CHAPTER 03

OPEN STUDENT FOUNDATION
Physics (Class 12)
PRACTICE SHEET DAY 3

Date : 20/02/24

Section A

- **Write the answer of the following questions. [Each carries 1 Mark]** **[10]**

1. Write a note on Mobility.

2. The resistance of the platinum wire of a platinum resistance thermometer at the ice point is 5 Ω and at steam point is 5.23 Ω. When it is inserted in a hot bath, the resistance of the wire is 5.795 Ω. Calculate the temperature of the bath.

3. Write only statements of Kirchhoff's junction rule and loop rule.

4. Derive the formula for equivalent emf and equivalent internal resistance for two cells having emf ε_1 and ε_2, internal resistance r_1 and r_2 are connected in parallel.

5. Drift velocity of an electron passing through conductor is given by equation, $v_d = -\frac{eE}{m}\tau$. By accepting this equation obtain the equation of conductivity, $\sigma = \frac{ne^2}{m}\tau$.

6. A heating element using nichrome connected to a 230 V supply draws an initial current of 4.6 A which settles after a few seconds to a steady value of 2.3 A. What is the steady temperature of the heating element if the room temperature is 27 °C. [$\alpha = 1.7 \times 10^{-4}$ °C^{-1}]

7. A battery of V volt and negligible internal resistance is connected across the diagonally opposite corners of a cubical network consisting of 12 equal resistors each of resistance R Ω. Determine the equivalent resistance of the network.

8. What is current density ? Derive Ohm's law in form of current density.

9. Write limitations of Ohm's law.

10. What is series connection of cell ? Derive equation of equivalent emf of two cells with emf ε_1 and ε_2 connected in series.

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Section [A] : 1 Marks Questions					
No	Ans	Chap	Sec	Que	Universal_QueId
1.	-	Chap 3	S8	1.1	QP23P11B1211_P1C3S8Q1.1
2.	-	Chap 3	S8	1.2	QP23P11B1211_P1C3S8Q1.2
3.	-	Chap 3	S8	2	QP23P11B1211_P1C3S8Q2
4.	-	Chap 3	S8	4	QP23P11B1211_P1C3S8Q4
5.	-	Chap 3	S8	5	QP23P11B1211_P1C3S8Q5
6.	-	Chap 3	S8	6	QP23P11B1211_P1C3S8Q6
7.	-	Chap 3	S8	7	QP23P11B1211_P1C3S8Q7
8.	-	Chap 3	S1	11	QP23P11B1211_P1C3S1Q11
9.	-	Chap 3	S1	18	QP23P11B1211_P1C3S1Q18
10.	-	Chap 3	S1	30	QP23P11B1211_P1C3S1Q30

Section A

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1. Write a note on Mobility.

➠ Try Yourself

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6. A heating element using nichrome connected to a 230 V supply draws an initial current of 4.6 A which settles after a few seconds to a steady value of 2.3 A. What is the steady temperature of the heating element if the room temperature is 27 °C. [$\alpha = 1.7 \times 10^{-4}$ °C^{-1}]

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7. A battery of V volt and negligible internal resistance is connected across the diagonally opposite corners of a cubical network consisting of 12 equal resistors each of resistance R Ω. Determine the equivalent resistance of the network.

➠ Try Yourself

8. What is current density ? Derive Ohm's law in form of current density.

➠ **Current density :** The electric current density at any point is defined as amount of electric current flowing per unit cross section perpendicular to the current at that point.

Current density is vector quantity,

$$J = \frac{I}{A}$$

➠ SI unit of current density is $\frac{A}{m^2}$ or (Am^{-2}) and its dimensional formula is [$M^0 L^{-2} T^0 A^1$]

➠ Ohm's law

$V = IR$ ... (1)

Consider conductor of length l, electric field be E, potential difference between ends of conductor be V then,

$$E = \frac{V}{l}$$

$$V = El$$

By putting the values from eq. 1, $R = \frac{\rho l}{A}$

$El = \frac{I\rho l}{A}$ but current density $\frac{I}{A} = J$

$\therefore E = J\rho$

➠ Here $\vec{E}$ and $\vec{J}$ both are vector quantities, so their vector relation,

$\therefore \vec{E} = \vec{J}\rho$

$\therefore \vec{E} = J \times \frac{1}{\sigma}$ where $\rho = \frac{1}{\sigma}$

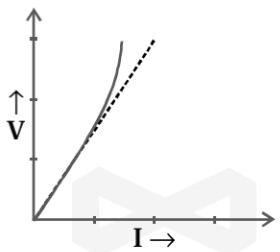
$\therefore \vec{J} = \vec{E}\sigma$

Often it is denoted as $\vec{E} = \vec{J}\rho$ and $\vec{J} = \vec{E}\sigma$.

9. Write limitations of Ohm's law.

➠ For certain materials and devices used in day to day life, voltage (V) and current (I) are not proportional to each other. So in such cases Ohm's law is not obeyed.

➠ (a) V and I are not proportional to each other.



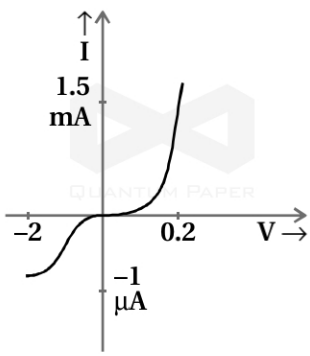
In graph, dotted line part shows that Ohm's law is obeyed, where as continuous curve of the graph shows that Ohm's law is not obeyed.

➠ When current flows through conductor, Joule heat is produced. Hence, when conductor is heated, its resistance increases. Hence, for such materials V and I graph will be continuous curve.

Example : Diode, Transistor.

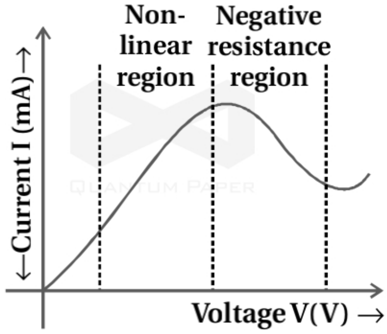
(b) Relation between I and V depend on polarity of V. Hence, for same positive or negative values of voltage, different current values are obtained.

Example : PN junction diode.



➠ In graph shown for positive and negative value of voltage and current, scales are different.

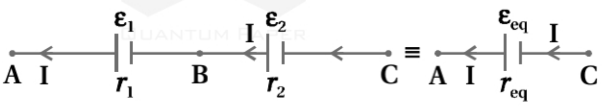
(c) I and V relation is not one-one function. For one value of current there are more than one values of voltage. For example, GaAs exhibit such behaviour.



➠ Figure shows I → V graph for GaAs. In such graph, $\frac{\Delta V}{\Delta I}$ is used to obtain resistance.

10. What is series connection of cell ? Derive equation of equivalent emf of two cells with emf ε_1 and ε_2 connected in series.

➠ When one terminal of two cells is connected with each other and other terminal of each cell is kept free, then such connection is called series connection of cell.



➠ In figure, battery having emf ε_1 and internal resistance r_1 is connected between A and B and battery with emf ε_2 and internal resistance r_2 is connected between B and C.

➠ Let equivalent emf between A and C be ε_{eq} and equivalent resistance of r_1 and r_2 be r_{eq}.

➠ Let potentials at point A, B and C be V(A), V(B) and V(C) respectively.

➠ p.d. between positive and negative terminal of first cell $V_{AB} = V(A) - V(B)$.

➠ p.d. between positive and negative terminal of second cell = V(B) – V(C).

$V(A) - V(B) = \varepsilon_1 - Ir_1$ ... (1)

$V(B) - V(C) = \varepsilon_2 - Ir_2$ ... (2)

➠ p.d. between A and C,

$V_{AC} = V_{AB} + V_{BC}$

$= [V(A) - V(B)] + [V(B) - V(C)]$

$= \varepsilon_1 - Ir_1 + \varepsilon_2 - Ir_2$

$= \varepsilon_1 + \varepsilon_2 - Ir_1 - Ir_2$

$= \varepsilon_1 + \varepsilon_2 - I(r_1 + r_2)$ ... (3)

For given combination, equivalent emf between A and C be ε_{eq} and internal resistance r_{eq},

$V_{AC} = V(A) - V(C) = \varepsilon_{eq} - Ir_{eq}$ ... (4)

Comparing (3) and (4),

$\varepsilon_{eq} = \varepsilon_1 + \varepsilon_2$

and $r_{eq} = r_1 + r_2$

If cells are connected in series in opposing condition then,

$V_{BC} = V(B) - V(C)$

$= -\varepsilon_2 - Ir_2$

$\therefore \varepsilon_{eq} = \varepsilon_1 - \varepsilon_2 \ (\varepsilon_1 > \varepsilon_2)$

➠ If '*n*' cells are connected in series helping condition then,

$\varepsilon_{eq} = \varepsilon_1 + \varepsilon_2 + \dots + \varepsilon_n$

equivalent internal resistance of combination will be equal to summation of individual internal resistance of each cell.

$r_{eq} = r_1 + r_2 + \dots + r_n$

If given cell is connected in opposing condition then emf of given cell will be considered as negative.