CBSE Test Paper-02

Class - 12 Physics (Current Electricity)

1. Drift is the random motion of the charged particles within a conductor,
   a. along with a very slow net motion in the opposite direction of the field
   b. along with accelerated motion in the direction of the field
   c. along with a decelerated motion in the direction of the field
   d. along with zero motion in the direction of the field
2. The Wheatstone bridge is balanced for four resistors R_1, R_2, R_3 and R_4 with a cell of emf 1.46 V. The cell is now replaced by another cell of emf 1.08 V. To obtain the balance again
   a. No resistance needs to be changed
   b. Both the resistance R_1 and R_4 should be changed
   c. All the four resistance should be changed
   d. Resistance R_4 should be changed only
3. Two cells of 1.25 V and 0.75 V are connected in series with anode of one connected to anode of the other. The effective voltage will be
   a. 1.25 V
   b. 2.0 V
   c. 0.75 V
   d. 0.50 V
4. Thermo emf set up in thermocouple varies as $E = aT - \frac{1}{2}bT^2$, where a, b are constant and T is temperature in Kelvin. If a = $16.3\mu V/^\circ C$ and $b = 0.042\mu V/(^\circ C)^2$, then inversion temperature is:
   a. 776°C
   b. 388°C
   c. None of these
   d. 279°C
5. If the electric current in a lamp decreases by 5%, then the power output decreases by
   a. 20%
   b. 25%
   c. 5%

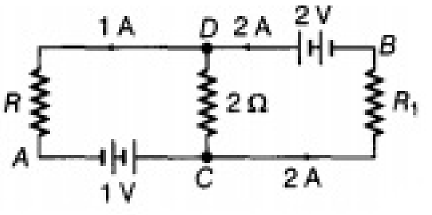
d. 10%

6. Define the term mobility of charge carriers in a conductor. Write its SI unit.

7. Show variation of resistivity of Si with temperature in graph.

8. Suppose balance point is not obtained on the potentiometer wire. Give one possible cause for this.

9. In the given circuit, assuming point A to be at zero potential, use Kirchhoff's rules to determine the potential at point B.



10. A 60 watt bulb carries a current of 0.5 ampere. Find the total charge passing through it in 1 hour.

11. The sequence of coloured bands in two carbon resistors R_1 and R_2 is
    i. brown, green, blue
    ii. orange, black, green.

    Find the ratio of their resistances.

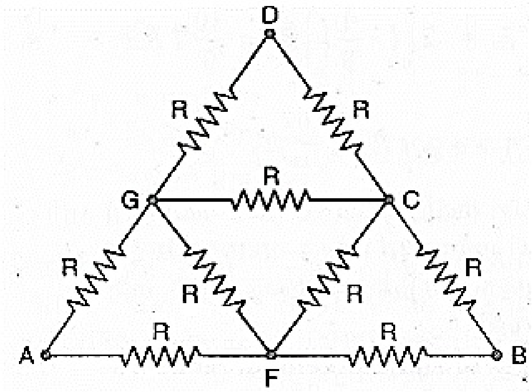
12. i. Define the term of drift velocity.
    ii. On the basis of electron drift, derive an expression for resistivity of a conductor in terms of number density of free electrons and relaxation time. On what factors does resistivity of a conductor depend?
    iii. Why alloys like Constantan and Manganin are used for making standard resistors?

13. A wire of 20Ω resistance is gradually stretched to double its original length. It is then cut into two equal parts. These parts are then connected in parallel across a 4.0 volt battery. Find the current drawn from the battery.

14. A heating element using nichrome connected to a 230 V supply draws an initial current of 3.2 A which settles after a few seconds to a steady value of 2.8 A. What is the steady temperature of the heating element if the room temperature is 27.0°C? Temperature co-efficient of resistance of nichrome averaged over the temperature

range involved is $1.70 \times 10^{-4} {}^\circ C^{-1}$.

15. For the network shown in figure below. Calculate the equivalent resistance between points A and B.



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Class - 12 Physics Current Electricity

Answers

1. a. along with a very slow net motion in the opposite direction of the field

   Explanation: The electrons in a conductor have random velocities and when an electric field is applied, they suffer repeated collisions and in the process move with a small average velocity, opposite to the direction of the field. This is equivalent to positive charge flowing in the direction of the field.

2. a. No resistance needs to be changed

   Explanation: The balance point of the Wheatstone's bridge is determined by the ratio of the resistances. The change in the e m f of the external battery will have no effect on the balance point.

3. d. 0.50 V

   Explanation: The cells are in opposition.

   $E_{eq} = E_1 - E_2 = 1.25 - 0.75 = 0.5V$

4. b. 388°C

   Explanation: Inversion temperature,

   $T_i = \frac{a}{b}$

   $\Rightarrow T_i = \frac{16.3}{0.042}$

   $T_i = 388^oC$

5. d. 10%

   Explanation: Power, $P = I^2R$

   $\Rightarrow \frac{P_2}{P_1} = \left[\frac{I_2}{I_1}\right]^2$

   $\Rightarrow \frac{P_2}{P_1} = \left[\frac{0.95 \times 0.95 I^2}{I^2}\right] = 0.9025$

   $\therefore$ Decrease in power $= \left(1 - \frac{P_2}{P_1}\right) \times 100$

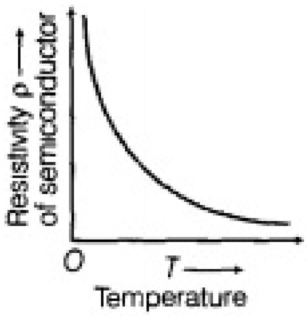
   Power decrease $\approx 10\%$

6. **Electron mobility** is how quickly an electron can move through a conductor. It's determined by the drift velocity and the strength of the electric field as shown in this equation:

$$\mu = \frac{\text{Drift velocity } (V_d)}{\text{Electric field } (E)}$$

Its SI unit is m^2/V-s or ms^{-1} N^{-1} C

7. The variation of resistivity with temperature for semiconductor (Si) is shown in figure below which shows resistivity of semiconductor material decreases continuously with increase in temperature.

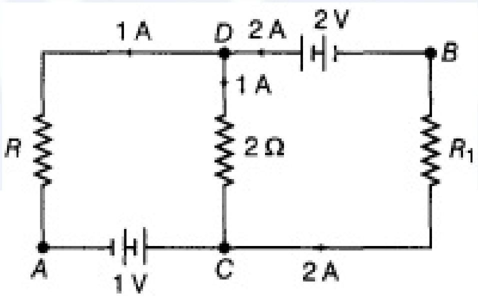


8. If the emf of the auxiliary battery is less than the emf of the cell to be measured, then the balance point will not be obtained on the potentiometer wire.

9. By applying Kirchhoff's first law at D,

   I_{DC} + 1 = 2

   I_{DC} = 1A



   Along ACDBA, V_A + 1 V + 1 $\times$ 2 - 2 = V_B

   But V_A = 0, V_B = 1 + 2 - 2 = 1V

   $\therefore$ V_B = 1 V

10. Charge, q = It $= 0.5 \times (60 \times 60)$ = 1800 coulomb.

11. The resistance value, tolerance, and wattage rating are generally printed onto the body of the resistor as numbers or letters when the resistors body is big enough to read the print, such as large power resistors. According to colour codes, resistance of two wires are
    i. Code of brown = 1

Code of green = 5

Code of blue = 6

$R_1 = 15 \times 10^6 \Omega \pm 20\%$

ii. Code of orange = 3

Code of black = 0

Code of green = 5

$R_2 = 30 \times 10^5 \Omega \pm 20\%$

$\therefore$ Ratio of resistances $\frac{R_1}{R_2} = \frac{15 \times 10^6}{30 \times 10^5} = 5 \Rightarrow \frac{R_1}{R_2} = 5 : 1$

so ratio of resistance for two wires is 5:1, however we have ignored the possible errors in measuring the resistance of two wires.

12. i. Drift Velocity : It the average velocity with which electrons move along the conductor under influence of electric field.

$v_d = \frac{I}{neA}$

ii. Specific resistance or resistivity of the material of a conductor is defined as the resistance of a unit length with unit area of cross-section of the material of the conductor.

The unit of resistivity is ohm-metre or Ω-m.

we know that

$R = \rho(l/A)$

$\Rightarrow \quad \rho = RA/l$

From Ohm's law,

V = IR

$\Rightarrow$ El = neAv_dR

$\Rightarrow \quad R = El/neAv_d$ and $v_d = \epsilon E\tau/m$

So, $R = \frac{El \times m}{ne^2 AE\tau} = \frac{ml}{ne^2 A\tau}$

Substituting the value of $R = \frac{ml}{ne^2 A\tau}$ in Eq. (i)

we have, $\rho = \left(ml/ne^2 A\tau\right) \cdot A/l$

$\Rightarrow$ Resistivity of the material, $\rho = m/ne^2\tau$

where $\tau =$ average relaxation time.

From the above formula, it is clear that resistivity of a conductor depends upon the following factors:

a. $\rho \propto \frac{1}{n}$, i.e., the resistivity of material is inversely proportional to the number density of free electrons (number of free electrons per unit volume). As the free electron density depends upon the nature of material, so resistivity of a conductor depends on the nature of the material.

b. $\rho \propto \mathbf{1}/\tau$, i.e. the resistivity of a material is inversely proportional to the average relaxation time τ of free electrons in the conductor. As the value of τ depends on the temperature as temperature increases, τ decreases, hence ρ increases.

iii. Alloys like Constantan and Manganin are used for making standard resistors because

i) They have high value of resistivity

ii) temperature coefficient of resistance is less

13. When any resistor is stretched to double its original length. The new resistance becomes four times of its original resistance as $R \propto \frac{1}{A}$ or $R \propto \frac{1}{\pi\left(\frac{d}{2}\right)^2}$

Here, $R = 20\Omega$ and V = 4.0 volt

New resistance = 4 R = $4 \times 20 = 80\Omega$ $R \propto \frac{4}{\pi d^2}$

Resistance of each part $\frac{80}{2} = 40\Omega$ (as divided in two parts)

$\therefore R_1 = 40\Omega, R_2 = 40\Omega$

Effective resistance in parallel combination R_P is

$\frac{1}{R_P} = \frac{1}{40} + \frac{1}{40} = \frac{2}{40} = \frac{1}{20}\left[\because \frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2}\right]$

$\therefore R_P = 20\Omega$

Current $I = \frac{V}{R_P} = \frac{4.0}{20} = 0.2A$

14. Here, $R_1 = \frac{230}{3.2} = 71.87\Omega$

$R_2 = \frac{230}{2.8} = 82.14\Omega$

$\alpha = 1.7 \times 10^{-4}{}^\circ C^{-1}$

t_1 = 27°

Since $R_2 = R_1[1 + \alpha(t_2 - t_1)]$

Thus, $t_2 = \frac{R_2 - R_1}{R_1 \cdot \alpha} + t_1$

or $t_2 = \frac{82.14 - 71.87}{71.87 \times 1.7 \times 10^{-4}} + 27$

= 840.56 + 27

= 867.56°C

= 867°C

15. The distribution of current in the circuit will be as shown in figure below following Kirchhoff's first law. Here point F is not a true junction, hence shown separate. If R' is the effective resistance of circuit between A and B then

E = IR' ...... (i)

In a closed circuit EABE

E = (I - I1)R + (I - I_1)R

= 2(I - I_1)R .... (ii)

In a closed circuit GDCG,

$\frac{I_2 R}{2}+\frac{R I_2}{-(I_1-I_2) R}=0$

or $I_2=\frac{I_1}{2}$ ...... (iii)

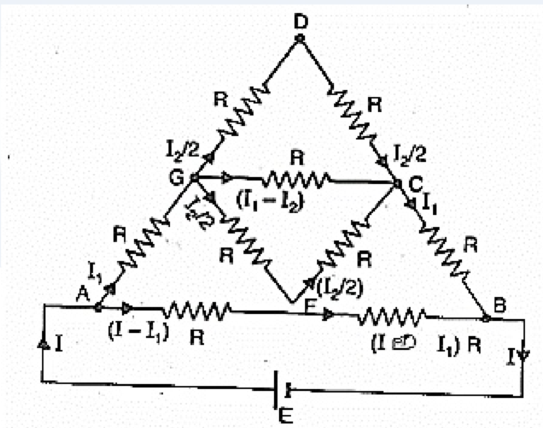
In a closed circuit AGCBA, we have

I_1R + (I_1 - I_2)R + I_1R - (I - I_1)R - (I - I_1)R = 0

or 5I_1 - I_2 = 2I

or $5 I_1-\frac{I_1}{2}=2 I$ [from (iii)]

or 9I_1 = 4I or $I_1=\frac{4}{9} I$



Putting this value in (ii) we get

$E=2\left(I-\frac{4}{9} I\right) R=\frac{10}{9} I R$ .... (iv)

Comparing (i) and (iv) we get $R^{\prime}=\frac{10}{9} R$