3. CURRENT ELECTRICITY

Single Page Simple Synopsis

Current Electricity explores the flow of electric charge, covering key concepts like electric current, resistance, and Ohm's Law.

KEY CONCEPTS:

1. **Electric Current (I)** is the rate of flow of electric charge through a conductor. Current can be steady (constant) or varying over time. **SI unit:** ampere (A).
2. **Ohm's Law** states that the current flowing through a conductor between two points is directly proportional to the voltage across the two points, provided the temperature remains constant.

   Formula: $I = \frac{V}{R}$. Here V is the potential difference and R is the resistance.
3. **Resistance (R):** The opposition to the flow of electric current, measured in ohms (Ω).

   Factors affecting resistance are resistivity (ρ) of the conductor, length (L), cross-sectional area (A).

   Formula: $R = \rho\frac{L}{A}$. Here ρ is the resistivity of the material
4. **Current Density (J)** is the current per unit area of cross-section.

   It is a vector quantity, indicating the direction of current flow.

   Formula: $J = \frac{I}{A}$ (or) $J = \sigma\vec{E}$
5. **Drift Velocity (v_d):** The average velocity of charge carriers (like electrons) in a conductor when an electric field is applied.

Kirchhoff's Laws: These laws help to find unknown currents and voltages across complex circuits.

6. **Kirchhoff's Current Law** (KCL) states that the total current entering a junction equals the total current leaving it. (or) Algebraic sum of currents meeting at any junction is zero.
7. **Kirchhoff's Voltage Law (KVL)** states that the sum of the electrical potential differences around any closed network is zero.
8. **Power in Electrical Circuits:**

   The power (P) consumed in a circuit is given by P=IV

   Here I is the current and V is the voltage.

Real Life Examples

- **Electric Bulbs and lights,** mobile phone charges, ACs, Electrical Vehicles,...

IMP. IPE POINTS

1. **Electric current** (I) is the rate of charge passing through a cross section of a conductor.

$I = \frac{q}{t}$ (or) $I_{instant} = \frac{dq}{dt}$

SI unit: ampere (A).

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2. **Drift velocity (v_d)** is the speed with which an electron gets drifted in a metallic conductor under the application of an external electric field . $v_d = \frac{I}{neA} = \frac{J}{ne}$

SI unit: ms^{-1}.

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3. **Resistance(R)** is the ratio between voltage and current. $R = \frac{V}{I}$ **SI unit:** ohm (Ω)

R depends on length, area, temperature and type of material.

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4. The resistance of a metal increases with the rise of temperature. But resistance of insulators and semiconductors decreases with the rise of temperature.

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5. **Resistivity** (ρ) of material of the conductor is the resistance of a conductor per unit length per unit area of cross section.

$\rho = \frac{RA}{l}$ (or) $\rho = \frac{E}{J}$

SI unit: Ωm.

ρ depends only on material and temperature.

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6. **Terminal voltage** (V) is the voltage between the terminals of a cell.

For **charging** of a cell, $V = \varepsilon + Ir$ (V>E)

For **discharging** of a cell, $V = \varepsilon - Ir$ (V<E)

where ε is emf and r is internal resistance

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7. **Current** passing through a circuit with a cell of emf ε, internal resistance r and external resistance R is $I = \frac{\varepsilon}{R + r}$

8. **Equivalent resistance** of 2 resistors connected in **series** is $R_s = R_1 + R_2$

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9. **Equivalent resistance** of two resistors connected in **parallel** is

$R_p = \frac{R_1 R_2}{R_1 + R_2}$

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10. When a conductor is stretched, its length increases, area of cross section decreases, but volume , density remain constant.
Its resistance $R \propto l^2$

For solving problems , $\frac{R_2}{R_1} = \frac{l_2^2}{l_1^2}$

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11. Electric power $P = VI$
(or) $P = I^2 R$ (or) $P = \frac{V^2}{R}$

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12. **Kirchhoff's junction rule:** $\sum I_{in} = \sum I_{out}$

Kirchhoff's loop rule: $\sum \varepsilon + \sum IR = 0$

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13. **Wheatstone bridge - balance condition:**

$\frac{R_2}{R_1} = \frac{R_4}{R_3}$; $i_g = 0$

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14. **Colour code of resistors:**
Digit (multiplier) = colour

0(10^0) = Black
1(10^1) = Brown
2(10^2) = Red
3(10^3) = Orange
4(10^4) = Yellow
5(10^5) = Green
6(10^6) = Blue
7(10^7) = Violet
8(10^8) = Gray
9(10^9) = White

The 1st and 2nd colours represent simply digits in the places.

But the third colour represents the power of the decimal multiplier.

4th colour represents tolerance.

Gold = 5% tolerance,

Silver = 10% tolerance,

No colour = 20% tolerance.

Memory Tip

B.B.Roy of Great Britain has a Very Good Wife.