Current Electricity **Marks: 30**

ANSWER KEY

Physics

Q.1 C	Q.2 C	Q.3 C	Q.4 A	Q.5 B	Q.6 B	Q.7 C	Q.8 B
Q.9 B	Q.10 C	Q.11 B	Q.12 A	Q.13 B	Q.14 A	Q.15 C	Q.16 C
Q.17 D	Q.18 C	Q.19 C	Q.20 D	Q.21 A	Q.22 D	Q.23 D	Q.24 C
Q.25 A	Q.26 D	Q.27 A	Q.28 D	Q.29 D	Q.30 D		

KUNAL ACADEMY

SOLUTION

Physics

Q.1 In a metrebridge experiment, when a nichrome wire is in the right gap, the balancing length is 60 cm. When the nichrome wire is uniformly stretched to increase its length by 20 % and again connected in the right gap balancing length is nearly

Correct option: (C)

Initially,

$$\frac{R_1}{R_2} = \frac{l_1}{l_2} = \frac{60}{40} = \frac{3}{2} \text{ ....(i)}$$

When, wire is stretched by 20 % i.e., becomes 1.2 L

Using ***Shortcut 3:*** When a wire having resistance R is stretched so as to make its length n R' then R' = n^2 R

Resistance will increase to $1.44R_2$

Hence, after stretching wire,

$$\frac{R'_1}{R'_2} = \frac{l}{100 - l}$$

But R'_1 = R and R'_2 = 1.44 R_2

$$\therefore \frac{R_1}{1.44\,R_2} = \frac{l}{100 - l}$$

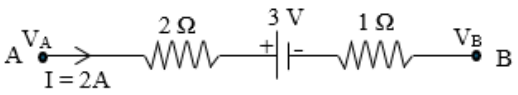
From (i),

$$\frac{3}{1.44 \times 2} = \frac{l}{100 - l}$$

$\therefore$ 300 – 3l = 2.88 l

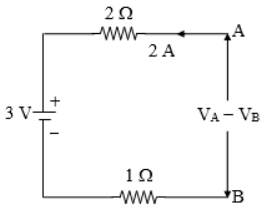
$$\therefore l = \frac{300}{5.88} \approx 51 \text{ cm}$$

Q.2 The potential difference ($V_A - V_B$) between the points A and B in the given figure is



Correct option: (C)

Given circuit can also be drawn as,



By Kirchhoff's voltage law,

$V_A - (2 \times 2) - (3) - (2 \times 1) - V_B = 0$

$\therefore$ $V_A - 4 - 3 - 2 - V_B = 0$

$\therefore$ $V_A - V_B = +9$ V

Q.3 In Wheatstone's bridge, the resistances in four arms are 6 Ω, 6 Ω, 6 Ω and 12 Ω. To make the bridge balance, resistance connected across 12 Ω is

Correct option: (C)

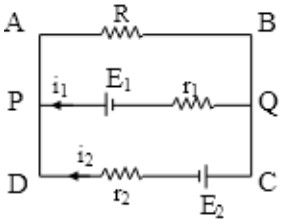
The resistances in four arms of a Wheatstone's bridge are, 6 Ω, 6 Ω, 6 Ω and 12 Ω.

Let S be the resistance to be connected across 12 Ω.

$\therefore$ Balance condition is, $\frac{6}{6} = \frac{6}{\left(\frac{12\,S}{12+S}\right)} \Rightarrow 12\,S = 6\,(12 + S)$

$\therefore$ 6 S = 72 $\Rightarrow$ S = 12 Ω

Q.4 See the electrical circuit shown in this figure. Which of the following equations is a correct equation for it?



Correct option: (A)

According to Kirchhoff's voltage law in loop ABQPA,

$-(i_1 + i_2)R - i_1r_1 + E_1 = 0$

$\therefore$ $E_1 - (i_1 + i_2)R - i_1r_1 = 0$

Q.5 A potentiometer wire of length 'L' and a resistance 'r' are connected in series with a battery of e.m.f. 'E_0' having internal resistance 'r_1'. An unknown e.m.f. is balanced at a length '*l*' of the potentiometer wire.

KUNAL ACADEMY

The e.m.f. 'E' of the unknown e.m.f. will be given by

Correct option: (B)

Current through the circuit,

$$I = \frac{E_0}{r + r_1}$$

Potential difference across the wire,

$$V = IR = \frac{E_0 r}{r + r_1}$$

$$\therefore \text{ Potential gradient} = \frac{E_0 r}{(r + r_1)L}$$

If balancing length for the cell is *l*, then

$$E = \frac{E_0 r}{(r + r_1)} \cdot \frac{l}{L}$$

Q.6 The deflection in the galvanometer falls to $\left(\frac{1}{5}\right)^{\text{th}}$, when 4 Ω resistance is connected in parallel with it. What will be the deflection if an additional resistance of 2 Ω is connected in parallel with the above shunted galvanometer?

Correct option: (B)

Given: $\frac{I_g}{I} = \frac{1}{5}$, S = 4 Ω

We know,

$$\frac{I_g}{I} = \frac{S}{S + G}$$

$$\therefore \frac{1}{5} = \frac{4}{4 + G}$$

$\therefore$ 4 + G = 20

$\therefore$ G = 20 – 4 = 16 Ω

The effective value after shunting the galvanometer with 2 Ω is

$$S' = \frac{2 \times 4}{2 + 4} = \frac{8}{6} = \frac{4}{3}\Omega$$

$$\therefore \frac{I_g}{I} = \frac{S'}{S' + G} = \frac{\frac{4}{3}}{\frac{4}{3} + 16} = \frac{4}{52} = \frac{1}{13}$$

Q.7 In a potentiometer experiment, a cell of e.m.f. 1.4 V gives balancing length of 40 cm. If the cell is replaced by another cell, balancing length is found to be 60 cm. What is the emf of second cell?

Correct option: (C)

$E_1 \propto L_1$ and $E_2 \propto L_2$

$\therefore \frac{E_1}{E_2} = \frac{L_1}{L_2} \Rightarrow \frac{1.4}{E_2} = \frac{40}{60} \Rightarrow E_2 = 2.1$ V

Q.8 The potential gradient along the length of a metre wire of uniform cross-section is 10 V/m. Let 'B' and 'C' be the two points at 30 cm and 70 cm marks respectively. The potential difference between the points B and C is

Correct option: (B)

The potential difference between the points B and C is: $V = K \times d = 10 \times (70 - 30) \times 10^{-2}$

$\therefore \quad V = 4V$

Q.9 An accumulator of 5 volt is connected through a resistance of 40 Ω to a potentiometer wire 10 m long and of resistance 10 Ω. For a cell, the null point is found at a length of 8 m from the common terminal. The current through the wire is

Correct option: (B)

$$I = \frac{E}{R + r_2} = \frac{5}{40 + 10} = \frac{5}{50} = 0.1\ A$$

Q.10 A potentiometer circuit has been set up for finding the internal resistance of a given cell. The main battery, used across the potentiometer wire, has an e.m.f. of 2.0 V and a negligible internal resistance. The potentiometer wire itself is 4 m long. When the resistance, R, connected across the given cell, has values of
i. Infinity ii. 9.5 Ω,
the 'balancing lengths', on the potentiometer wire are found to be 3 m and 2.85 m, respectively.
The value of internal resistance of the cell is

Correct option: (C)

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

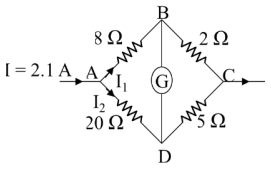
$$= \left(\frac{3}{2.85} - 1\right) 9.5$$

$$= \frac{0.15}{2.85} \times 9.5 = 0.5\ \Omega$$

Q.11 In the given figure, when galvanometer shows no deflection, the current flowing

KUNAL ACADEMY

through 5 Ω resistance is



Correct option: (B)

Given: I_2 is current through arm ADC.

∴ Current through arm ABC, $I_1 = 2.1 - I_2$

Given: No detlection through galvanometer

⇒ Voltage across both arms is same, i.e.,

$(20 + 5)I_2 = (8 + 2)(2.1 - I_2)$

$25\ I_2 = 21 - 10\ I_2$

∴ $I_2 = \frac{21}{35} = 0.6$ A

∴ Current through 5 Ω = $I_0 = 0.6$ A

Q.12 A milliammeter of resistance 5 ohm gives a full scale deflection for a current of 15 mA. If the milliammeter is to be used to measure current upto 1.5 A, then the resistance that must be attached to the milliammeter is

Correct option: (A)

$S = \frac{I_g G}{I - I_g} = \frac{15 \times 10^{-3} \times 5}{1.5 - 15 \times 10^{-3}} = 0.0505\ \Omega$

Q.13 In a metrebridge, when R_1 and X are the resistances in left gap and right gap respectively, the null point is obtained at 40 cm from the left. Now, when the resistance R_2 is in left gap and X in right gap, then the null point is obtained at 60 cm from the left. When the resistance in left gap is changed to $(R_1 + R_2)$, the null point will be at

Correct option: (B)

1st case: $\frac{R_1}{X} = \frac{2}{3}$ ….(i)

2nd case: $\frac{R_2}{X} = \frac{3}{2}$ ….(ii)

Adding equations (i) and (ii),

$\frac{R_1}{X} + \frac{R_2}{X} = \frac{2}{3} + \frac{3}{2}$

$\frac{R_1 + R_2}{X} = \frac{13}{6}$

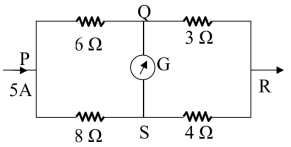
Let l be the distance of null point from left.

$\frac{l}{100 - l} = \frac{13}{6}$

∴ $6\ l = 1300 - 13\ l$

∴ $19\ l = 1300 \Rightarrow l = \frac{1300}{19} = 68.4$ cm from left.

Q.14 Potential difference between the points P and Q is nearly



Correct option: (A)

Let total current be denoted as I. The given circuit is a Wheatstone bridge.

⇒ $R_1 = 6 + 3 = 9\ \Omega$

⇒ $R_2 = 8 + 4 = 12\ \Omega$

According to KCL, the current will get divided into two parts I_1 and I_2

∴ $I_1 = \frac{R_2 I}{(R_1 + R_2)}$

Substituting the values,

$I_1 = \frac{12}{9 + 12} \times 5$

$I_1 = 2.85\ A$

Potential difference between P and Q is

$V = I_1 R$

$V = 2.85 \times 6$

$V = 17$ V

Q.15 A potentiometer consists of a wire of length 6 m and resistance 10 Ω. It is connected to a cell of e.m.f. 5 V. The potential difference per unit length of the wire will be

Correct option: (C)

Potential difference per unit length, $\frac{V}{L} = \frac{5}{6} = 0.83$ V/m

Q.16 In a meter bridge experiment, null point is obtained at 25 cm from one end of wire, when resistance X is balanced against another resistance Y. Now the resistance (4.5)X is balanced against Y

KUNAL ACADEMY

where $X < Y$. The new position of null point from same end of wire is at

Correct option: (C)

Balancing condition for meter bridge,

$$\frac{X}{Y} = \frac{l}{100 - l} \quad \text{...(i)}$$

Null point is obtained at,

$$l = 25cm$$

$$\frac{X}{Y} = \frac{25}{100 - 25} = \frac{1}{3} \quad \text{...(ii)[From(i)]}$$

For resistance 4.5X,

$$\frac{4.5X}{Y} = \frac{l}{100 - l} \quad \text{...[From (i)]}$$

$$\therefore \quad 4.5\left(\frac{1}{3}\right) = \frac{l}{100 - l} \quad \text{...[From (ii)]}$$

$\therefore$ 450 – 4.5l = 3l

$$\therefore \quad l = \frac{450}{7.5}$$

$$= 60cm$$

Q.17 In a metre bridge, uniform metal wire of length 5 m connected in left gap is balanced by a resistance 'R' Ω in right gap. The null point obtained divides the bridge wire in the ratio 3 : 2. The resistance of 1 metre length of metal wire connected in left gap is (in ohm)

Correct option: (D)

Given: The right gap resistance is R Ω and ratio of division of the wire due to null point is 3:2.

$$\Rightarrow \frac{X}{R} = \frac{3}{2}$$ where X is the unknown resistance

$$\Rightarrow X = \frac{3R}{2}$$

$\therefore$ Resistance of the 1 m wire in the left gap is

$$\frac{5}{\frac{3R}{2}} = \frac{10}{3} R = 0.3R$$

Q.18 When a resistance 'R' is connected in series with a galvanometer of resistance 150 Ω, it acts as a voltmeter of range 0 to 15 V. When a resistance of 1500 Ω is connected in series with 'R', the range of voltmeter gets doubled so the value of R in ohm is

Correct option: (C)

When the 150 Ω resistor is connected,

$$\Rightarrow I_1 = \frac{15}{150 + R}$$

Given, when 1500 Ω resistor is connected the range is doubled.

$$\Rightarrow I_2 = \frac{(2 \times 15)}{1650 + \mathbf{R}}$$

Also, $I_1 = I_2$

$$\Rightarrow \frac{15}{150 + R} = \frac{30}{1650 + R}$$

$$\frac{15(1650 + R)}{30} = 150 + R$$

1650+ R = 300 + 2R

$\therefore$ R = 1350 Ω

Q.19 A potentiometer wire has length 4 m and resistance 12 Ω. The resistance that must be connected in series with the wire and a battery of e.m.f. 1.6 V, so as to get a potential gradient 1 mV per cm on the wire is (Neglect internal resistance of battery)

Correct option: (C)

P.D. across the wire

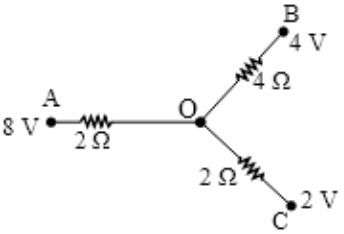
= Potential gradient × length

V_0 = 1mV/cm × 400 cm = 0.4 V

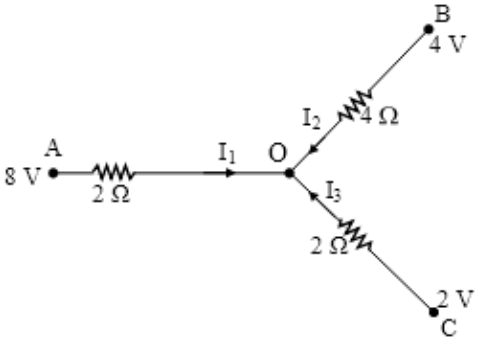
Current in the wire, I = $\frac{0.4}{12} = \frac{1}{30}$ A

$$R = \frac{V - V_0}{I} = \frac{1.6 - 0.4}{1/30} = 36\ \Omega$$

Q.20 In the following network potential at 'O' is



Correct option: (D)



Let potential at O be V_0.

KUNAL ACADEMY

According to Kirchhoff's current law,

$I_1 + I_2 + I_3 = 0$

$$\frac{8 - V_0}{2} + \frac{4 - V_0}{4} + \frac{2 - V_0}{2} = 0$$

$\therefore 2(8 - V_0) + 4 - V_0 + 2(2 - V_0) = 0$

$\therefore 16 - 2V_0 + 4 - V_0 + 4 - 2V_0 = 0$

$\therefore 5V_0 = 24$

$\therefore V_0 = \frac{24}{5} = 4.8$ V

Q.21 In balanced metre bridge 5 Ω is connected in the left gap and R Ω in the right gap. When R Ω is shunted with an equal resistance, the new balance point is at 1.6 l_1 where 'l_1' is the earlier balancing length. The value of 'l_1' is

Correct option: (A)

From the given data, we can write

$$\frac{5}{R} = \frac{l_1}{100 - l_1} \quad \text{....(i)}$$

After R is shunted by R,

$$\frac{5}{\left(\frac{R}{2}\right)} = \frac{1.6l_1}{100 - 1.6l_1}$$

$$\therefore \quad \frac{10}{R} = \frac{1.6l_1}{100 - 1.6l_1} \quad \text{....(ii)}$$

Dividing equation (i) by equation (ii),

$$\frac{5}{10} = \frac{l_1}{100 - l_1} \times \frac{100 - 1.6l_1}{1.6l_1}$$

$$\frac{1}{2} = \frac{100 - 1.6l_1}{(100 - l_1) \times 1.6}$$

$$200 - 3.2l_1 = 160 - 1.6l_1$$

$$1.6l_1 = 40$$

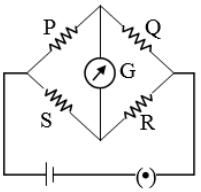
$$\therefore \quad l_1 = \frac{40}{1.6} = 25 \text{ cm}$$

Q.22 In a metrebridge, the balancing length from the left end (standard resistance of one ohm is in the right gap) is found to be 20 cm. The value of the unknown resistance is

Correct option: (D)

$$\frac{X}{1} = \frac{20}{80} \Rightarrow X = \frac{1}{4}\ \Omega = 0.25\ \Omega$$

Q.23 In the Wheatstone's bridge shown in figure, where P = 2 Ω, Q = 3 Ω, R = 6 Ω and S = 8 Ω. In order to balance the bridge, shunt resistance across the 'S' must be



Correct option: (D)

Let shunt resistance connected to S be r. Then equivalent resistance of branch containing S will be $\frac{Sr}{S + r}$ ...(parallel connection)

...(i)

Balancing condition for Wheatstone bridge is given by, $\frac{P}{Q} = \frac{S}{R}$

Substituting (i),

$$\frac{P}{Q} = \frac{Sr}{(S + r)R}$$

Given that,

P = 2 Ω, Q = 3 Ω, R = 6 Ω and S = 8 Ω

$\Rightarrow \frac{2}{3} = \frac{8r}{(8 + r)6} \Rightarrow 96 + 12r = 24r$

$\therefore$ r = 8 Ω

Q.24 To determine the internal resistance of a cell with potentiometer, when the cell is shunted by a resistance of 5 Ω, the balancing length is 250 cm. When the cell is shunted by 20 Ω, the balancing length of potentiometer wire is 400 cm. The internal resistance of the cell is

Correct option: (C)

$$r = R\left(\frac{l}{l_1} - 1\right) = 5\left(\frac{l}{250} - 1\right) \quad \text{...(i)}$$

Similarly

$$r = R\left(\frac{l}{l_1} - 1\right) = 20\left(\frac{l}{400} - 1\right) \quad \text{...(ii)}$$

$$5\left(\frac{l}{250} - 1\right) = 20\left(\frac{l}{400} - 1\right)$$

$$\frac{l}{50} - 5 = \frac{l}{20} - 20$$

$$15 = \frac{3l}{100} \Rightarrow l = 500\text{cm}$$

KUNAL ACADEMY

Substituting in (i),

r = $5\left(\frac{500}{250}-1\right)$ = 5 Ω

Q.25 A potentiometer wire has length of 5 m and a resistance of 16 Ω. The driving cell has an e.m.f of 5 V and an internal resistance of 4 Ω. When two cells of e.m.f. 1.3 V and 1.1 V are connected so as to assist each other and then oppose each other, the balancing lengths are respectively

Correct option: (A)

K = $\frac{ER}{(R+r)L}$

E = 5 V, r = 4 Ω, L = 5 m, R = 16 Ω

∴ K = $\frac{5\times16}{(16+4)\times5}$

∴ K = 0.8 V/m

When 'E_1' and 'E_2' are connected so as to assist each other

$E_1 + E_2 = Kl_1$

$1.3 + 1.1 = 0.8 \times l_1$

∴ l_1 = 3 m

When 'E_1' and 'E_2' are connected so as to oppose each other,

$E_1 - E_2 = Kl_2$

$1.3 - 1.1 = 0.8 \times l_2$

∴ l_2 = 0.25 m

Thinking Hatke -

As value for balancing lengths are different in all the options, it is sufficient to calculate balancing length in any one case (Assisting/opposing) to reach the final answer.

Q.26 A daniel cell is balanced on 165 cm length of a potentiometer wire. Now the cell is short-circuited by a resistance 2.5 ohm and then the balanced length obtained is 140 cm. The internal resistance of the daniel cell is

Correct option: (D)

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

∴ R = $\left(\frac{165-140}{140}\right)$2.5 ≈ 0.45 Ω

Q.27 Four resistors P, Q, R and S having resistances 6 Ω, 6 Ω, 4 Ω and 6 Ω respectively, are arranged to form a Wheatstone's bridge. The value of the resistance with which S must be shunted in order to balance the bridge is

Correct option: (A)

For the balance condition,

$\frac{P}{Q} = \frac{R}{S||X}$ where X is the resistance with which S is shunted,

∴ $\frac{6}{6} = \frac{4}{\left(\frac{6\times X}{6+X}\right)}$

∴ 6X = 24 + 4X ⇒ X = 12 Ω

Q.28 Potentiometer wire is 4 m long and potential difference of 3 V is maintained between the ends. The e.m.f. of the cell which balances against a length of 100 cm of the potentiometer wire is

Correct option: (D)

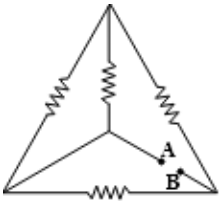
Given: V = 3V, L = 4m

∴ Potential gradient = $\frac{V}{L} = \frac{3}{4}V/m$

P.D. across 1 m of the wire =

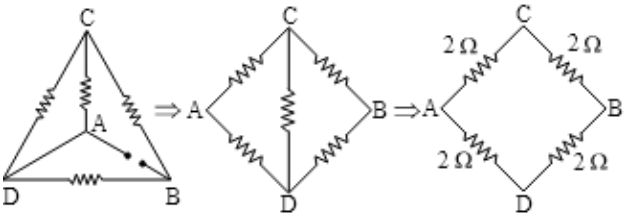
$\frac{3}{4}\times1 = \frac{3}{4} = 0.75V$

Q.29 In the network shown in the figure, each of the resistance is equal to 2 Ω. The resistance between the points A and B is



Correct option: (D)

The equivalent circuits are as shown below



The circuit is a balanced Wheatstone's bridge.

Hence effective resistance between A and B

= 4 Ω || 4 Ω = 2 Ω

Q.30 A potentiometer wire of length 10 m is connected in series with a battery. The e.m.f. of a cell balances against 250 cm

KUNAL ACADEMY

length of wire. If length of potentiometer wire is increased by 1 m, the new balancing length of wire will be

Correct option: (D)

EMF of cell,

$E = kl'$

$E = \frac{E'}{l} \times l'$

$E = \frac{E'}{10} \times 2.5$ ….(i)

After increasing the length by 1 m,

$E = \frac{E'}{11} \times x$

Substituting for E from equation (i)

$\frac{E'}{10} \times 2.5 = \frac{E'}{11} \times x$

$\therefore \quad x = \frac{2.5 \times 11}{10} = 2.75 \text{ m}$

KUNAL ACADEMY