O P JINDAL SCHOOL, SAVITRINAGAR

PRACTICE PAPER

CLASS XII PHYSICS **TOPIC : CURRENT ELECTRICITY**

Date : 02/05/20 **MM :25**

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1 (a) You are required to select a carbon resistor of resistance 47 kW ± 10% from a large collection. What should be the sequence of colour bands used to code it ? 2

(b) Write two characteristics of manganin which make it suitable for making standard resistances.

2 A cell of emf E and internal resistance r is connected to two external resistances R_1 and R_2 and a perfect ammeter. The current in the circuit is measured in four different situations :

(i) without any external resistance in the circuit,

(ii) with resistance R_1 only,

(iii) with R_1 and R_2 in series combination, and 2

(iv) with R_1 and R_2 in parallel combination.

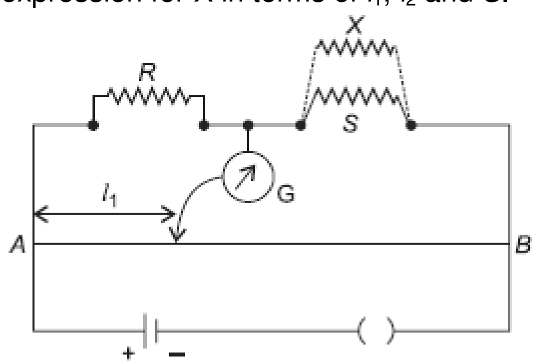
The currents measured in the four cases are 4.2 A, 1.05 A, 0.42 A, 1.4 A but not necessarily in that order. Identify the currents corresponding to the four cases mentioned above.

3 State the two Kirchhoff 's rules used in electric networks. How are these rules justified? 2

4 (i) State the principle of working of a meter bridge.

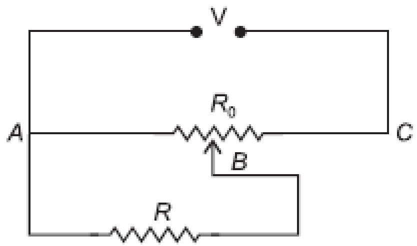
(ii) In a meter bridge balance point is found at a distance l_1 with resistances R and S as shown in the figure.

When an unknown resistance X is connected in parallel with the resistance S, the balance point shifts to a distance l_2. Find the expression for X in terms of l_1, l_2 and S. 3



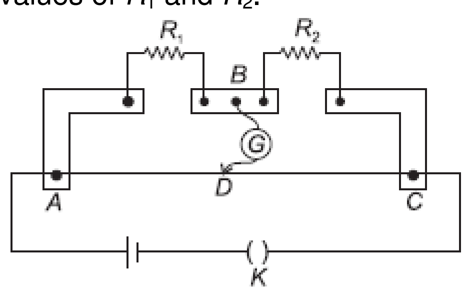
5 State the underlying principle of a potentiometer.
Describe briefly, giving the necessary circuit diagram, how a potentiometer is used to measure the internal resistance of a given cell. 3

6 A resistance of $R\ \Omega$ draws current from a potentiometer as shown in the figure.
The potentiometer has a total resistance $R_0\ \Omega$.
A voltage V is supplied to the potentiometer.
Derive an expression for the voltage across R when the sliding contact is in the middle of the potentiometer. 3



7 (a) State, with the help of circuit diagram, the working principle of a meter bridge. Obtain the expression used for determining the unknown resistance.
(b) What happens if the galvanometer and cell are interchanged at the balance point of the bridge ?
(c) Why is it considered important to obtain the balance point near the midpoint of the wire? 5

8 (a) State Kirchhoff 's rules for a network. Using Kirchhoff 's rules, obtain the balance condition in terms of the resistances of four arms of wheatstone bridge.
(b) In the meter bridge exprimental set up, shown in the figure, the null point D is obtained at a distance of 40 cm from end A of the meter bridge wire. If a resistance of 10 Ω is connected in series with R_1, null point is obtained at AD = 60 cm. Calculate the values of R_1 and R_2. 5



O P JINDAL SCHOOL, SAVITRINAGAR

PRACTICE PAPER (SOLUTION)

CLASS XII PHYSICS **TOPIC : CURRENT ELECTRICITY**

Date : 03/05/20 **MM :25**

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1 (a) You are required to select a carbon resistor of resistance 47 kW ± 10% from a large collection. What should be the sequence of colour bands used to code it ? 2
(b) Write two characteristics of manganin which make it suitable for making standard resistances.

ANS: (a) The sequence of colour bands is yellow, violet, orange and silver.
(b) (i) High resistivity. (ii) Low temperature coefficient of resistivity.

2 A cell of emf E and internal resistance r is connected to two external resistances R_1 and R_2 and a perfect ammeter. The current in the circuit is measured in four different situations :
(i) without any external resistance in the circuit,
(ii) with resistance R_1 only,
(iii) with R_1 and R_2 in series combination, and 2
(iv) with R_1 and R_2 in parallel combination.
The currents measured in the four cases are 4.2 A, 1.05 A, 0.42 A, 1.4 A but not necessarily in that order. Identify the currents corresponding to the four cases mentioned above.

ANS: (i) Without any external resistance, the current will have maximum value.

I = 4.2 A $\left(\because I = \frac{E}{r}\right)$

(*ii*) When only resistance R_1 is joined in the circuit, the current further gets reduced.

I = 1.05 A $\left(\because I = \frac{E}{r + R_1}\right)$

(iii) In series combination, an equivalent resistance (R_1 and R_2) is maximum. So, current in the circuit is least.

I = 0.42 A $\left(\because I = \frac{E}{r + R_1 + R_2}\right)$

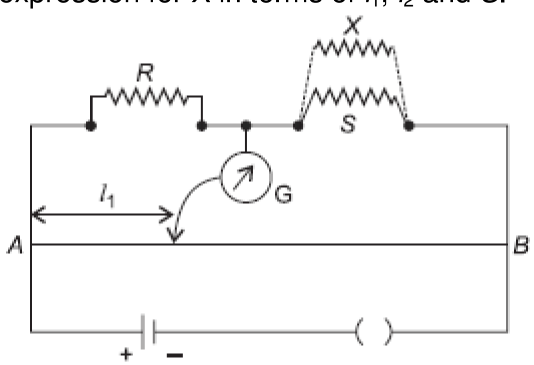
(iv) In parallel combination, an equivalent resistance (R_1 and R_2) is lesser than the least resistance of the combination. So current will have the greater value.

$I = 1.4$ A $\left(\because I = \dfrac{E}{r + \dfrac{R_1R_2}{R_1 + R_2}}\right)$

3 State the two Kirchhoff 's rules used in electric networks. How are these rules justified? 2

ANS: **Kirchhoff's Rules:**
(i) **Junction rule:** At any junction, the sum of the currents entering the junction is equal to the sum of currents leaving the junction.
(ii) **Loop rule:** The algebraic sum of changes in potential around any closed loop involving resistors and cells in the loop is zero.
Junction rule obeys the law of conservation of charge, as at any junction, there is no accumulation of charge while loop rule obeys the law of conservation of energy. At any instant of time, the total energy supplied by cells is equal to the total energy consumed by resistors.

4 (i) State the principle of working of a meter bridge.
(ii) In a meter bridge balance point is found at a distance l_1 with resistances R and S as shown in the figure.
When an unknown resistance X is connected in parallel with the resistance S, the balance point shifts to a distance l_2. Find the expression for X in terms of l_1, l_2 and S.



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ANS: (i) Refer to Point no. 18 [Important Terms, Definitions and Formulae]
(ii) With R and S alone, we have

$$\frac{R}{S} = \frac{l_1}{(100 - l_1)} \Rightarrow R(100 - l_1) = Sl_1 \qquad ...(i)$$

With S and X in parallel with R on the left gap,

$$\frac{R}{\left(\frac{SX}{S+X}\right)} = \frac{l_2}{(100-l_2)} \Rightarrow R(100-l_2) = \frac{SXl_2}{(S+X)} \quad ...(ii)$$

Dividing equations (*i*) and (*ii*), we get

$$\frac{100-l_1}{100-l_2} = \frac{l_1(S+X)}{Xl_2}$$

$$\Rightarrow \quad 100\,Xl_2 - l_1l_2X = 100\,l_1S + 100\,l_1X - l_2l_1S - l_2l_1X$$

$$\therefore \quad X = \frac{100l_1S - l_1l_2S}{100(l_2-l_1)}$$

5 State the underlying principle of a potentiometer.
Describe briefly, giving the necessary circuit diagram, how a potentiometer is used to measure the internal resistance of a given cell. 3

ANS: The principle of working of a potentiometer : The potential drop along a wire is directly proportional to its corresponding length provided the current is constant and the wire is of uniform area of cross-section and physical conditions remain the same.

i.e. $V \propto l$

To measure the internal resistance of a cell : With an open key K_2, the balancing length is obtained. Let it be length l_1. We have relation

$$\varepsilon = \phi l_1 \quad ...(i)$$

where ϕ = potential gradient

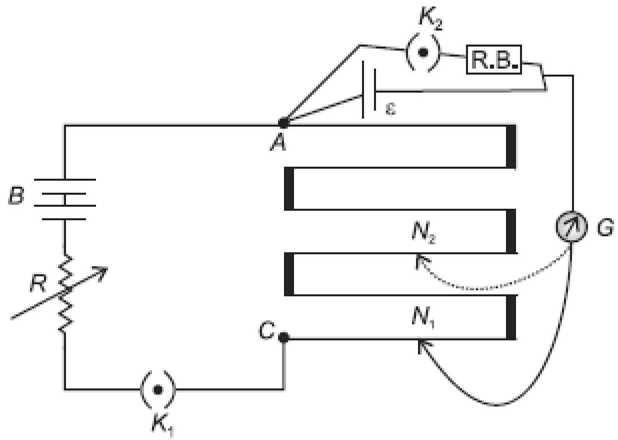
When key K_2 is closed, the cell passes a current I through the resistance box having resistance *R*.

If *V* is the terminal potential difference of the cell and l_2 is the balancing length. We have relation

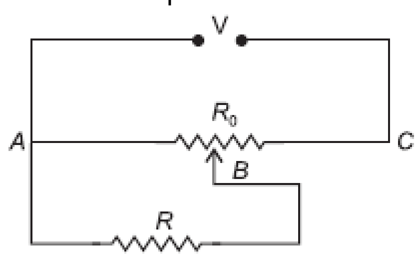
$$V = \phi l_2 \quad ...(ii)$$

From equations (*i*) and (*ii*), we have $\frac{\varepsilon}{V} = \frac{l_1}{l_2}$

We know that $r = \left(\frac{\varepsilon}{V} - 1\right)R \Rightarrow r = \left(\frac{l_1}{l_2} - 1\right)R$



6 A resistance of $R\ \Omega$ draws current from a potentiometer as shown in the figure.
The potentiometer has a total resistance $R_0\ \Omega$.
A voltage V is supplied to the potentiometer.
Derive an expression for the voltage across R when the sliding contact is in the middle of the potentiometer. 3



ANS: The total resistance between A and B is given by

$$R_1 = \frac{\left(\frac{R_0}{2}\right)R}{\frac{R_0}{2} + R} = \frac{R_0 R}{R_0 + 2R}$$

The equivalent resistance between A and C is given by

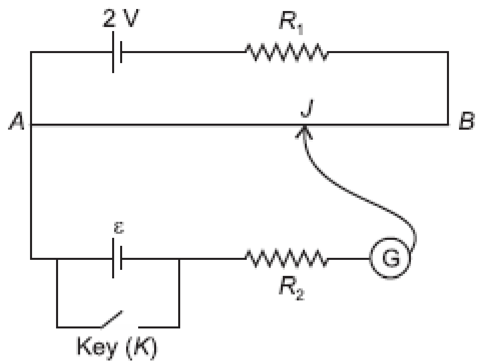
$$\therefore \qquad R_2 = \frac{R_0 R}{R_0 + 2R} + \frac{R_0}{2} = \frac{2R_0 R + R_0^2 + 2R_0 R}{2(R_0 + 2R)} = \frac{R_0^2 + 4RR_0}{2(R_0 + 2R)}$$

$$\therefore \text{Current through potentiometer, } I = \frac{V}{R} = V\left[\frac{2(R_0 + 2R)}{R_0^2 + 4RR_0}\right]$$

Let potential difference across AB be V_1, then $V_1 = I \times R_1$

$$\therefore \quad V_1 = \frac{2V(R_0+2R)}{R_0(R_0+4R)} \times \frac{R_0 R}{(R_0+2R)} = \left(\frac{2R}{R_0+4R}\right)V$$

7 (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?



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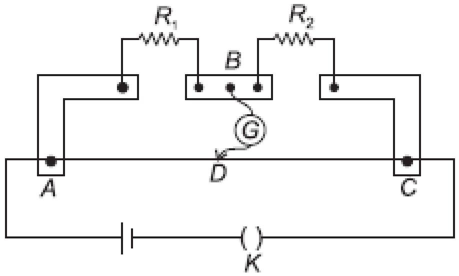
ANS: (a) Principle of working of a Potentiometer:
Refer to Ans. 55.
Potential gradient is constant for a given current but varies with the current in potentiometer circuit.
(b) (i) High resistance R_2 will only reduce the current as long as it flows and so the galvanometer will not over-shoot.

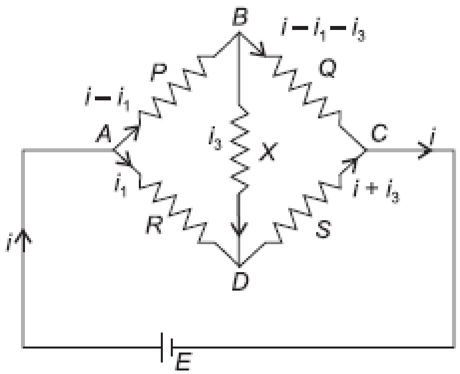
(ii) On decreasing R_1 potential gradient $k = \frac{I\rho}{A}$ will increase due to increase in current and balance point will shift towards A.
(iii) (1) When ε is greater than 2 V, it will drive current in the potentiometer wire and no balance point will be obtained.
(2) When the key K is closed, the cell of emf ε is shortcircuited so there will be no balancing point.

8 (a) State Kirchhoff 's rules for a network. Using Kirchhoff 's rules, obtain the balance condition in terms of the resistances of four arms of wheatstone bridge.
(b) In the meter bridge exprimental set up, shown in the figure, the null point D is obtained at a distance of 40 cm from end A of the meter bridge wire. If a resistance of 10 Ω is connected in series with R_1, null point is obtained at AD = 60 cm. Calculate the values of R_1 and R_2. 5



ANS: Kirchhoff 's rules: Refer to Point no. 16 [Important Terms, Definition and Formulae]
Let us consider a wheatstone bridge.
Take loop *ABDA*,

$P(i - i_1) + Xi_3 - Ri_1 = 0$ ...(*i*)



Take loop BCDB

$Q(i - i_1 - i_3) - S(i_1 + i_3) - Xi_3 = 0$

$Q(i - i_1) - Qi_3 - Si_1 - (S + X)i_3 = 0$ ...(*ii*)

When the point *B* and *D* are at same potential, the bridge is said to be balanced.
As in balanced state, $i_3 = 0$, from equations (i) and (ii), we get

$P(i - i_1) = Ri_1$

$Q(i - i_1) = Si_1$

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

(b) For the first balanced bridge situation

$$\frac{R_1}{R_2} = \frac{40}{100 - 40} = \frac{40}{60} = \frac{2}{3} \qquad ...(i)$$

If a resistance of 10 Ω is connected in series with R_1, the equivalent resistance $R_{eq} = R_1 + 10$ for the second balanced bridge situation

$$\frac{R_{eq}}{R_2} = \frac{60}{100-40} = \frac{60}{40}$$

$$\frac{R_1+10}{R_2} = \frac{6}{4} \Rightarrow \frac{R_1}{R_2} + \frac{10}{R_2} = \frac{3}{2} \qquad ...(ii)$$

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

$$\frac{2}{3} + \frac{10}{R_2} = \frac{3}{2} \quad \Rightarrow \quad \frac{10}{R_2} = \frac{3}{2} - \frac{2}{3} = \frac{9-4}{6}$$

$$\therefore \qquad R_2 = \frac{10 \times 6}{5} = 12\,\Omega \text{ and } R_1 = 8\,\Omega$$