Physics 12th Guess Questions with answer for CBSE of Year 2021

Current electricity

VSA

1. Define electrical conductivity of a conductor and give its S.I. unit.

Answer:

The reciprocal of electrical resistance of a conductor (R) is known as electrical conductivity (G).

i.e. $G = \frac{1}{R}$

Its SI unit is per ohm or Siemen.

2. What happens to the power dissipation if the value of electric current passing through a conductor of constant resistance is doubled?

Answer:

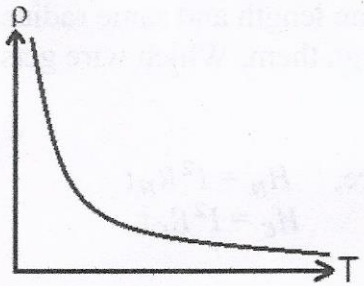
Power dissipation $P = I^2R$

Hence, power dissipation would be four times after doubling of electric current.

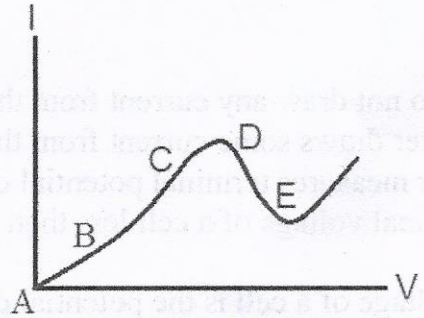
3. Sketch a graph showing variation of resistivity of carbon with temperature.

Answer:

Carbon is a semiconductor. Therefore, required graph will



4. Graph showing the variation of current verses voltage for a material GaAs is shown in the figure. Identify the region of



(i) Negative resistance

(ii) Where Ohm's law is obeyed

Answer:
(i) D to E (ii) A to B

5. Define the term 'mobility' of charge carrier in a conductor. Write its SI unit.
Answer:

The magnitude of drift velocity of charge (V_d) per unit applied electric field (E) is called Mobility of charge (μ).

$\therefore \quad \mu = \frac{V_d}{E}$ ..... (i)

Its SI unit is $ms^{-1}\ CN^{-1}$.

6. Which of the two has higher resistance: a 1000W heater or a 100 W tungsten bulb, both marked for 230V.
Answer:

Resistance of 1000 watt heater, $R_1 = \frac{V^2}{P} = \frac{230 \times 230}{1000} = 52.9\ \Omega$

Resistance of 100 watt tungsten bulb, $R_2 = \frac{V^2}{P} = \frac{230 \times 230}{100} = 529\ \Omega$

Hence, resistance of 100 watt tungsten bulb is more.

7. Nichrome and copper wires of same length and same radius are connected in series. Current I is passed through them. Which wire gets heated up more? Justify your answer.
Answer:

Heat produced in Nichrome wire, $H_N = I^2 R_N t$
Heat produced in copper wire, $H_C = I^2 R_C t$
Since, $R_N > R_C$
So, $H_N > H_C$

8. Why is potentiometer preferred over a voltmeter for determining the emf of a cell ?
Answer:
Potentiometer do not draw any current from the cell during measurement, whereas voltmeter draws some current from the cell during measurement. Hence voltmeter measures terminal potential difference of cell.

9. Why is the terminal voltage of a cell less then its emf ?
Answer:
The terminal voltage of a cell is the potential difference of a cell when current is drawn from the cell, whereas emf is the potential difference of a cell when current is not drawn from the cell.

10. How does the random motion of free electrons in a conductor get affected, when a potential difference is applied across its ends ?

Answer:

The motion of free electrons get directed opposite to the applied field.

11. How does one explain increase in resistivity of a metal with increase in temperature ?

Answer:

With increase in temperature, the relaxation time(τ) decreases and hence resistivity $\left(\rho = \frac{m}{ne^2\tau}\right)$ increases.

12. Two students A and B were asked to pick a resistor of 15 kΩ from a collection of carbon resistors. A picks a resistor with bands of colours: brown, green and orange while B picks a resistor with bands of black, green and red. Who is picked correct resistor.

Answer:

A → brown	green	orange	
1	5	10^3	= 15 kΩ
B → black	green	red	
1	5	10^2	= 1.5 kΩ

Therefore, a picks correct resistor.

Assertion –reason Type Questions

Following questions have two statements - one labelled Assertion (A) and the other labelled Reason (R).

Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.

a) Both A and R are true and R is the correct explanation of A
b) Both A and R are true but R is NOT the correct explanation of A
c) A is true but R is false
d) A is false and R is also false

1. **Assertion (A)**

The emf of the driver cell in the potentiometer experiment should be greater than the emf of the cell to be determined.

Reason (R)

The fall of potential across the potentiometer wire should not be less than the emf of the cell to be determined.

Correct option: (a)

2. **Assertion (A)**

The bending of an insulated wire increases the resistance of wire.

Reason (R)

The drift velocity of electrons in bent wire decreases.

Correct option: (d)

3. **Assertion (A)**
A domestic electrical appliance, working on a three pin, will continue working even if the top pin is removed
Reason (R)
The third pin is used only as a safety device.
Correct option: (a)

4. **Assertion (A)**
In parallel combination of electrical appliances, total power consumption is equal to the sum of the powers of the individual appliances.
Reason (R)
In parallel combination, the voltage across each appliance is the same, as required for the proper working of electrical appliance.
Correct option: (a)

5. **Assertion (A)**
When the cell is in open circuit, there is no force on a test charge inside the electrolyte of the cell.
Reason (R)
There is no field inside the cell, when the cell is in open circuit.
Correct option: (a)

6. **Assertion (A)**
A potentiometer of longer length is used for accurate measurement.
Reason (R)
The potential gradient for a potentiometer of longer length with a given source of emf becomes small.
Correct option: (a)

7. **Assertion (A)**
Insulator do not allow flow of current through themselves.
Reason (R)
They have no free charge carriers.
Correct option: (a)

8. **Assertion (A)**
When cells are connected in series to the external load, the effective emf increases.
Reason (R)
The cells help each other in sending the current to the external load.
Correct option: (a)

9. **Assertion (A)**
In series combination of electric bulbs, the bulb of lower power emits more light than that of higher power bulb.
Reason (R)
In series combination, the lower power bulb gets more current than the higher power bulb.
Correct option: (c)

10. **Assertion (A)**
A potentiometer of longer length is used for accurate measurement.
Reason (R)
The potential gradient for a potentiometer of longer length with a given source emf becomes small.
Correct option: (a)

Fill in the blanks

1. The resistance of wire is 4 Ω. If the length of wire is increased twice of its original length, then new resistance of wire would be ..... .
Answer: 16 Ω
Explanation:

$$R = \rho\frac{l}{A} = \rho\frac{l^2}{Al} = \rho\frac{l^2}{V} \quad \text{Where } V = Al = \text{volume of wire}$$

$$\therefore \quad R_{old} = \rho\frac{(l_1)^2}{V} = \rho\frac{l^2}{V} = 4\ \Omega \quad \ldots\ldots (i)$$

$$\text{And} \quad R_{new} = \rho\frac{(l_2)^2}{V} = \rho\frac{(2l)^2}{V} = \rho\frac{4l^2}{V} = 4\,\rho\frac{l^2}{V}$$

$$= 4 \times R_1 \quad = 4 \times 4 = 16\ \Omega$$

2. A uniform wire of resistance 1 ohm is cut into four equal parts and then they are connected in parallel. The resistance of combination is ..... .
Answer: $\frac{1}{16}\Omega$
Explanation:

Resistance of each part after diving into four equal parts will, $R = \frac{1}{4}\Omega$

∴ Equivalent resistance of parallel combination of four resistors ($R = \frac{1}{4}\Omega$) will,

$$R_P = \frac{R}{n} = \frac{1/4}{4} = \frac{1}{16}\Omega$$

3. The resistivity of a metallic wire is ρ. If its length is doubled , then its new resistivity would be ..... .
Answer: ρ
Explanation:
The resistivity of wire does not depend on the dimensions of wire.
4. Two Cells of emfs ε_1 and ε_2, and internal resistances r_1 and r_2 respectively are joined in parallel. Their equivalent emf will be ..... .
Answer:

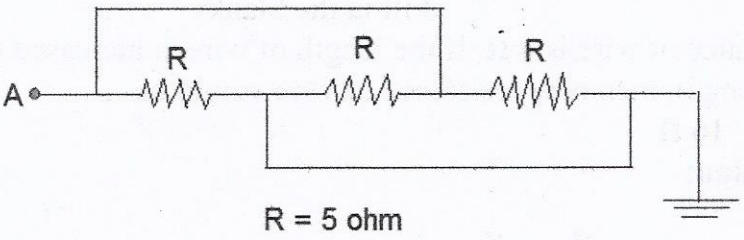
$$\frac{\varepsilon_1 r_2 + \varepsilon_2 r_1}{r_1 + r_2}$$

5. Kirchhoff's first law ($\Sigma I=0$) and second law ($\Sigma IR=\Sigma E$) are respectively based on ..... and ..... .

Answer:

Conservation of charge ; Conservation of energy

6. The potential of A is 10 volt. The current flowing in the earth will be .....



R = 5 ohm

Answer: 6 amp.

Explanation:

All resistors are connected in parallel, hence $R_{eq} = \frac{5}{3}$ ohm. ,

$$I = \frac{V}{R} = \frac{10}{5/3} = 6 \text{ amp.}$$

7. A current flows in a wire of resistance 5 Ω at potential difference 7 volt for 20 minutes. The heat produced by wire is ..... .

Answer: 2800 Cal

Explanation:

$$H = VIt = \frac{V^2}{R} \times t = \frac{7^2}{5} \times 1200 = 11760 \text{ J} = \frac{11760}{4.2} \text{ Cal} = 2800 \text{ Cal}$$

8. The specific resistance of metal depends on the ..... of free electrons and nature.

Answer: density

9. The colours of bands on carbon resistor from left to right are brown, green, yellow and golden. The value of resistance of carbon resistor is ..... .

Answer: 150 kΩ ± 5%

10. In a potentiometer, balance point is obtained at length 339.4 cm for a cell of emf 1.0182 V. The potential gradient of the potentiometer is .....

Answer: 0.3 Vm^{-1}

Explanation:

Potential gradient, $k = \frac{\varepsilon}{l} = \frac{1.0182\ V}{339.4\ cm} = \frac{1.0182\ V}{3.394\ m} = 0.3\ Vm^{-1}$.

11. A balance point is obtained on the potentiometer wire, if the fall of potential along the potentiometer wire due to ..... is greater than the ..... to be balanced.

Answer:

driving cell ; emf of the cell.

12. The balanced position of meter bridge is ..... on interchanging the positions of battery and galvanometer.

Answer: unchanged

13. A meter bridge can not be used to measure ..... resistances.

Answer:

very high or very low.

14. The expression for potential gradient of potentiometer wire in terms of specific resistance ρ of the wire, area of its cross section A and current I flowing through wire is ..... .

Answer: $\frac{I\rho}{A}$

Explanation:

$$k = \frac{\varepsilon}{l} = \frac{IR}{l} = \frac{I\frac{\rho l}{A}}{l} = \frac{I\rho}{A}$$

15. We ..... interchange the position of the battery in the auxilliary circuit and cell whose emf is to determined in potentiometer circuit diagram.

Answer: cannot

16. If a battery of emf ε and internal resistance r is being charged by a current I from a charger, then the rate at which energy is supplied by charger is ..... and the rate at which chemical energy is stored in the battery is ..... .

Answer: $(\varepsilon + Ir)I$; εI

Explanation:

The rate of energy supplied by charger i.e. power,

$P = VI = \{\varepsilon - (-I)r\} I = (\varepsilon + Ir)I$

And the rate of chemical energy stored in the battery i.e. power of battery,

$P = \varepsilon I$

17. A 220V and 1000W Bulb is connected to a 110V supply. The power consumed by bulb will be ..... .

Answer: 250 W

Explanation:

$$P = \frac{V^2}{R} \quad \text{Or} \quad R = \frac{V^2}{P} = \frac{220 \times 220}{1000} = 48.4 \text{ ohm},$$

$$\text{Again } P = \frac{V^2}{R} = \frac{110 \times 110}{48.4} = 250 \text{ W}$$

Study based questions / Based on the given Passage

Read the following passes carefully and choose the correct option of questions (i), (ii), (iii) and (iv):
A wire of length 12 cm ; resistance 12 Ω and of uniform area of cross section is cut into twelve equal parts, which are connected to form a skelton cube. A cell of emf 2 V is connected across the two diagonally opposite corners of cube. Using Kirchhoff's law of junctions and loop, answer the following questions:

(i) The effective resistance of circuit is

(a) $\frac{5}{6}$ Ω (b) $\frac{7}{12}$ Ω

(c) $\frac{6}{7}$ Ω (d) $\frac{4}{5}$ Ω

Correct option: (a)

Explanation:

The effective resistance between diagonally opposite corners of skelton cube $(R) = \frac{5r}{6} = \frac{5 \times 1}{6}$ [since $r = \frac{12\ ohm}{12cm} = 1$ ohm/cm.] $= \frac{5}{6}$

(ii) The current drawn from the battery is

(a) 2.5 A (b) 3.4 A (c) 2.4 A (d) 2.3 A

Correct option: (c)

Explanation:

Current drawn from the battery, $I = \frac{\varepsilon}{R} = \frac{2}{5/6} = 2.4$ A

(iii)The maximum current flowing in an arm of network is

(a) 0.4 A (b) 1.2 A (c) 2.4 A (d) 0.8 A

Correct option: (d)

Explanation:

The maximum current flowing in an arm of network $= \frac{2I}{6} = \frac{2 \times 2.4}{6}$

$= 0.8$ A

(iv) The minimum potential difference across an arm of network is

(a) 1.2 V (b) 0.8 V (c) 0.4 V (d) 2.4 V

Correct option: (c)

Explanation:

The minimum potential difference across an arm of network $= \frac{Ir}{6}$

$= \frac{2.4 \times 1}{6} = 0.4$ V

SA (2 marks)

1. Using the concept of drift velocity of charge carrier in a conductor, deduce the relationship between current density and resistivity of the conductor.
Answer:

Drift velocity $v_d = \frac{eE\tau}{m}$

$\therefore$ From relation $I = AneV_d$,

$$I = Ane \times \frac{eE\tau}{m}$$

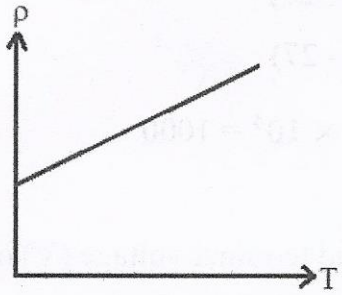
Or $\frac{I}{A} = \frac{ne^2\tau}{m} E$

Or $j = \frac{1}{\rho} E$ $\left[since\ \rho = \frac{m}{ne^2\tau}\right]$

Or $j = \frac{E}{\rho}$

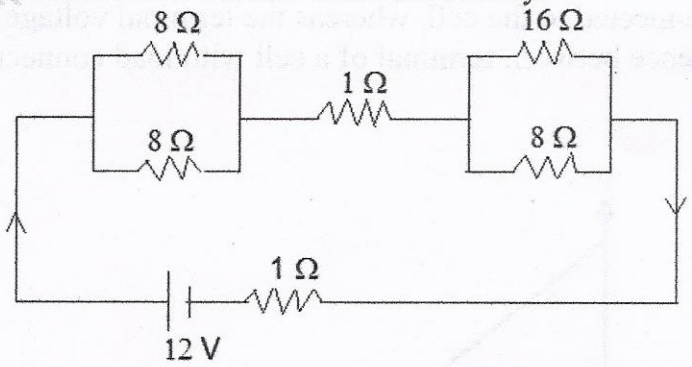
2. Draw a graph showing the variation of resistivity with temperature for Nichrome. Which property of Nichrome is used to make standard resistance coil?

Answer:



The very weak dependence on temperature of Nichrome, it is used to make standard resistance coil.

3. A network of resistors is connected to a 12 V battery with internal resistance of 1Ω., as shown in the following figure. Compute the equivalent resistance of the network and current drawn from the battery.



Answer:

Equivalent resistance of network $= \frac{R_1 \times R_2}{R_1 + R_2} + R_3 + \frac{R_5 \times R_6}{R_5 + R_6} + r$

$= \frac{8\times 8}{8+8} + 1 + \frac{16\times 8}{16+8} + 1 = 4 + 1 + 5.33 + 1 = 11.33\ \Omega$

$\therefore$ Current drawn from the battery, $I = \frac{V}{R_{eq}} = \frac{12}{11.33} = 1.06\ A$

4. Calculate the temperature at which the resistance of a conductor becomes 20% more than its resistance at 27^0C. The value of the temperature coefficient of resistance of the conductor is $2 \times 10^{-4}\ K^{-1}$.

Answer:

Given, temperature coefficient of resistance $\alpha = 2 \times 10^{-4}\ K^{-1}$

Let resistance at $T_1 = 27^0$ is $R_1 = R$

$\therefore$ Resistance at unknown temperature T_2 will

$R_2 = R + 20\%$ of $R = R + 0.20R = 1.20R$

$\because \quad R_2 = R_1 [1 + \alpha (T_2 - T_1)]$

Or $\quad 1.20\,R = R [1 + 2 \times 10^{-4} (T_2 - 27)]$

Or $\quad 1.20 = 1 + 2\times 10^{-4} (T_2 - 27)$

Or $\quad 1.20 - 1 = 2\times 10^{-4} (T_2 - 27)$

Or $\quad T_2 - 27 = \frac{0.20}{2\times 10^{-4}} = 0.10 \times 10^4 = 1000$

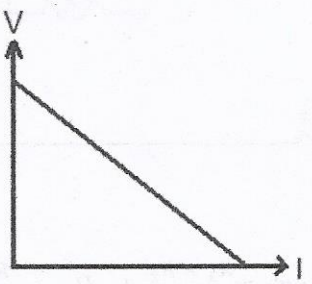
$\therefore \quad T_2 = 1000 + 27 = 1027^0$ C

5. (a) Distinguish between emf (ε) and terminal voltage (V) of a cell having internal resistance r.
(b) Draw a plot showing the variation of terminal voltage (V) vs the current (I) drawn from the cell. Using this plot, how does one determine the internal resistance of the cell ?

Answer:

(a) The emf (ε) is the potential difference between terminal of a cell without load connected to the cell, whereas the terminal voltage is the potential difference between terminal of a cell with load connected to the cell.

(b)



The slope of V-I graph is equal to the terminal voltage of cell.

Internal resistance of cell , $r = \frac{\varepsilon - V}{I}$

6. When a battery of emf ε and internal resistance r is connected with an external resistance of 12 Ω, then produces a current of 0.5 A. When connected across a resistance of 25 Ω, it produces a current of 0.25 A. Determine (i) the emf and (ii) the internal resistance of the cell.

Answer:

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

$\therefore$ For first case,

$$\varepsilon = I_1(R_1 + r) \quad \text{Or} \quad \varepsilon = 0.5\,(12 + r)$$

Or $\varepsilon = 6 + 0.5\,r$ ..... (i)

For second case,

$$\varepsilon = I_2(R_2 + r) \quad \text{Or} \quad \varepsilon = 0.25\,(25 + r)$$

Or $\varepsilon = 6.25 + 0.25\,r$ ..... (ii)

Comparing equation (i) and (ii),

$6 + 0.5\,r = 6.25 + 0.25\,r$ Or $0.5r - 0.25r = 6.25 - 6$

Or $0.25\,r = 0.25$ Or $r = 1$ ohm

From equation (i),

$\varepsilon = 6 + 0.5 \times 1 = 6.5$ volt

LA-I (3 marks)

1. (a) A wire is stretched 50%, Calculate % change in its resistance.

(b) Obtain an expression for resistivity of a conductor.

Answer:

(a)

Let old length of wire $l_1 = l$

$\therefore$ New length of wire, $l_2 = l + 50\%$ of $l = l + \frac{l}{2} = \frac{3}{2}l$

$\because$ $R = \rho\frac{l}{A} = \rho\frac{l^2}{Al} = \rho\frac{l^2}{V}$ ..... (i)

Where V = Al = volume of wire

$\therefore$ $R_1 = \rho\frac{(l_1)^2}{V}$ ..... (ii) and $R_2 = \rho\frac{(l_2)^2}{V}$ ..... (iii)

Diving equation (iii) by equation (ii),

$$\frac{R_2}{R_1} = \frac{(l_2)^2}{(l_1)^2} = \left(\frac{l_2}{l_1}\right)^2 = \left(\frac{1.5\,l}{l}\right)^2 = \left(\frac{3}{2}\right)^2 = \frac{9}{4}$$

Or $R_2 = \frac{9}{4} \times R_1$

Increase in resistance $= R_2 - R_1 = \frac{9}{4} \times R_1 - R_1 = \frac{5}{4} R_1$

$\therefore$ Percentage increase in resistance $= \frac{5/4\, R_1}{R_1} \times 100\ \% = \frac{5}{4} \times 100 = 125\%$

(b)

The resistance (R) of a conductor is directly proportional to the length of conductor (l) and inversely proportional to the cross sectional area of conductor.

$$\therefore \quad R \propto \frac{l}{A} \quad \Rightarrow R = \rho \frac{l}{A} \quad \ldots\ldots\ldots\ldots\ldots\ldots \text{(i)}$$

Where ρ is a constant of proportionality and is called specific resistance or resistivity of conductor. Its value depends upon nature of material of conductor, But, does not depend upon dimensions of the conductor.

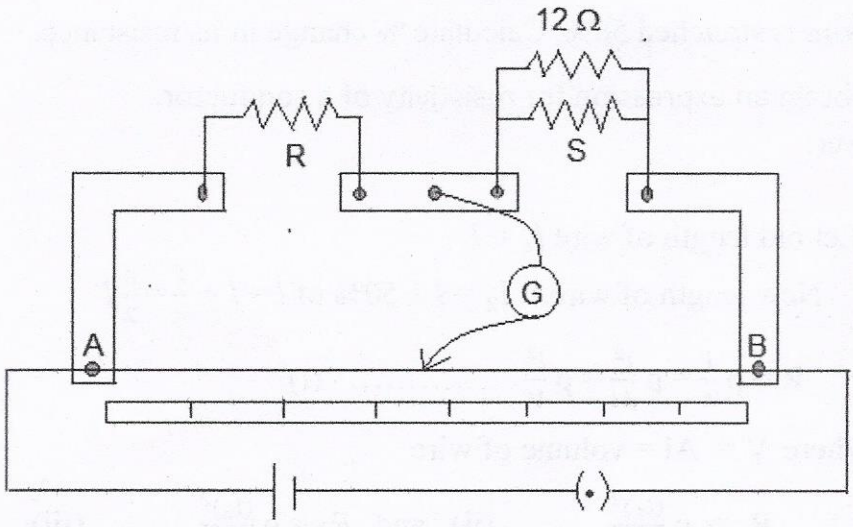
According to Ohm's Law,

$$V = IR = I \rho \frac{l}{A} \qquad [\text{ from equation (i) }]$$

$$\Rightarrow \rho = \frac{VA}{Il} \quad \ldots\ldots\ldots\ldots\ldots \text{(ii)}$$

The SI unit of resistivity is ohm meter(Ωm).

2. In a meter bridge, the null point is found at 40 cm from A. If resistance of 12 Ω is connected in parallel with S, the null point occurs at 50 cm from A. Determine the values of R and S.



Answer:.

For case I, $l = 40$ cm

$$\therefore \quad \frac{S}{R} = \frac{(100-l)}{l} = \frac{(100-40)}{40} = \frac{60}{40} = \frac{3}{2}$$

Or $\quad S = \frac{3}{2} R$

Or $\frac{2S}{3} = R$ ..... (i)

For case II, $l = 50$ cm When 12 ohm resistance is connected parallel to S

Equivalent resistance of 12 ohm and S will be $S_{eq} = \frac{12 \times S}{12+S}$

$\therefore \quad \frac{S_{eq}}{R} = \frac{(100-l)}{l} = \frac{(100-50)}{50} = 1$

Or $S_{eq} = R$ Or $\frac{12 \times S}{12+S} = R$

Or $\frac{12 \times S}{12+S} = \frac{2S}{3}$ [from equation (i)]

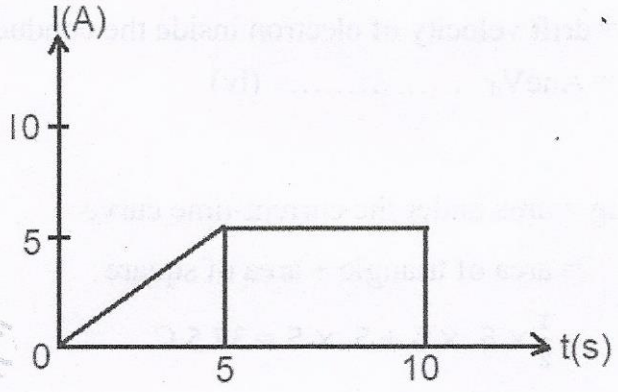
Or $36\ S = 24\ S + 2S^2$

Or $36 = 24 + 2S$ Or $2S = 36 - 24 = 12$ Or $S = 6$ ohms

$\therefore \quad R = \frac{2S}{3} = \frac{2 \times 6}{3} = 4$ ohm.

3. (a) Deduce the relation between current I flowing through a conductor and drift velocity v_d of the electrons.

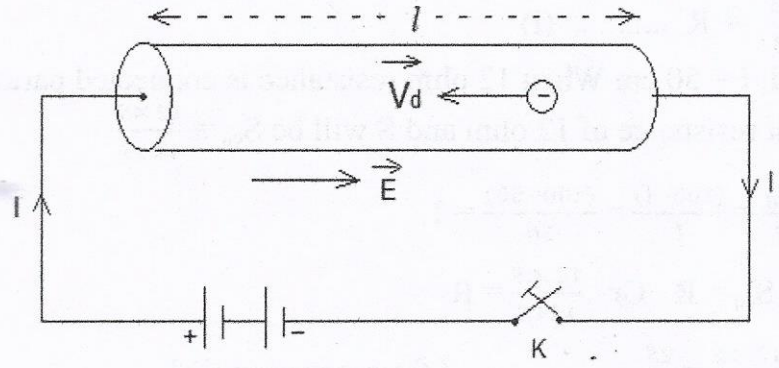
(b) Figure shows a plot of current I flowing through the cross-section of Wire versus the time t. Use the plot to find the charge flowing in 10 s through the wire.



Answer:

(a) **Relation between current density and drift velocity:**

Consider a conducting wire of length l and cross sectional area A.



∴ Volume of conductor = A*l* ..... (i)

If number of free electrons per unit volume of conductor is n, then total number of free electrons in the conductor,

N = *Aln* ..... (ii)

Again, if charge on an electron is , e then total charge in conductor,

q = Ne = *Alne* ..... (iii) [∵ Q = Ne]

If I current flows through the conductor on applying potential difference V across sides of conductor , then

$I = \frac{q}{t} = \frac{Alne}{t} = Ane \times \frac{l}{t} = AneV_d$

Where $V_d = \frac{l}{t}$ = drift velocity of electron inside the conductor

∴ $I = AneV_d$ ..... (iv)

(b)

Charge flowing = area under the current-time curve

= area of triangle + area of square

$= \frac{1}{2} \times 5 \times 5 + 5 \times 5 = 37.5$ C

LA-II (5 marks)

1. (a) Define the term drift velocity.
   (b) On the basis of electron drift, derive an expression for resistivity of a Conductor in terms of number density of free electrons and relaxation time.
   On what factors does resistivity of a conductor depend ?
   (c) Why alloys like constantan and manganin are used for making standard resistors?

Answer:

(a) The average velocity acquired by free electrons in a conductor after applying external electric field across ends of conductor is called drift velocity.

$$v_d = \frac{-eE\tau}{m} \quad \ldots\ldots\ldots \text{(i)}$$

(b) since, $v_d = \frac{eE\tau}{m}$

Or $\frac{I}{nAe} = \frac{eE\tau}{m}$ $\quad [I = nAev_d]$

Or $I = \frac{nAe^2E\tau}{m}$ or $\frac{V}{R} = \frac{nAe^2E\tau}{m}$

Or $\frac{El}{R} = \frac{nAe^2E\tau}{m}$ or $\frac{l}{R} = \frac{nAe^2\tau}{m}$

Or $\frac{R}{l} = \frac{m}{nAe^2\tau}$ or $R = \frac{ml}{nAe^2\tau}$

Or $\frac{\rho l}{A} = \frac{ml}{nAe^2\tau}$ $\quad [R = \frac{\rho l}{A}]$

Or $\rho = \frac{m}{ne^2\tau}$ $\quad \ldots\ldots\ldots \text{(ii)}$

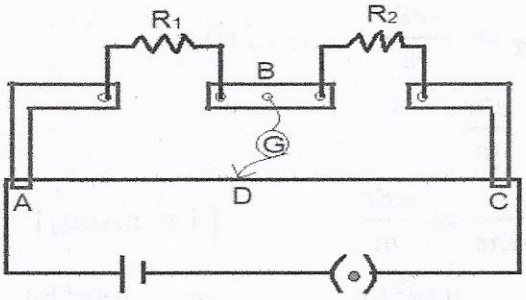
For a conductor e = charge on an electron and m = mass of an electron are constant.

Hence, Resistivity of a conductor depends on the relaxation time (τ) i.e. temperature and the number density of free electrons (n).

(c) Because, dependence on temperature of resistivity of constantan and manganin is very weak, alloys like constantan and manganin are used for making standard resistors.

2. (a) State Kirchhoff's rule for an electric network. Using these rules, obtain the balanced condition in terms of the resistances of four arms of Wheatstone bridge.

(b) In the meter bridge experiment 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 ohm is connected in series with R_1, null point is obtained at AD = 60 cm. Calculate the values of R_1 and R_2.

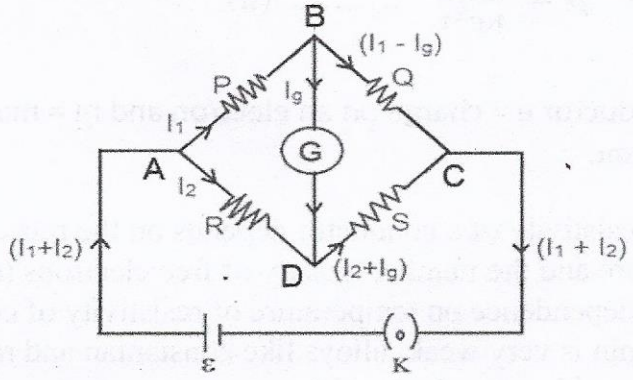


Answer:

(a) **Junction Rule:-** At any junction of an electric network, the sum of the currents entering to the junction is equal to the sum of currents leaving from the junction.

Loop rule:- in any closed loop of an electric network involving resistors and cells, the sum of potential drops across all component is equal to the sum of electromotive forces of cells connected in that loop.

Balanced condition of Wheatstone bridge:



The current following in branches of Wheatstone bridge is shown in the figure.

Appling Kirchhoff's loop rule in closed loop ABDA, we get

$$I_1P + I_gG - I_2R = 0 \quad \ldots\ldots\ldots\ldots \text{(i)}$$

Again, applying Kirchhoff's loop rule in closed loop BCDB, we get

$$(I_1 - I_g)Q - I_gG - (I_2 + I_g)S = 0 \quad \ldots\ldots\ldots\ldots \text{(ii)}$$

The value of R is adjusted such that the galvanometer shows no deflection i.e. $I_g = 0$.

In this situation, Wheatstone bridge is called balanced.

Putting $I_g = 0$ in equation (i) and (ii) , we get

$$I_1P + 0 - I_2R = 0$$

Or $I_1P - I_2R = 0$

Or $I_1 P = I_2 R$ ..... (iii)

And

$$(I_1 - 0)\,Q - 0 - (I_2 + 0)\,S = 0$$

Or $I_1 Q - I_2 S = 0$

Or $I_1 Q = I_2 S$ ..... (iv)

Dividing equation (iii) by equation (iv), we get

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

This is required condition.

(b)

For Case I: $\frac{R_1}{R_2} = \frac{l_1}{100 - l_1} = \frac{40}{100-40} = \frac{40}{60} = \frac{2}{3}$ ..... (i)

For Case II: $\frac{R_1+10}{R_2} = \frac{l_2}{100 - l_2} = \frac{60}{100-60} = \frac{60}{40} = \frac{3}{2}$ ..... (ii)

Or $\frac{R_1}{R_2} + \frac{10}{R_2} = \frac{3}{2}$ Or $\frac{2}{3} + \frac{10}{R_2} = \frac{3}{2}$ [from equation (i)]

Or $\frac{10}{R_2} = \frac{3}{2} - \frac{2}{3} = \frac{5}{6}$ Or $R_2 = 12$ ohm.

Putting $R_2 = 12$ ohm in equation (i), we get $R_1 = 8$ ohm.