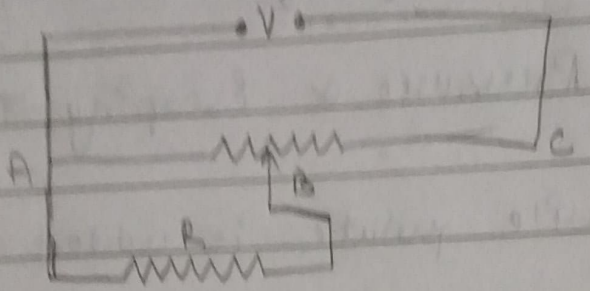
28-6-21

Home Assignment

Question

A resistance R draws current from a potentiometer of resistance R_0 as shown. Derive an expression for the voltage across R when the sliding contact is in the middle of the potentiometer wire.



➢ When the sliding contact is in middle, a resistance of $R_0/2$ is connected in series with a parallel combination of R and $R_0/2$.

Net resistance

$$R_{eq} = \frac{R_0}{2} + \frac{R_0}{2} \| R$$

Current flowing through the circuit is

$$I = \frac{V}{R_{eq}}$$

Potential across R is

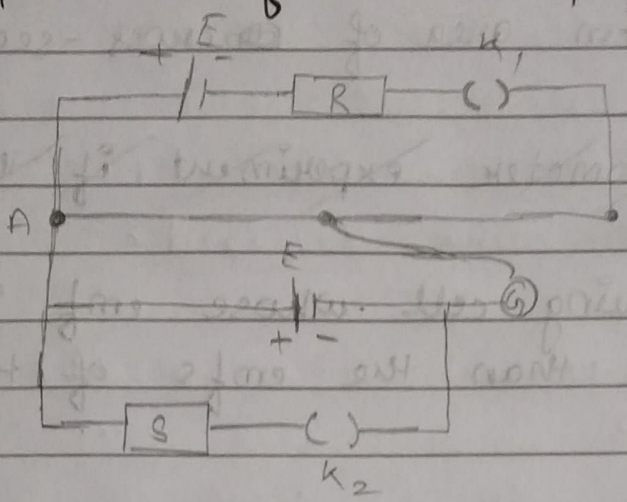
$$V_R = I\left(\frac{R_0}{2} \| R\right)$$

$$V_R = \frac{V}{R_{eq}}\left(\frac{R_0}{2} \| R\right)$$

$$V_R = \frac{R}{4R + R_0} V$$

Question

Two students X and Y perform an experiment on potentiometer separately using the circuit given below. Keeping other parameters unchanged, how will the position of the null point be affected, if



a) X increases the value of resistance R in the setup by keeping the key K_1 closed and the key K_2 open?

⇒ By increasing R the current through AB decreases, so potential gradient decreases.
Hence a greater length of wire would be needed for balancing the same potential difference.

b) Y decreases the value of resistance S in the setup, while the key K_2 remains open and then K_1 closed?

⇒ By decreasing resistance S, the current through AB remains the same, potential gradient does not change. As K_2 is open so there is no effect of S on null point.

Question

a) State the underlying principle of a potentiometer. Why is it necessary to

(i) use a long wire

(ii) have uniform area of cross-section of the wire and

(iii) In a potentiometer experiment, if the area of the cross-

(iii) use a driving cell whose emf is taken to be greater than the emfs of the primary cells?

⇒ Principle of potentiometer:

The potential drop across the length of a steady current carrying wire of uniform cross section is proportional to the length of the wire.

(i) We use a long wire to have a lower value of potential gradient i.e. a lower 'least count' or greater sensitivity of the potentiometer.

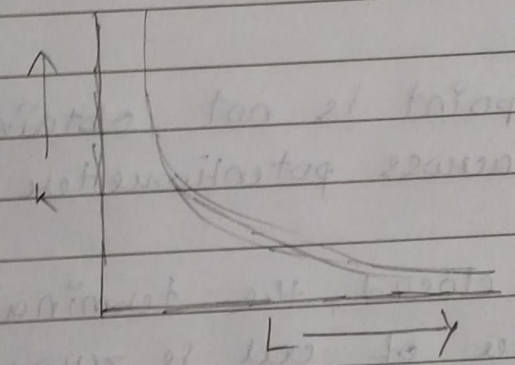
(ii) The area of cross-section has to be uniform to get a 'uniform wire' as per the principle of the potentiometer.

(iii) The emf of the driving cell has to be greater than the emf of the primary cell as otherwise no balance point would be obtained.

b) In a potentiometer experiment, if the area of the cross-section of the wire increases uniformly from one end to the other, draw a graph showing how potential gradient would vary as the length of the wire increases from one end.

⇒ Potential gradient $k = \frac{V}{L}$

∴ The required graph is as shown below.



Question

Below figure shows the circuit diagram of a potentiometer for determining the emf ε of a cell of negligible internal resistance.

a) What is the purpose of using high resistance R_2?

b) How does the position of balance point (J) change when the resistance R_1 is increased?

c) Why cannot the point be obtained,
i) when the emf $\mathcal{E}$ is greater than 2V and
ii) when the key k is closed.

a) The purpose of high resistance R_2 is to reduce the current through the galvanometer when jockey is far from balance point, this saves the galvanometer and the cell from being damaged.

b) When resistance R_1 is decreased, the potential gradient of potentiometer wire increases, so balance point (J) shifts to longer length of wire.

c) 1) The balance point is not obtained because maximum emf across potentiometer wire is 2V.

2) When key(K) is closed, the terminal potential difference of cell is zero; so balance point cannot be between A and B.