CURRENT ELECTRICITY

CLASS XII

Current Electricity

Electric Current

- $I = \frac{q}{t} = \frac{ne}{t}$
- In case of an electron revolving in a circle of radius r with speed v, period of revolution is $T = \frac{2\pi r}{v}$
- Frequency of revolution $\upsilon = \frac{v}{2\pi r}$
- Current at any point of the orbit is $I = \frac{e}{T} = \frac{ev}{2\pi r}$

Ohm's Law, Resistance and Resistivity

- $V = IR$
- Resistance of uniform conductor of length l and cross sectional area A, $R = \frac{\rho l}{A}$
- Resistivity or specific resistance, $\rho = \frac{RA}{l}$
- Effective specific resistance in series combination is $\frac{\rho_1 l_1 + \rho_2 l_2}{l_1 + l_2}$ (A is same).
- Effective specific resistance in parallel combination is $\frac{(A_1 + A_2)\rho_1\rho_2}{A_1\rho_2 + A_2\rho_1}$ (l is same).

Current Density, Conductance and Conductivity

- Conductance, $G = \frac{1}{R}$
- Conductivity, $\sigma = \frac{1}{\rho} = \frac{l}{RA}$
- Current density, $J = \frac{I}{A} = \sigma E = nev_d$

Electric Power

$P = VI = I^2R = \frac{V^2}{R}$

Kirchhoff's Laws

- Law of conservation of charge applied at a junction, *i.e.*, $\Sigma I = 0$
- Law of conservation of energy applied in closed loop, *i.e.*, $\Sigma\varepsilon = \Sigma IR$

Drift Velocity and Mobility of Charge

- Drift speed, $v_d = \frac{eE}{m}\tau$
- Mobility, $\mu_e = \frac{v_d}{E}$
- Current in terms of drift velocity, $I = neAv_d = \frac{ne^2A\tau E}{m} = neA\mu_e E = neA\mu_e\frac{V}{l}$
- In terms of relaxation time τ, $R = \frac{ml}{ne^2\tau A}$ and $\rho = \frac{m}{ne^2\tau}$

Variation of Resistance with Temperature

- Temperature coefficient of resistance, $\alpha = \frac{R_2 - R_1}{R_1(T_2 - T_1)}$

If $T_1 = 0°C$ and $T_2 = T\,°C$ then $\alpha = \frac{R_T - R_0}{R_0 \times T}$ or $R_T = R_0(1 + \alpha T)$

Combination of Resistances

- In series, equivalent resistance, $R_s = R_1 + R_2 + R_3 + ...$
- In parallel, equivalent resistance, $\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + ...$
- For two resistances in parallel current through the two resistances will be, $I_1 = \frac{R_2 I}{R_1 + R_2}, I_2 = \frac{R_1 I}{R_1 + R_2}$
- When resistances are connected in series, the current through each resistance is same. In parallel combination voltage is same.

Emf, Internal Resistance, Current in case of Grouping of Cells

- Emf of a cell, $\varepsilon = \frac{W}{q}$
- Terminal potential difference where current is being drawn from the cell, $V = \varepsilon - Ir$
- Terminal potential difference when the cell is being charged $V = \varepsilon + Ir$
- Internal resistance of a cell, $r = R\left[\frac{\varepsilon - V}{V}\right]$
- Grouping of identical cells :
  - Cells in series, $I = \frac{n\varepsilon}{R + nr}$ (n cells)
  - Cells in parallel, $I = \frac{m\varepsilon}{mR + r}$ (m cells)
  - Cells in mixed grouping, $I = \frac{mn\varepsilon}{mR + nr}$

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