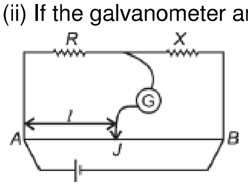
O P JINDAL SCHOOL, SAVITRINAGAR

PRACTICE PAPER (SOLUTION)

CLASS XII PHYSICS **TOPIC : CURRENT ELECTRICITY**

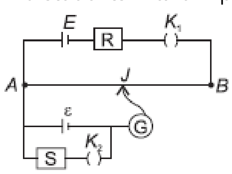
Date : 06/05/20 **MM :25**

1 In the meter bridge experiment, balance point was observed at *J* with *AJ* = *l*.
(i) The values of *R* and *X* were doubled and then interchanged. What would be the new position of balance point?
(ii) If the galvanometer and battery are interchanged at the balance position, how will the balance point get affected? 2



ANS: (i) Here, $\frac{R}{X} = \frac{l}{100-l}$
As on doubling the values of *R* and *X*, the ratio does not change and the balance point remains same.
(*ii*) As the ratio of resistors does not change, the balance point again remains same.

2 Two students *X* and *Y* perform an experiment on potentiometer separately using the circuit given below. 2



Keeping other parameters unchanged, how will the position of the null point be affected if
(i) *X* increases the value of resistance *R* in the set-up by keeping the key K_1 closed and the key K_2 open?
(ii) *Y* decreases the value of resistance *S* in the set-up, while the key K_2 remains open and the key K_1 closed.

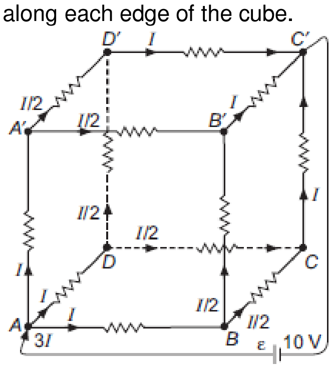
ANS: (i) Current through a potentiometer wire decreases. Thus, potential gradient decreases. As $k = \frac{V}{l}$, with the decrease in potential gradient, the balancing length increases, i.e. null point will shift towards *B*.
(*ii*) Current through a potentiometer wire remains same, i.e. potential gradient

does not change. As a result, the null point remains same

3 Wheatstone bridge method is considered unsuitable for the measurement of very low resistances. Why? 2

ANS: (i) For measuring a low resistance, all other resistances used should have a low value to ensure the sensitivity of the bridge.
(ii) A galvanometer of very low resistance is required which of course be very insensitive.
(iii) The end resistances and the resistances of connecting wire become comparable to the resistance being measured.
All these factors introduce an error in the result.

4 (a) State the Kirchoff 's law.
(b) A battery of 10V and negligible internal resistance is connected across the diagonally opposite corners of a cubical network consisting of 12 resistors each of resistance 1Ω in figure. Determine the equivalent resistance of the network and the current along each edge of the cube. 3



ANS: (a) Refer to Point no. 16 [Important Terms, Definitions and Formulae]
(b) Ist Step: We specify current in all the 12 edges of the cube in terms of I_1 using the Kirchhoff 's first law and the symmetry in the problem.
2nd Step: We take closed loop *ABCC′EA* and apply Kirchhoff 's second rule.

$$-IR - \frac{I}{2}R - IR + \varepsilon = 0 \quad \Rightarrow \quad \varepsilon = \frac{5}{2}IR$$

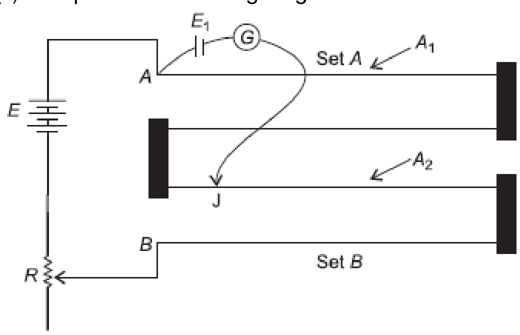
Suppose the equivalent resistance of the network is R_{eq}, i.e. $R_{eq} = \frac{\varepsilon}{3I} = \frac{5}{6}R$

For $R = 1\,\Omega$, $\quad R_{eq} = \frac{5}{6}\Omega$

For $\varepsilon = 10$ V, $\quad 3I = \dfrac{10}{5/6} = 12\,\text{A} \Rightarrow I = 4\,\text{A}, \quad \therefore \dfrac{I}{2} = 2\,\text{A}$

Current through each edge of the cube is now obvious from the diagram.

5 You are given two sets of potentiometer circuit to measure the emf E_1 of a cell.
Set A: consists of a potentiometer wire of a material of resistivity ρ_1, area of cross-section A_1 and length l.
Set B: consists of a potentiometer of two composite wires of equal lengths $l/2$ each, of resistivity ρ_1, ρ_2 and area of cross-section A_1, A_2 respectively.
(i) Find the relation between resistivity of the two wires with respect to their area of cross-section, if the current flowing in the two sets is same.
(ii) Compare the balancing length obtained in the two sets.



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ANS:

(i) $\therefore$

$$I = \frac{\varepsilon}{R + \rho_1 \dfrac{l}{A_1}} \qquad \text{(For set } A\text{)} \quad ...(i)$$

$$I = \frac{\varepsilon}{R + \dfrac{\rho_1 l}{2A_1} + \dfrac{\rho_2 l}{2A_2}} \qquad \text{(For set } B\text{)} \quad ...(ii)$$

Equating equations (i) and (ii), we get

$$\frac{\rho_1 l}{A_1} = \frac{\rho_1 l}{2A_1} + \frac{\rho_2 l}{2A_2} \Rightarrow \frac{\rho_1}{A_1} = \frac{\rho_2}{A_2}$$

(ii) ∵ Potential difference across the wire of set $A = V_A = I\dfrac{\rho_1 l}{A_1}$

∴ Potential gradient of the potentiometer wire for set A,

$$k = \frac{I\rho_1}{A_1} \qquad ...(i)$$

Potential drop across the potentiometer wire in set B

$$V_B = \frac{I\rho_1 l}{2A_1} + \frac{I\rho_2 l}{2A_2}$$

∴ Potential gradient of the composite wire of set B,

$$k' = \frac{V_B}{l} = \frac{I\rho_1}{2A_1} + \frac{I\rho_2}{2A_2} \qquad \left[\because \frac{\rho_1}{A_1} = \frac{\rho_2}{A_2}\right]$$

$$\therefore \quad k' = 2\times\frac{I\rho_1}{2A_1} = \frac{I\rho_1}{A_1} = k \qquad \text{[From equation (i)]}$$

∴ Balancing length obtained in the two sets is same.

6 (a) State the principle of working of a potentiometer.

(b) Figure shows the circuit diagram of a potentiometer for determining the emf ε of a cell of negligible internal resistance.

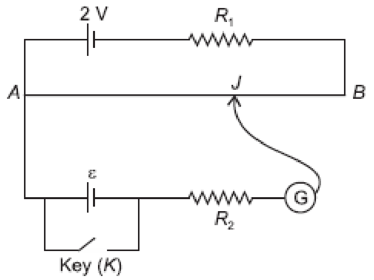
(i) What is the purpose of using high resistance R_2?

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

(iii) Why cannot the balance point be obtained

(1) When the emf ε is greater than 2 V, and

(2) When the key (K) is closed? 3



ANS: (a) Principle of working of a Potentiometer:

Refer to Ans. 55.

Potential gradient is constant for a given current but varies with the current in potentiometer circuit.

(b) (i) High resistance R_2 will only reduce the current as long as it flows and so the galvanometer will not over-shoot.

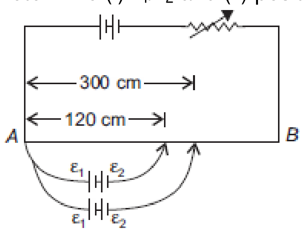
(ii) On decreasing R_1 potential gradient $k = \frac{I\rho}{A}$ will increase due to increase in current and balance point will shift towards A.

(iii) (1) When ε is greater than 2 V, it will drive current in the potentiometer wire and no balance point will be obtained.

(2) When the key *K* is closed, the cell of emf ε is shortcircuited so there will be no balancing point.

7 (a) State the principle of potentiometer. Define potential gradient. Obtain an expression for potential gradient in terms of resistivity of the potentiometer wire.

(b) Figure shows a long potentiometer wire *AB* having a constant potential gradient. The null points for the two primary cells of emfs ε_1 and ε_2 connected in the manner shown are obtained at a distance of l_1 = 120 cm and l_2 = 300 cm from the end A. Determine (i) $\varepsilon_1/\varepsilon_2$ and (ii) position of null point for the cell ε_1 only.



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ANS: (a) Principle of potentiometer: Refer to Ans. 55.

Potential gradient: The fall of potential per unit length of the potentiometer wire is called potential gradient.

$$k = \frac{V}{L}$$

where *L* is the length of potentiometer wire and *V* is the potential difference across it.

$$k = \frac{IR}{L} = \frac{I\rho l}{LA} \qquad \left(\because R = \rho\frac{l}{A}\right)$$

(*b*) (*i*) Given: l_1 = 120 cm, l_2 = 300 cm

$\varepsilon_1 + \varepsilon_2 = k\,300$; $\varepsilon_1 - \varepsilon_2 = k\,120$

Dividing both the equations, we get

$$\therefore \quad \frac{\varepsilon_1 + \varepsilon_2}{\varepsilon_1 - \varepsilon_2} = \frac{300}{120} = \frac{10}{4} \quad \Rightarrow \quad 4\varepsilon_1 + 4\varepsilon_2 = 10\varepsilon_1 - 10\varepsilon_2 \qquad ...(i)$$

$$\therefore \quad 6\varepsilon_1 = 14\varepsilon_2 \quad \Rightarrow \quad \frac{\varepsilon_1}{\varepsilon_2} = \frac{14}{6} = \frac{7}{3} \qquad ...(ii)$$

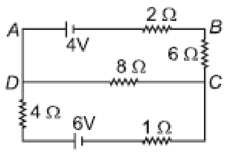
(*ii*) $\varepsilon_1 + \varepsilon_2 = k\,300$

$\Rightarrow \varepsilon_1 - \varepsilon_2 = k\,120$

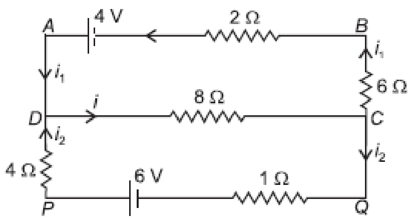
Adding both the equations, we get

$\therefore 2\varepsilon_1 = k\,420$
$\Rightarrow \varepsilon_1 = k\,210$
i.e. balancing length is 210 cm.

8 State Kirchhoff 's laws of an electrical network. Using Kirchhoff 's laws, calculate the potential difference across the 8 Ω resistor. 5



ANS: Kirchhoff's Rules: Refer to Point no. 16. [Important terms, Definitions and Formulae]
$i = i_1 + i_2$ …(i)
Consider a loop *ADCBA*,



$8i + 6i + 2i_1 = 4$
$8i + 8i_1 = 4$
$2i + 2i_1 = 1$ …(*ii*)
Consider a loop *DCQPD*,
$8i + i_2 + 4i_2 = 6$
$8i + 5i_2 = 6$ …(*iii*)
On solving equations (*i*), (*ii*) and (*iii*) we get
$i = \frac{17}{36}$
Thus, potential drop across the 8 Ω resistor is
$V = i \times 8$
$V = \frac{17}{36} \times 8$
$V = \frac{34}{9}$ volt