PHYSICS

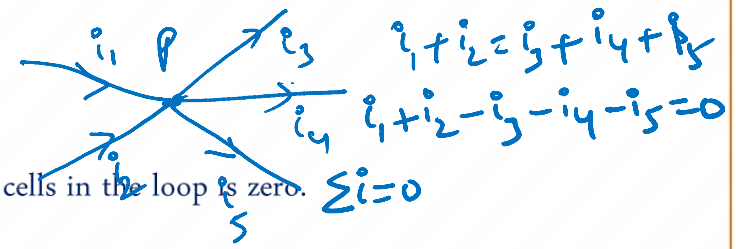
CURRENT ELECTRICITY

1) State Kirchhoff's law for an electrical network. Using these laws deduce the condition for balance in a Wheatstone bridge.?

A) Kirchhoff's First law :

At any junction the sum of the currents entering the junction is equal to the sum of currents leaving the junction.

$$\sum i = 0$$



Kirchhoff's second law :

The algebraic sum of charges in potential around any closed loop involving resistors and cells in the loop is zero.

$$\sum v = 0$$

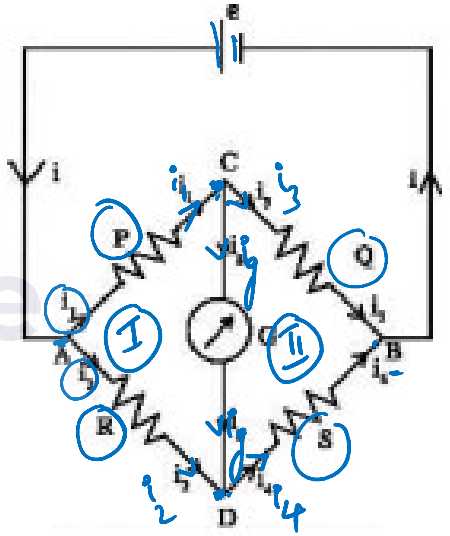
Wheat stone bridge :-

From kirchhoff's I^{st} Law at Junction 'C'

$$I_1 = I_g + I_3 \quad \text{——— (1)}$$

From kirchhoff's I^{st} Law at Junction 'D'

$$I_2 + I_g = I_4 \quad \text{——— (2)}$$



From kirchhoff's IInd law for loop 'ACDA'

$$I_1P + I_gG = I_2R \quad \text{——} (3)$$

From kirchhoff's IInd law for loop 'CBDC'

$$I_3Q = I_4S + I_gG \quad \text{——} (4)$$

What strone bridge is said to be balanced when $I_g = 0$

From equation (1) $I_1 = I_3$

From equation (2) $I_4 = I_2$

From equation (3) $I_1P = I_2R$ —— (5)

From equation (4)

$I_3Q = I_4S$ —— (6)

$$\frac{\text{equation (5)}}{\text{equation (6)}} = \frac{I_1P}{I_3Q} = \frac{I_2R}{I_4S}$$

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

8M

2) State the working principle of potentiometer. Explain with the help of circuit diagram how the emf of two primary cells are compared by using the potentiometer ?

A) Principle of potentiometer :-

The potential difference across any portion of the wire is directly proportional to the length of that portion.

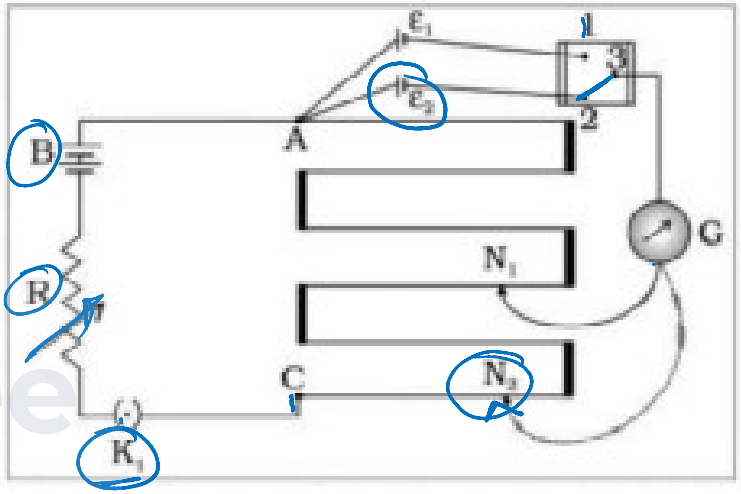
$$V \propto l$$

$$V = \phi l$$

Comparing emf's of two cells using potentiometer :

When the first cell is brought into the circuit the balancing length is 'l_1'

then $\varepsilon_1 = \phi l_1$ ——— (1)



When the second cell is brought into the circuit the balancing length is 'l_2'

then $\varepsilon_2 = \phi l_2$ ——— (2)

equation (1) Dividing with equation (2)

$$\frac{\varepsilon_1}{\varepsilon_2} = \frac{\phi l_1}{\phi l_2}, \qquad \boxed{\frac{\varepsilon_1}{\varepsilon_2} = \frac{l_1}{l_2}}$$

3) State the working principle of potentiometer. Explain with the help of circuit diagram how the potentiometer is used to determine the internal resistance of the given primary cell.?

A) Principle of potentiometer :-

The potential difference across any portion of the wire is directly proportional to the length of that portion.

$$V \propto l$$

$$V = \phi l$$

Determination of Internal resistance of a cell using potentiometer :

(i) when key k_1 is closed, k_2 open

$$\mathcal{E} = \phi l_1 \quad \text{——— (1)}$$

(ii) K_1, K_2 key are closed

$$V = \phi l_2 \quad \text{——— (2)}$$

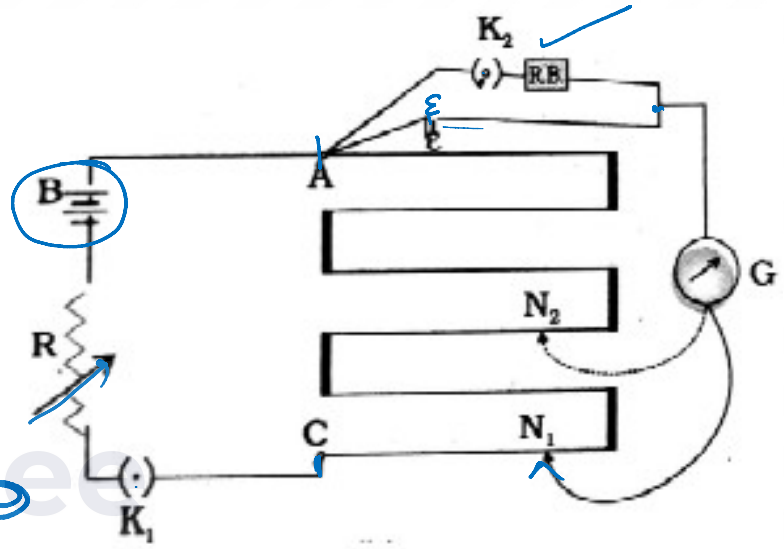
equation (1) dividing with equation (2)

$$\frac{\mathcal{E}}{V} = \frac{l_1}{l_2} \quad \text{——— (3)}$$

But $\mathcal{E} = I(r+R)$, $V = IR$

$$\frac{I(r+R)}{IR} = \frac{l_1}{l_2},$$

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



2m **4)** In a potentiometer arrangement, a cell of emf 1.25 V gives a balance point at 35.0 cm length Of the wire. If the cell is replaced by another cell and the balance point shifts to 63.0 cm, what is the emf of the second cell?

A)

$\varepsilon_1 = 1.25\ V$

$l_1 = 35\ cm$

$l_2 = 63\ cm$

$$\frac{\varepsilon_2}{\varepsilon_1} = \frac{l_2}{l_1}$$

$$\varepsilon_2 = \varepsilon_1 \left(\frac{l_2}{l_1}\right)$$

$$\varepsilon_2 = 1.25 \left(\frac{63}{35}\right)$$

$$\varepsilon_2 = 2.25\ V$$

2m **5)** A potentiometer wire is 5m long and a potential difference of 6 V is maintained between its ends. Find the emf of a cell which balances against a length of 180 cm of the potentiometer wire.

A)

$$\frac{\varepsilon_2}{\varepsilon_1} = \frac{l_2}{l_1}$$

$$\varepsilon_2 = \varepsilon_1 \left(\frac{l_2}{l_1}\right)$$

$$\varepsilon_2 = 6\left(\frac{180}{420}\right)$$

$$\varepsilon_2 = 2.16\,V$$

$\varepsilon_1 = 6\,V$

$l_2 = 180\,cm$

$l = 5m = 500\,cm$

$l_1 = l - l_2 = 500 - 180 = 420\,cm$

THANK YOU