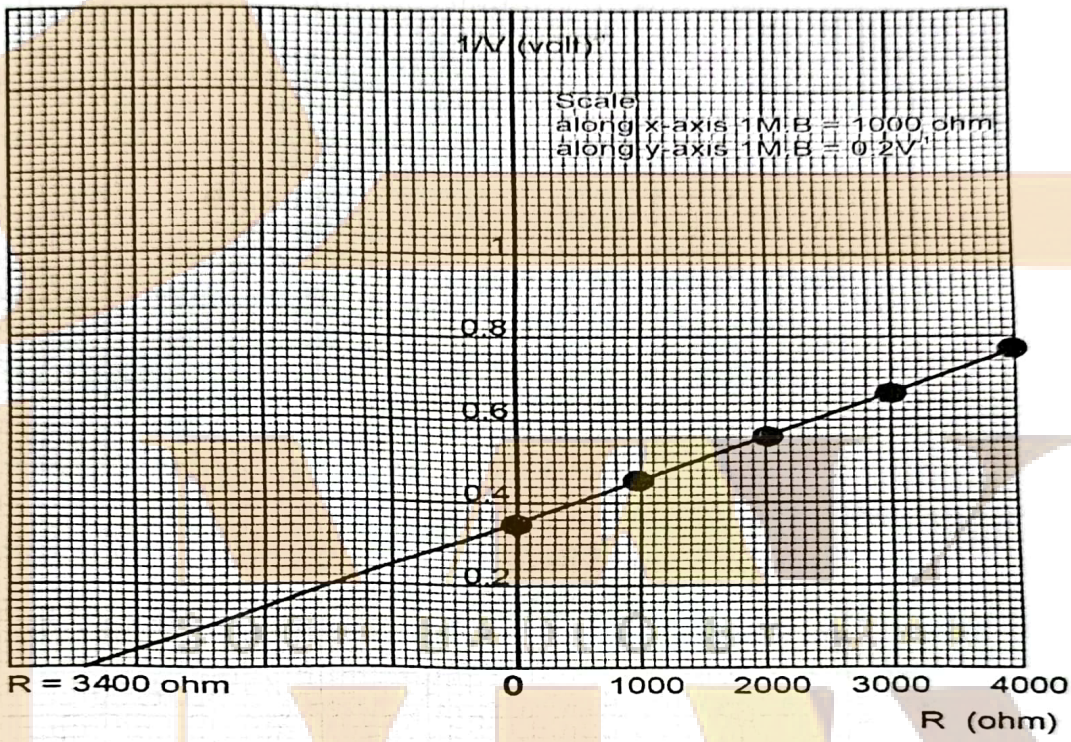
No of readings	Resistance R	Voltmeter reading V	1/V
unit	ohm	volt	V^{-1}
1	0	3	0.33
2	500	2.7	0.37
3	1000	2.4	0.416
4	1500	2.1	0.476
5	2000	1.85	0.54
6	2500	1.65	0.606

SOLUTION WORKSHEET – 02

Q.1

No of readings	Resistance R	Voltmeter reading	1/V
unit	ohm	volts	
1	0	3	0.33
2	1000	2.3	0.43
3	2000	1.8	0.58
4	3000	1.5	0.666
5	4000	1.3	0.77

i)



ii) It is a low range voltmeter. A voltmeter can be changed to milli voltmeter by decreasing its series resistance because milli voltmeter has comparatively low resistance with voltmeter.

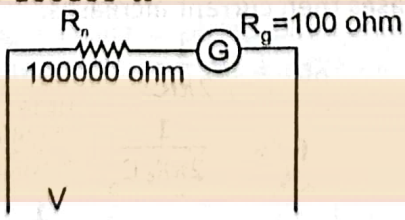
iii) No D.C. voltmeter can only be used in D.C. circuits.it cannot measure A.C voltage.

iv) **Galvanometer can be converted into a voltmeter** by connecting a suitable high resistance in series with the galvanometer.

Resistance of voltmeter $R_V = R_g + R_h$

$R_V = 100+100000$

$R_V = 100100\ \Omega$



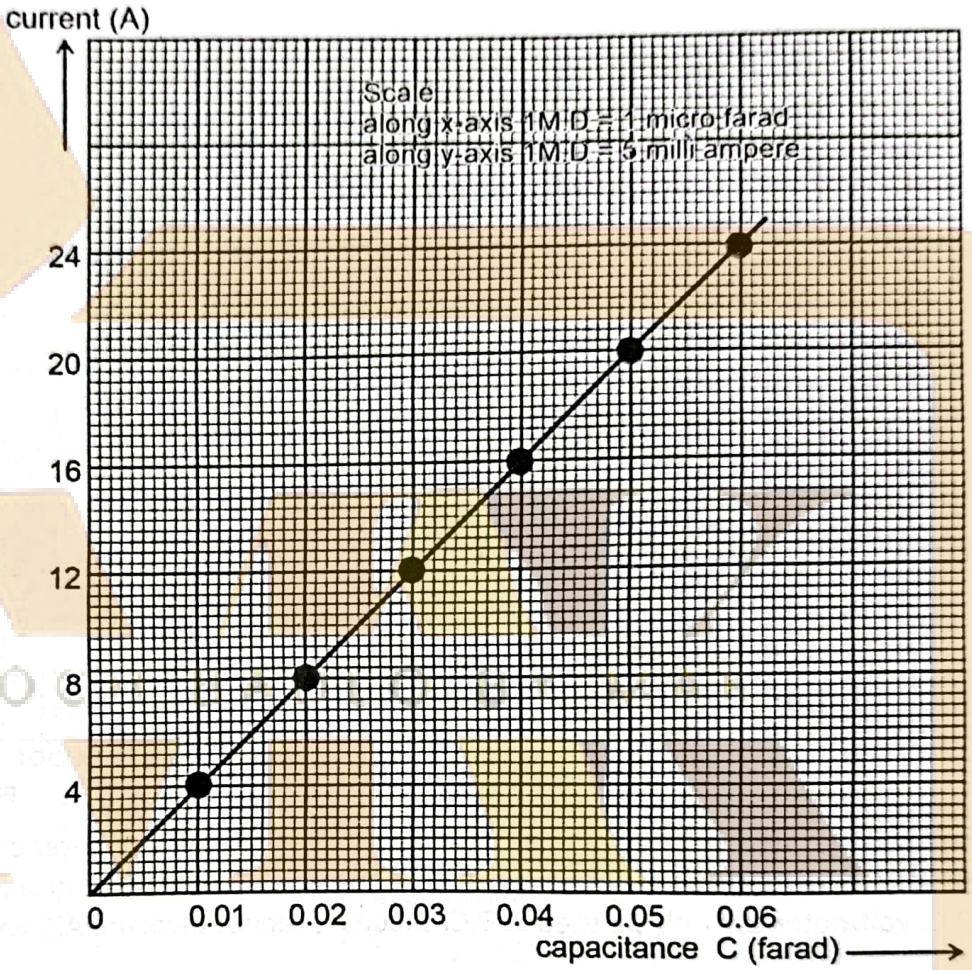
EXP-6 Determine the relation between current and capacitance when different capacitors are used in AC circuit using different series and parallel combinations of capacitors.

SOLUTION WORKSHEET – 01

Q.1 (i)

Capacity (F)	0.01	0.02	0.03	0.04	0.05	0.06
Current (A)	4	8	12	16	20	24
I/C	400	400	400	400	400	400

ii)



iii) Graph between current -capacitance is a straight line.

iv) Slope of graph $= \frac{I}{C} = \frac{24}{0.06} = 400$

Slope of graph is constant.

When capacitance increases then current increases.

v)

$$X_c = \frac{1}{2\pi fC}$$

$$f = \frac{1}{2\pi X_c C}$$

$$= \frac{1}{2 \times 3.142 \times 3185 \times 1 \times 10^{-6}}$$

$$f = 50 \text{ Hz}$$

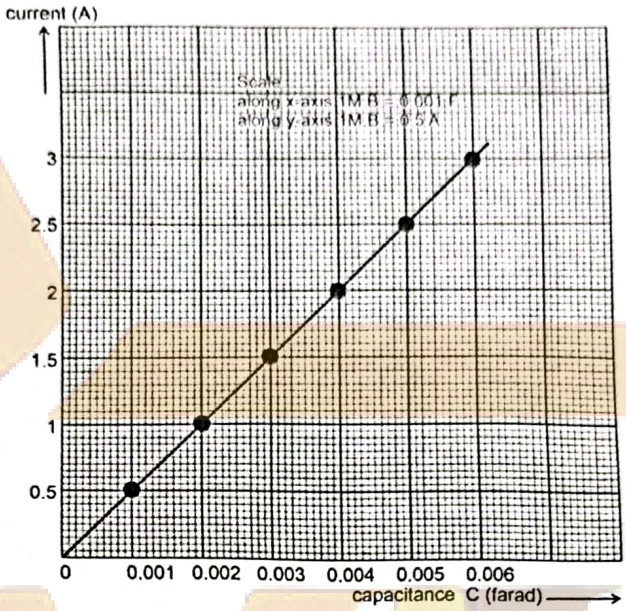
SOLUTION WORKSHEET – 02

Q.1

(i)

Capacity (farad)	0.001	0.002	0.003	0.004	0.005	0.006
Current (ampere)	0.5	1	1.5	2	2.5	3
I/C (A/F)	500	500	500	500	500	500

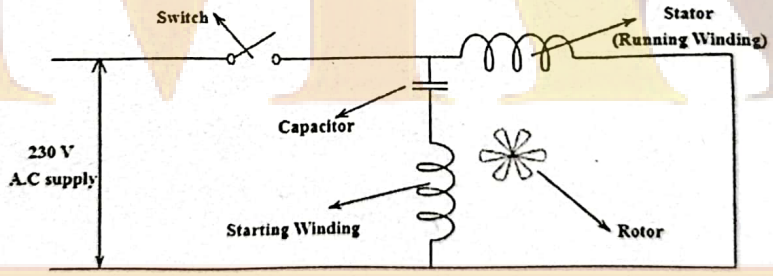
ii)



iii) Graph between current -capacitance is a straight line which shows that current increases with increase in capacitance.

iv) When capacitors are connected in series with voltage source then charge stored in the capacitors is same and potential difference across different capacitors is different.

v) The circuit arrangement of electrical fan have one switch, one starting winding and one running winding and stator, one capacitor serially connected with starting winding.



To create magnetic rotation in a fan, a capacitor is used. The capacitor is serially connected to the starting winding, causing a phase difference in the current between the two windings. This creates a magnetic flux, causing the fan's rotor to rotate.

vi) SI unit of capacitance is farad.

$$farad = \frac{coulomb}{volt}$$

$$\text{farad} = \frac{c}{J/c} = \frac{c^2}{J}$$

$$\text{farad in terms of base unit} = \frac{(As)^2}{kg\ m^2\ s^{-2}}$$

$$\text{Base unit of capacitance} = kg^{-1}\ m^2\ s^4\ A^2$$

$$\text{Dimensions of capacitance} = [C] = [M^{-1}L^{-2}T^4A^2]$$

EXP-1 Determine time constant by charging and discharging a capacitor through a resistor

SOLUTION WORKSHEET – 01

Q.1

$V = V_o(1 - e^{-t/RC})$ ... (1)

i)

$\Rightarrow$ As $t = 1$ RC and $V_o = 12$ V (Given)

$\Rightarrow$ Eq.1 becomes $V = V_0 (1 - e^{-RC/RC}) = 12(1 - e^{-1})$

$\Rightarrow$ $V = 12(0.632) = 7.58$ V

$Q = CV = 1000 \times 10^{-3} \times 7.58 = 7.58 \times 10^{-3}$ C

ii)

$V = V_o(e^{-t/RC})$ ... (1)

$\Rightarrow$ As $t = 2$ RC and $V_o = 12$ V (Given)

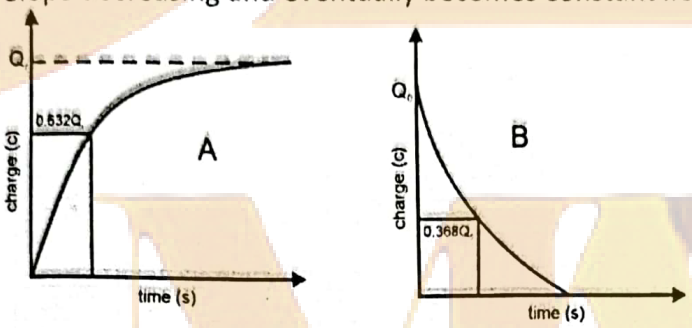
$\Rightarrow$ Eq.1 becomes $V \Rightarrow V_o(e^{-2RC/RC}) = 12(e^{-2}) = 12(0.135)$

$\Rightarrow$ $V = 1.6$ V

iii) $T = RC = 10 \times 10^3 \times 1000 \times 10^{-6} = 10$ S

iv The charging curve for a RC charging circuit is exponential

v) Slope decreasing and eventually becomes constant i.e. saturation



SOLUTION WORKSHEET – 02

Q.2 (i) Maximum voltage is 7 V

ii) $V = V_o e^{-t/RC}$ ... (1)

$\Rightarrow$ As $t = 3$ RC and $V_o = 7$ V (Given)

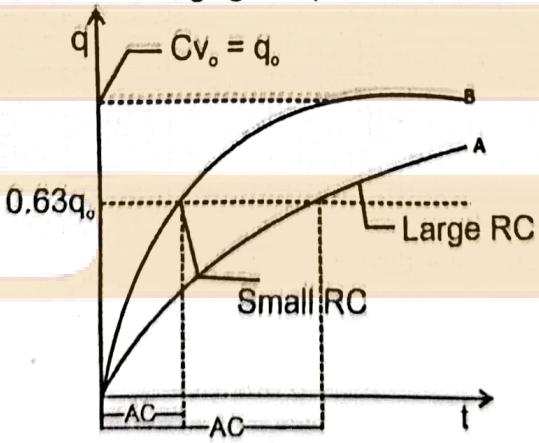
$\Rightarrow$ Eq.1 becomes $V = V_o(e^{-3RC/RC}) = 7(e^{-3}) = 7(0.05)$

$\Rightarrow$ $V = 0.35$ V

iii) $t = 5 \times 10^3 \times 2 \times 10^{-6} = 0.01$ s

iv Graph B shows the discharging of capacitor.

(v)



Graph B shows faster charging of a capacitor because its time constant ic smaller.

EXP-2 Investigate the relationship between current passing through a tungsten filament lamp and the potential applied across it.

SOLUTION WORKSHEET – 01

Q.1

(i)

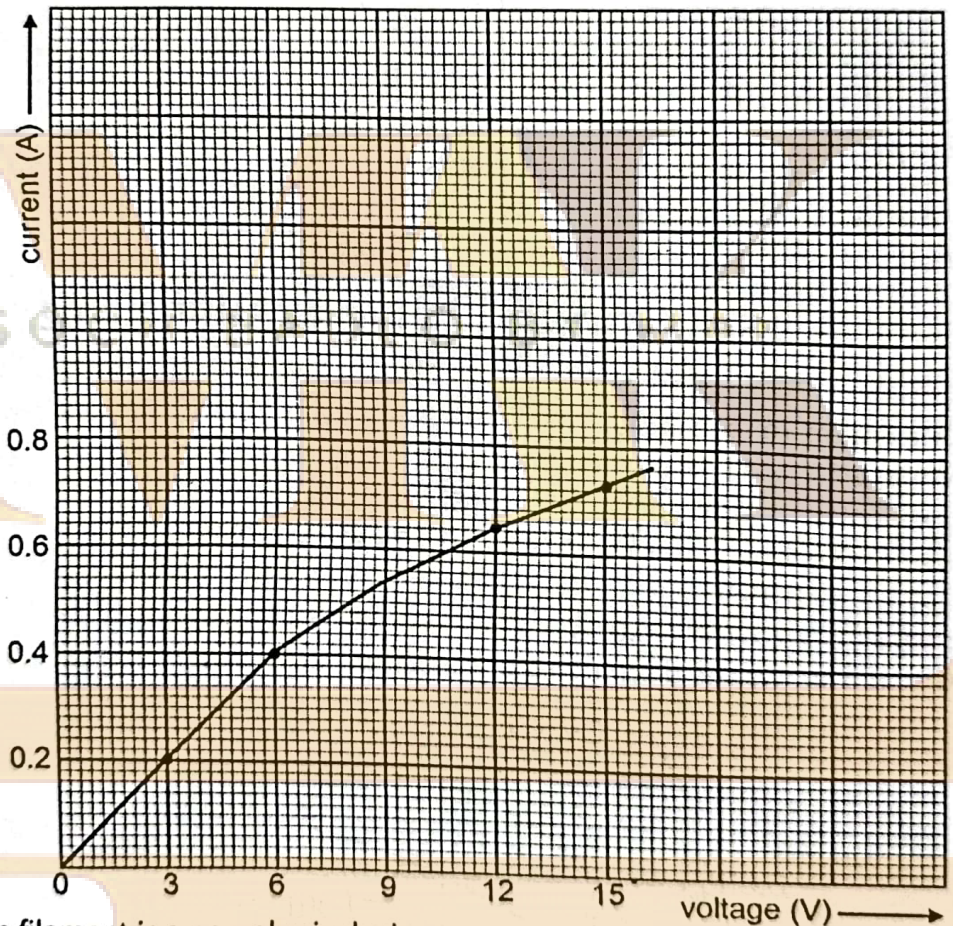
- 24 volt battery
- bulb (18 V, 1A)
- voltmeter
- high resistance rheostat
- ammeter
- connecting wires.

ii)

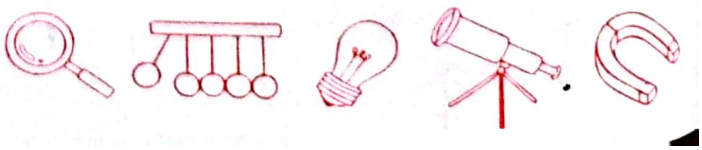
No. of Obs.	Ammeter Reading I (ampere)	Voltmeter Reading V (volt)	V/I
1	0	0	
2	0.23	03	13
3	0.42	06	14.24
4	0.53	09	16.98
5	0.65	12	18.46
6	0.71	15	21.13

iii) In a typical experiment, **voltage** is often the independent variable, and **current** is the dependent variable.

iv)



v) Tungsten filament is a non-ohmic device



SOLUTION WORKSHEET – 02

Q.1

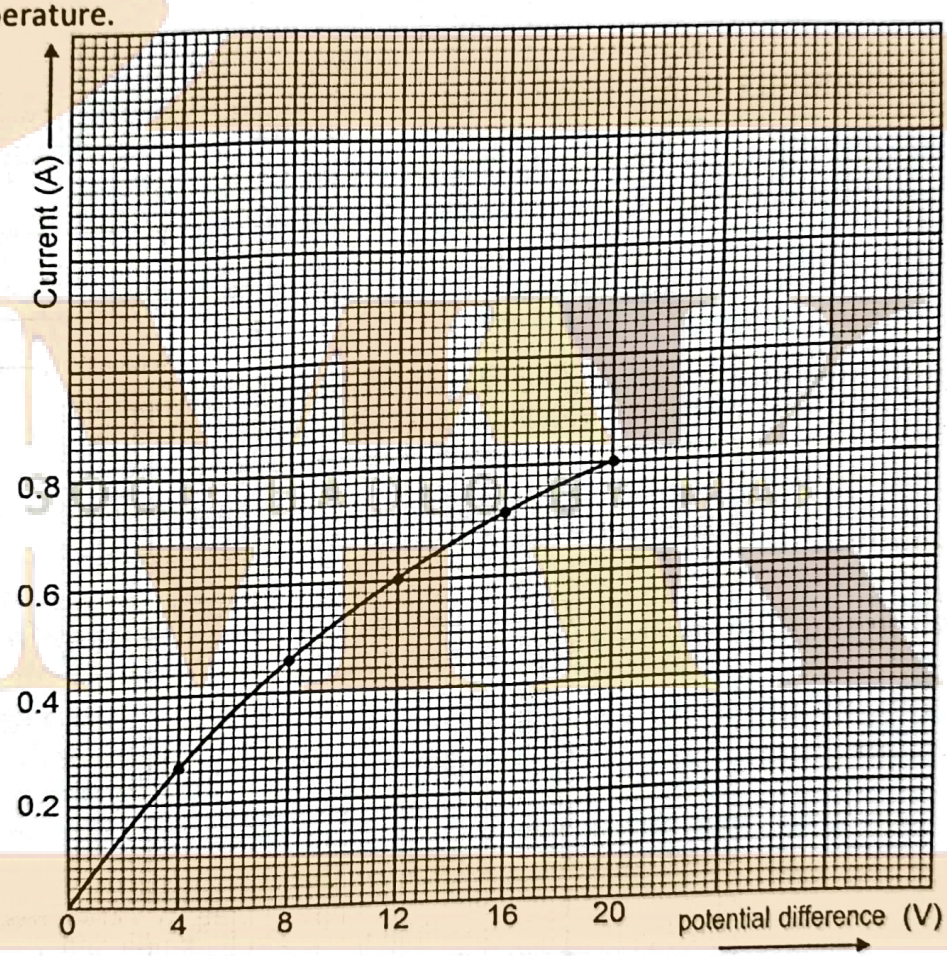
(i)

No. of Obs.	Ammeter Reading I (ampere)	Voltmeter Reading V (volt)	R= V/I
1	0	0	
2	0.33	04	12.12
3	0.47	08	17
4	0.59	12	20.34
5	0.70	16	22.86
6	0.79	20	25.32

ii) Resistance is variable and with rise in temperature, it increases.

iii) It is a non-ohmic device because the resistance is not constant and increases with rise in temperature.

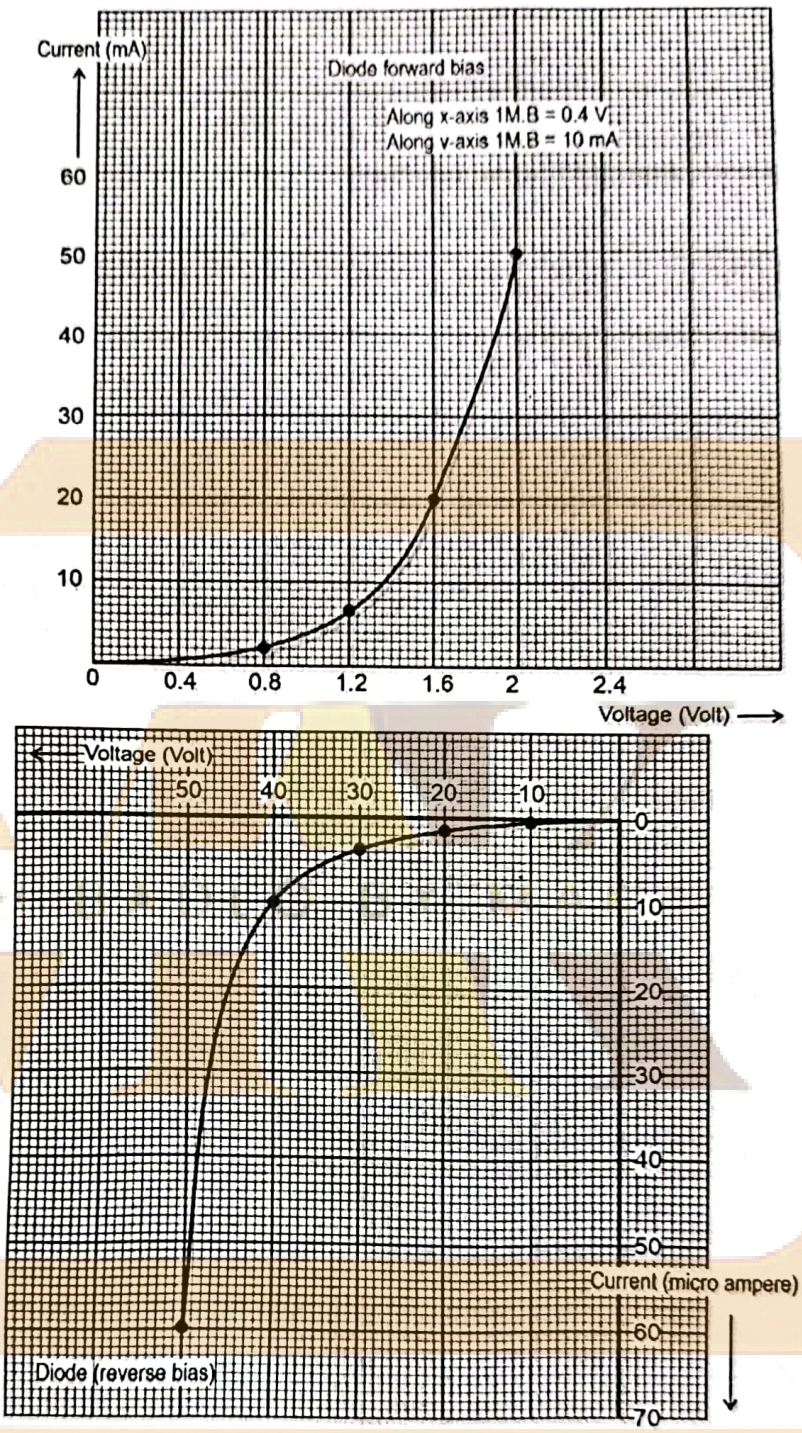
iv)



EXP-3 Draw characteristics of semiconductor diode and calculate forward and reverse current resistances.

SOLUTION WORKSHEET – 01

Q.2
(i)



ii. During reverse biasing of diode depletion layer width increases, hence resistance increases.

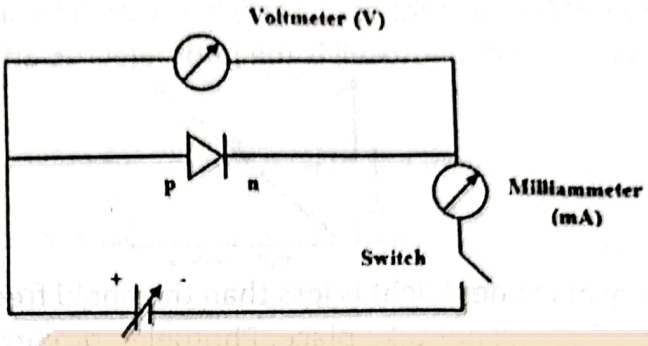
iii. Resistance is smaller in forward biasing as compared to reverse biasing of diode; therefore, forward bias current is larger than reverse bias current.

iv. The reverse current saturates because it is limited due to small and constant number of thermally generated minority charge carriers in the depletion region of the diode under reverse bias conditions.

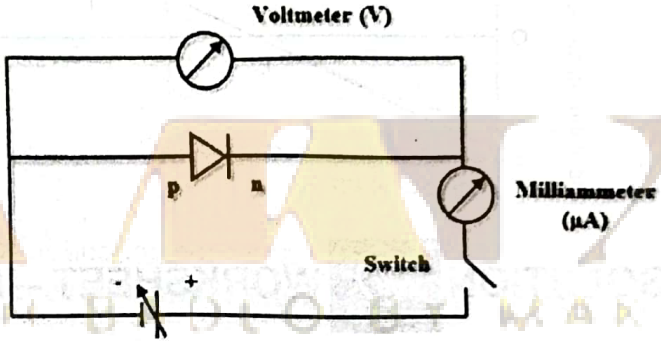
Q.2 A semi-conductor diode

i.
- milliammeter
- voltmeter
- rheostat
- key
- battery
- connecting wires

ii. The circuit arrangement for studying V-I characteristics of a p-n junction diode in forward bias is given below.



The circuit arrangement for studying V-I characteristics of a p-n junction diode in reverse bias is given below.



iii. Majority charge carriers are responsible for the current flow i.e. electrons in N-region and holes in P-region during forward bias of PN-junction.

iv. Reverse current flows due to minority charge carriers and resistance of diode is very high (mega ohm) during reverse bias. Forward bias current flows due to majority charge carriers and resistance is low. Therefore, reverse current is very small than forward current.

v. Diode is a non-ohmic device because its resistance is not constant and graph between I-V is not a straight line.

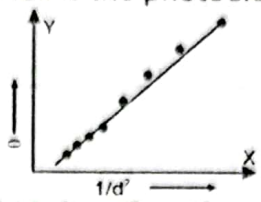
EXP-4 Study of the variation of electric current with intensity of light using a photocell

SOLUTION WORKSHEET – 01

Q.2 i. Photo-electric cell, sensitive ammeter or galvanometer, battery, rheostat, key, electric bulb and meter rod

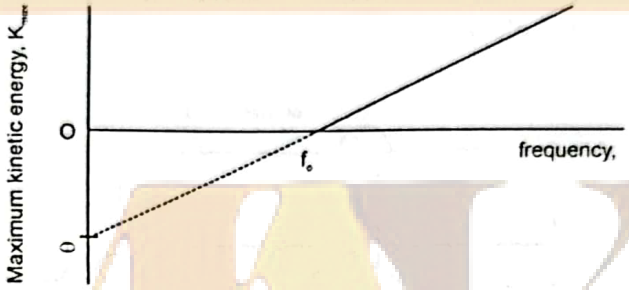
ii. Yes, the slope will be constant as the graph is a straight line

iii. The working principle of photocell is the photoelectric effect.



iv. If the frequency of incident light is less than threshold frequency then photoelectric effect will not take place. Photoelectric current will be zero.

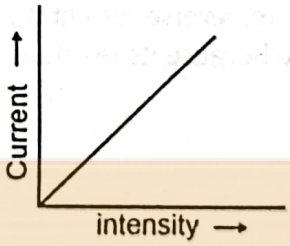
v.



SOLUTION WORKSHEET – 02

Q.2 i. • Photo-electric cell • sensitive galvanometer • battery • rheostat • key • electric bulb

ii. Photoelectric current is directly proportional to intensity of light. It increases with increase in intensity of light.



iii. As the same current flows in series circuit therefore micro-Ammeter is connected in series with photocell for accurate measurement of photoelectric current.

iv. If frequency of light is greater than threshold frequency but number of photons falling on the photocell is same then photoelectric current remains same. The extra energy is taken up by electrons as kinetic energy.

v. If the distance between the source of light and photocell is increases, the intensity of light decreases and the microammeter reading will decrease because photoelectric current decreases.

EXP-5 Analyse the variation of resistance of thermistor with temperature

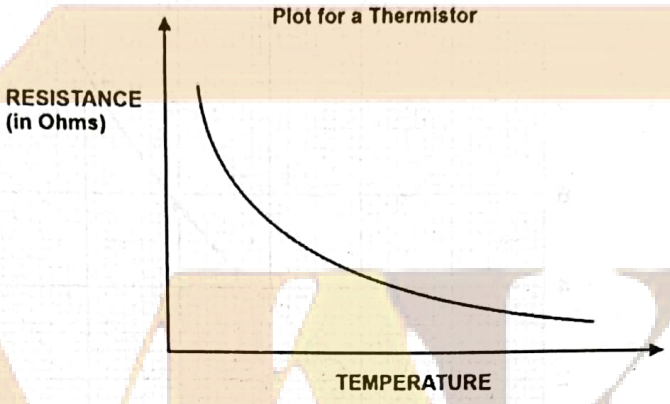
SOLUTION WORKSHEET – 01

Q.2

i. (1) Thermistor (2) battery (3) key (4) Rheostat
(5) Voltmeter (6) Milli-ammeter (7) Thermometer (8)Connecting wires
(9) Heating arrangement

ii. Resistance increases for thermistor with rise in temperature which have positive temperature co-efficient (PTC) .
And resistance decreases for thermistor with rise in temperature which have negative temperature coefficient (NTC).

iii. (a) Thermistor have NTC because resistance decreases as temperature increases.
(b)



iv. Burner can be used for heating purposes.

v. No, it's resistance varies with temperature, so it is non- ohmic device.

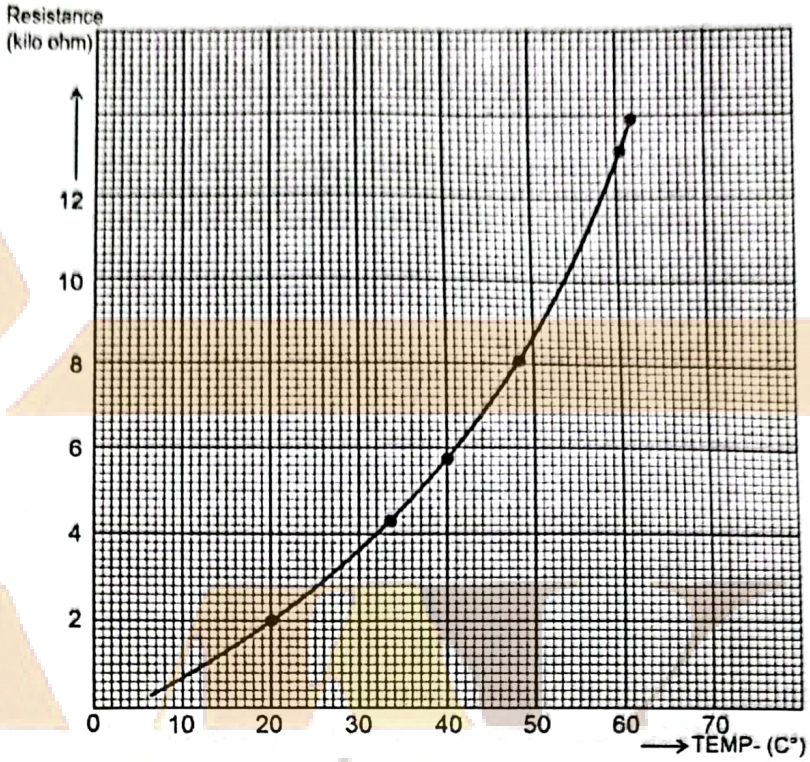
SOLUTION WORKSHEET – 02

Q.2

i. No, it's a non-ohmic device, so resistance is not constant Because its resistance changes with rise in temperature.

ii. The resistance of PTC thermistor increases with increases in temperature.

iii. **(a)**



Slope is variable as it's a non-ohmic device.

iv. They are used for temperature control and measurements.

A thermistor with **positive temperature** co-efficient of resistance (PTC) generally used for fuse purpose.

- as overcurrent protection devices.
- used as heater in automobile industry to provide additional heat inside cabin with diesel engine to heat diesel in cold climatic condition before engine injection.
- NTC are used in Modern appliances, communication tools and accessories like mobile phones, computers, LCD displays, CPUs, rechargeable batteries, and medical and patient monitoring equipment.
- A thermistor with a negative temperature co-efficient (NTC) can be used to start an alarm when temperature of winding of motors, transformers and generators increases.
- Refrigerators and freezers, as well as small appliances like hair dryers, curling irons, ovens, toasters, thermostats, air conditioners and fire alarms also have NTCs for temperature control.
- A thermistor with a negative temperature co-efficient (NTC) is used to low-temperature measurements of the order of 10 K.