SHIKSHA CLASSES

Subject : Physics **BOARD ANSWER PAPER** **Total Marks : 20**
Class : XII **Topic: 9. Current Electricity**

Section (A)

Q.1 : A) Select and write the most appro priate answer from given alternatives in each sub-question [5]

1) Kirchhoff's current law is in accordance with the law of conservation of

Ans. : c) Charge

2) The least number of cells each of emf 2.0 V and internal resistance 0.5 ohm to produce current of a 2 A in an external resistance 4.0 ohm will be.

Ans. : c) 8 cells

$$1 = \frac{nE}{nr + R}$$

$$2 = \frac{n \times 2}{n(0.5) + 4}$$

$$n(0.5) + 4 = \frac{2n}{2}$$

$$n(0.5) + 4 = n \qquad 0.5n + 4 = n$$

$$n - 0.5n = 4 \qquad n(1 - 0.5) = 4$$

$$n0.5) = 4 \qquad n = \frac{4}{0.5} = 8 \text{ cells}$$

3] In meter bridge experiment, to minimize the error due to contact resistance

Ans. : a) The null point is taken near the centre of wire

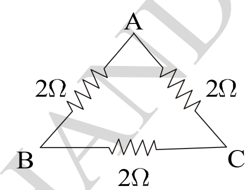
4] A potentiometer is used to measure the e.m.f. of a cell. At the null point, no current flows through

Ans. : c) Both main and cell circuits.

5) Three resistors each of 2 ohm are connected together in a triangular shape. The resistance between any two vertices will be.

Ans. : a) 4/3 ohm

equivalent resistance between B and C



$$R_{BC} = \frac{(2+2) \times 2}{2+2+2} = \frac{8}{6} = \frac{4}{3}\Omega$$

B) Very short answer type Question [2]

1] State the principle of potentiometer.

Ans.: Principle of potentiometer, "The potential difference between any two points of a potentiometer wire is directly proportional to the length of wire between these two points."

2] Internal resistance of a cell depends on which factors?

Ans. : The internal resistance of the cell depends on (i) nature of electrolyte
(ii) Temperature of Electrolyte.

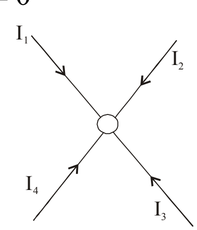
Section (B)

Q. 2. Attempt any three [6]

1] State Kirchhoff's laws.

Ans : i) **Kirchhoff's current law :** The algebraic sum of electric currents at any junction is always equal to zero.

$$\sum I = 0$$



$$I_1 + I_2 + I_4 - I_3 = 0$$

ii) **Kirchhoff's voltage law :** In a closed loop of electrical network, the algebraic sum of potential differences for all components plus the algebraic sum of all emfs is equal to zero. $\sum E + \sum IR = 0$.

2. A galvanometer has a resistance of 50 ohm and its full scale of deflection current is 50 µA. What resistance should be added to it to have a range of 0-10 V?

Ans : **Given :** 50Ω

maximum voltage to be measured is

V = 10 volt

The resistance to be added in series

$$X = \frac{V}{I_G} - G = \frac{10}{50\times10^{-6}} - 50$$

$$= X + 50 = \frac{10}{50\times10^{-6}}$$

$$X + 50 = 0.2\times10^{6}$$

$$X + 50 = 200\times10^{-3}\times10^{6}$$

$$X + 50 = 200\times10^{3}$$

$$X = (200-50)\times10^{3}$$

$$\boxed{X = 150\times10^{3}\Omega}.$$

3] State any two sources of errors in meter bridge experiment and how to minimize it.

Ans : i) If the wire is not uniform, the resistance per unit length will not be same everywhere. So, there will be an error in the value of unknown resistance.

ii) The points where the wire is joined to the copper strips, the contact resistance is developed which produces an error in the value of unknown resistance X.

Minimisation of the error :

i) The wire must be uniform and should have same cross-sectional area throughout the length.

ii) The value of resistance from the resistance box should be chosen such that the null point is near the centre of the wire, i.e. between 35 cm and 65 cm.

iii) The experiment should be repeated by interchanging the resistance in left and right gaps.

iv) The ends of the wire must coincide with 0 and 100 cm mark on the meter scale.

4] The e.m.f. of a cell is 2V. It balances the length of 250 cm of a potentiometer wire when it is in open circuit. When it is shunted by a resistance of 4 Ω, the balancing length is reduced by 50 cm. Calculate the internal resistance of cell.

Ans : reduced length = 250 – 50

= 200 cm

= 2 m

1) $$r = R\left(\frac{l_1}{l_2} - 1\right) = 4\left(\frac{2.5}{2.0} - 1\right)$$

$$r = 4\left(\frac{2.5-2.0}{2.0}\right)$$

$$r = 4\left(\frac{0.5}{2.0}\right) = 1\Omega.$$

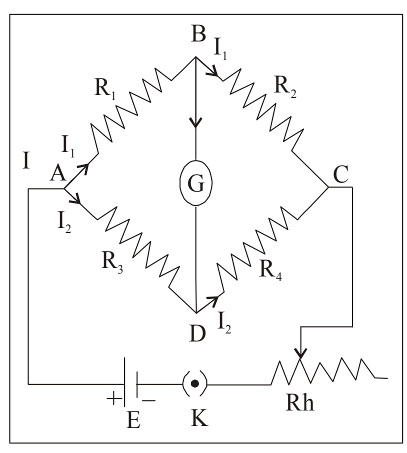
Section (C)

Q. 3. Attempt any one **[3]**

1. Obtain the condition for balanced Wheatstone's network.

Ans : A simple circuit devised by Wheatstone for determining unknown resistance is called Wheatstone's network.

It consists of four resistances R_1, R_2, R_3 and R_4 along the four arms of a quadrilateral ABCD.



A cell E, key K and rheostat are connected between A and C in series.

A galvanometer is connected between B and D.

Resistances R_1 , R_2 , R_3, and R_4 are selected such that potential at B is equal to potential at D. The galvanometer gives zero deflection and the network is said to be balanced.

To derive the condition for balanced bridge.

Applying Kirchhoff's voltage law to loop ABDA,

$-I_1 R_1 - I_g G + I_2 R_3 = 0$

For a balanced bridge, $I_g = 0$.

$O \times I_g = 0$

$\therefore \quad -I_1 R_1 = -I_2 R_3$

$\therefore \quad I_1 R_1 = I_2 R_3 \quad ...... (1)$

Applying Kirchhoff's voltage law to loop BCDB,

$-I_1 R_2 + I_2 R_4 + I_g G = 0$

For a balanced bridge, $I_g = 0$.

$O \times I_g = 0$

$\therefore \quad -I_1 R_2 = -I_2 R_4$

$\therefore \quad I_1 R_2 = I_2 R_4 \quad ...... (2)$

Dividing equation (1) by equation (2)

$$\therefore \quad \frac{I_1 R_1}{I_1 R_2} = \frac{I_2 R_3}{I_2 R_4}$$

$$\therefore \quad \frac{R_1}{R_2} = \frac{R_3}{R_4}$$

If any three resistances are known, we can determine the fourth resistance. This is called balancing condition.

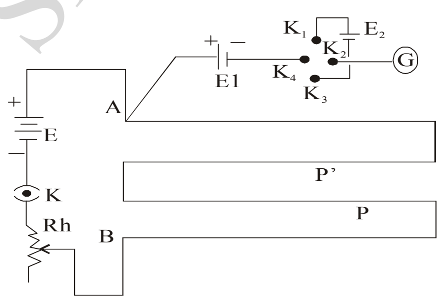
$$\therefore \quad \frac{R_1}{R_2} = \frac{R_3}{R_4}$$

If any three resistances are known, we can determine the fourth resistance.

This is called balancing condition.

2] Explain the use of potentiometer to compare the e.m.f.s of two cells by sum and difference method.

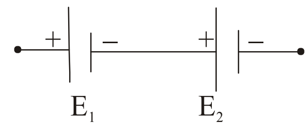
Ans : **Circuit diagram :**



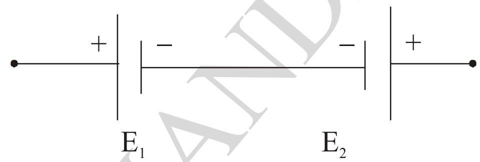
Connect the circuit according to the circuit diagram.

Close the key K to pass the current through potentiometer wire. A potential gradient is developed across the wire.

When K_1 and K_3 are closed, the cells E_1 and E_2 assist each other. When K_2 and K_4 are closed E_1 and E_2 oppose each other.



Effective e.m.f. = $E_1 + E_2$ Cells assisting each other



Effective e.m.f. = $E_1 - E_2$ Cells opposing each other close the keys K_1 and K_3 and touch the jockey at different points of the wire to obtain null deflection. Let the balancing length AP=L_1.

$$E_1 + E_2 = I\sigma L_1 \quad ..... (1)$$

σ = resistance per unit length of wire close the keys K_2 and K_4 and find the balancing length AP' = L_2.

$$E_1 - E_2 = I\sigma L_2 \quad ...... (2)$$

Dividing equation (1) by equation (2),

$$\frac{E_1 + E_2}{E_1 - E_2} = \frac{I\sigma L_1}{I\sigma L_2} = \frac{L_1}{L_2}$$

Using componendo and dividendo,

$$\frac{E_1 + E_2 + E_1 - E_2}{E_1 + E_2 - E_1 + E_2} = \frac{L_1 + L_2}{L_1 - L_2}$$

$$\therefore \; \frac{2E_1}{2E_2} = \frac{L_1 + L_2}{L_1 - L_2} \qquad \therefore \; \frac{E_1}{E_2} = \frac{L_1 + L_2}{L_1 - L_2}$$

Knowing L_1 and L_2, the e.m.f.s of two cells can be compared.

Section (D)

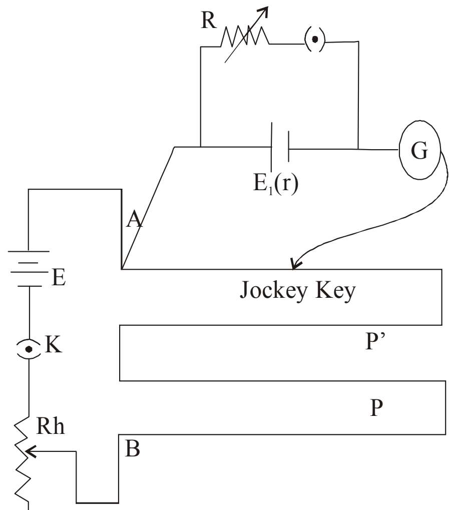
Q. 4. Attempt any one **[4]**

1) a. Explain the use of potentiometer to determine the internal resistance of a cell.

Ans : The potentiometer wire is connected in series with battery of e.m.f. E, key K and rheostat

Rh in order to establish a current in the circuit so that a potential gradient is developed across the wire.

Circuit diagram :



E–battery

Positive terminal of E_1 is connected at A and negative terminal is connected to galvanometer and then to the jockey. A resistance box (R) in series with key K_1 is connected in parallel with the cell of E_1 whose internal resistance is to be determined.

Connect the circuit as per the circuit diagram. Close the key K to establish current and potential gradient along the wire.

Keep the key K_1 open and touch the jockey at different points of the potentiometer wire and find a point at which galvanometer shows null deflection. Let the balancing length AP = 1_1 .

$\because$ no current is flowing through the cell,

$\therefore E_1 = I\sigma 1_1$ .... (1)

Close key K_1 and take some suitable resistance from resistance box. Find the balancing length AP' = 1_2

$\because$ The current is flowing through the cell, through R, $\therefore$ terminal potential difference of the cell balances the potential difference across length 1_2 .

$V = I\sigma 1_2$ ...... (2)

Divide equation (1) by (2) $\frac{E_1}{V} = \frac{1_1}{1_2}$ ....(3)

Let the internal resistance of cell be r.

$\therefore$ Current through $R = \frac{E_1}{R+r}$

$\therefore$ Terminal potential difference V = IR.

$$V = \frac{E_1 R}{R+r}$$

$$\therefore \frac{E_1}{V} = \frac{R+r}{R} \quad .... (4)$$

Form equations (3) and (4)

$\therefore$ $R1_2 + r1_2 = R1_1$

$\therefore$ $r1_2 = R1_1 - R1_2 = R(1_1 - 1_2)$

$$\therefore r = \frac{R(1_1 - 1_2)}{1_2}$$

$$\therefore r = R\left[\frac{1_1}{1_2} - 1\right] \quad \therefore r = R\left[\frac{E}{V} - 1\right]$$

Using equation (5), knowing the value of R, 1_1 and 1_2, the internal resistance of cell (r) can be determined.

b. A potentiometer wire of length 4 m has a resistance of 4Ω. What resistance must be connected in series with the wire and a battery of e.m.f. 2V so as to get a potential drop of 100 μV / *mm* along the wire?

Ans : Given : L = 4m, E = 2V, R = 4Ω , r_c = 2Ω

To find : R_1 = ?

Solu^n : Potential drop $= \frac{V}{L} = 100\mu V / mm$

per unit lenght

$$= \frac{100 \times 10^{-6}}{10^{-3}} = 10^{-4+3} = 10^{-1} = 0.1 \text{ V/m}$$

Let R_1 be the resistance connected in series for which the desired P.D. is obtained.

The current in the circuit is

$$I = \frac{E}{R + r_c + R_1} = \frac{2}{4 + 2 + R_1}$$

The potential drop across the wire is

$$V = Ir = \frac{2}{(6 + R_1)} \times 4$$

$$V = \frac{8}{(6 + R_1)}$$

Potential drop per meter of the wire

$$\frac{V}{L} = \frac{8}{4(6+R_1)} = \frac{2}{6+R_1}$$

$$0.1 = \frac{2}{6+R_1}$$

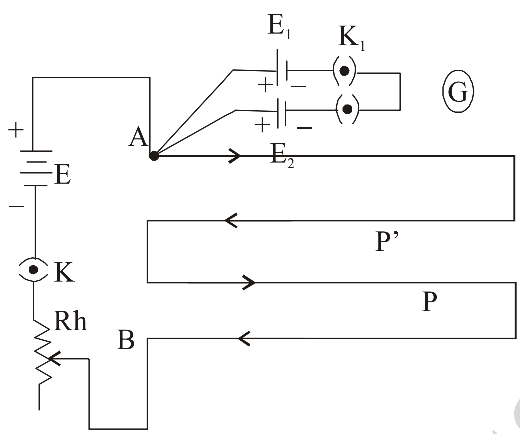
$6 + R_1 = 20$

$\therefore$ $R_1 = 14\Omega$.

OR

2) a. Explain the use of potentiometer to compare the e.m.f.s of two cells by connecting them individually.

Ans : **Circuit diagram :**



Connect the circuit as per the circuit diagram. Close the key k and pass a current through the potentiometer wire so that a potential gradient is established in the circuit.

The positive terminal of E_1 and E_2 are connected at A, where the positive terminal of battery E is connected. Negative terminals of E_1 and E_2 are connected to keys K_1 and K_2 respectively. The com mon terminal of K_1 and K_2 is connected to galvanometer and them to the jockey.

Close the key K_1 and touch the jockey at different points of the wire and find a point at which galvanometer shows null deflection. Let AP be balancing length = l_1

$\because$ no current is flows through the cell,

$\therefore$ E_1 = potential difference across AP.

$\therefore$ $E_1 = I\sigma l_1$ .... (1)

σ = resistance per unit length.

Remove K_1 and close K_2 and again find the balancing length. Let AP' = l_2.

$E_2 = I\sigma l_2$ ....(2)

Dividing equation (1) by equation (2),

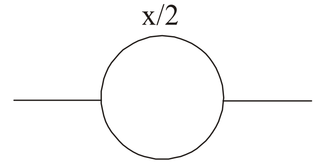
$$\frac{E_1}{E_2} = \frac{I\sigma l_1}{I\sigma l_2}$$

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

Knowing l_1 and l_2 , comparison of e.m.f.s of two cells $\frac{E_1}{E_2}$ can be calculated.

b. A wire of uniform cross-section is bent in the shape of a ring. Two diametrically opposite points on the wire are connected in the left gap of a meter bridge. In the right gap, a resistance of 15Ω is introduced. If the null point is obtained at 70 cm from the left end of the meter bridge wire, find the resistance of the wire of the ring.

Ans : $$\frac{1}{R_p} = \frac{1}{x/2} + \frac{1}{x/2} = \frac{2}{x} + \frac{2}{x} = \frac{4}{x}$$



$R_p = \frac{x}{4}$ by conecting R_p in left gap and in

Right gap contain R = 15Ω then,

$$\frac{R_p}{R} = \frac{l_x}{100 - l_x}$$

$$\frac{\frac{x}{4}}{15} = \frac{70}{30}$$

$$\frac{x}{60} = \frac{70}{30}$$

X = 140Ω.

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