Potentiometer

It is a versatile instrument. It is basically a long piece of wire uniform wire 5-7 m in length.

Principal A current I flows through wire which can be varied by variable resistance (R) in the circuit.

Principal: As the wire is uniform the potential difference b/w A and at any point at distance l from A is

$$\boxed{\varepsilon = \phi l} \quad \text{--- (1)}$$

ϕ → potential drop per unit length.

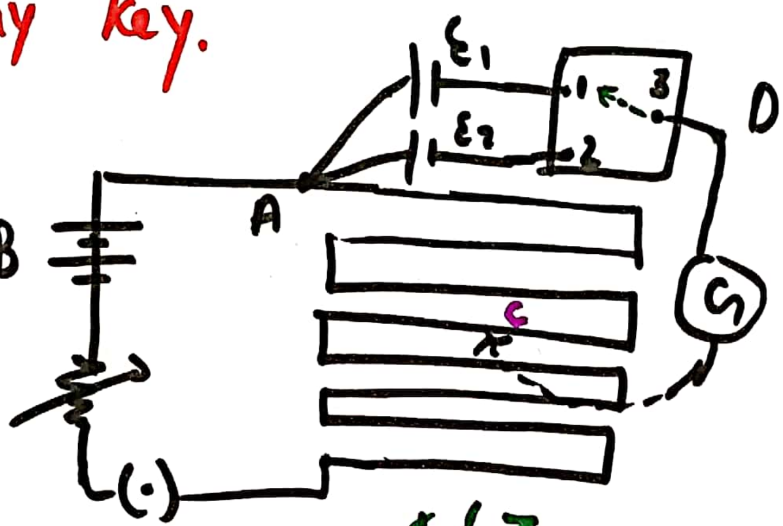
Application

(i) To compare the EMF of two alls

(ii) To measure internal resistance of cell.

I'st Application : To compare EMF of Cell.

consider a two cell of emf ε_1 & ε_2 connected to potentiometer using two way key.



let in first key 1 & 3 is connected so that Galvanometer is connected to ε_1

Let at point C there is no deflection in Galvanometer.

Apply KVL in looop ACDA

$$\varepsilon_{AC} - \varepsilon_1 = 0$$

$$\phi l_1 - \varepsilon_1 = 0 \quad \text{—— (2)}$$

Similarly for another cell, key 2 & 3 is connected & null deflection at new point C

$$\varepsilon_{AC} - \varepsilon_2 = 0$$

$$\phi l_2 - \epsilon_2 = 0 \quad \text{--- (3)}$$

Using (2) & (3)

$$\phi l_1 = \epsilon_1 \quad \text{--- (4)}$$

$$\phi l_2 = \epsilon_2 \quad \text{--- (5)}$$

(4) ÷ (5)

$$\frac{\phi l_1}{\phi l_2} = \frac{\epsilon_1}{\epsilon_2}$$

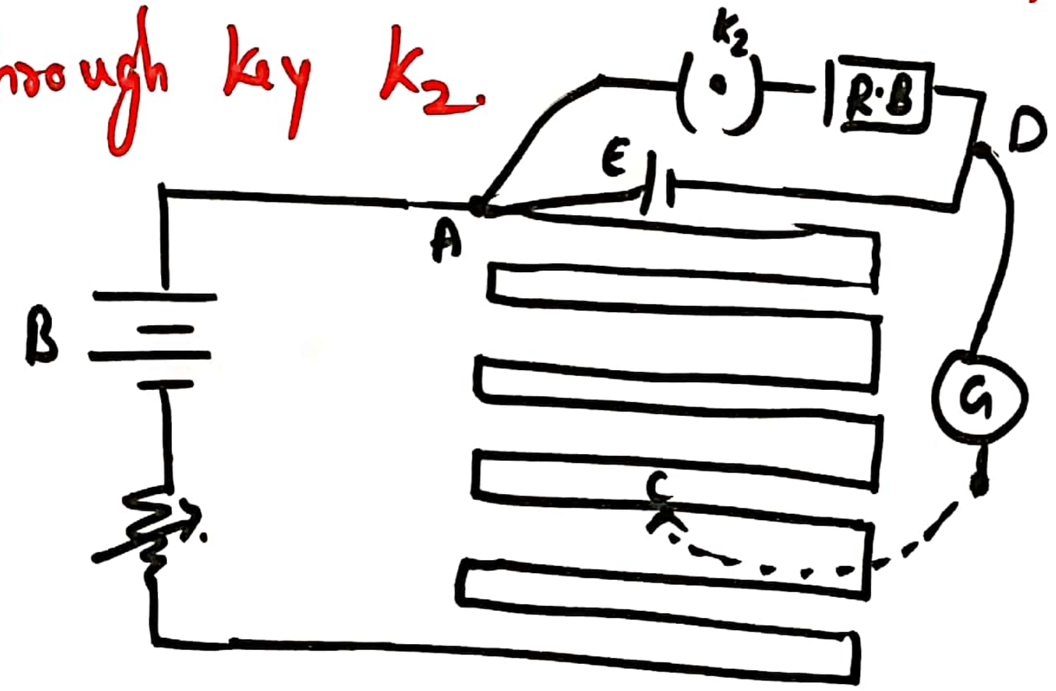
$$\boxed{\frac{\epsilon_1}{\epsilon_2} = \frac{l_1}{l_2}}$$

Comp. of emf of two cell.

If one of cell EMF is known than other cell emf can be calculated.

II Application: To measure internal resistance of cell.

Consider a cell of emf ϵ whose internal resistance (r) is unknown. is connected across resistance box through key K_2.



When key K_2 is open, balance (zero deflection) is obtained at length l_1

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

When key K_2 is closed, the cell sends a current (I) through resistance box (R). If V is terminal potential difference of cell. & balance (zero deflection) obtained at length l_2

$$V = \phi l_2 \quad \text{—— (2)}$$

① ÷ ②

$$\frac{\varepsilon}{V} = \frac{l_1}{l_2} \quad \text{— ③}$$

We know.

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

$$V = IR$$

Put in ③

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

$$rl_2 + Rl_2 = Rl_1$$

$$rl_2 = R(l_1 - l_2)$$

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

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

Where. $r \rightarrow$ internal resistance of cell

$R \rightarrow$ value of resistance from resistance box.

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