Unit 1: Static Electricity

Lesson 1: Meaning of Static Electricity
- Electricity: The flow of electric charges (electrons or ions).
- Types of Charges:
  - Positive (+): e.g., protons.
  - Negative (–): e.g., electrons.
- Conductors: Allow charge to move freely (e.g., metals).
- Insulators: Do not allow charge to move easily (e.g., rubber, plastic).
-Static Electricity: Produced by friction; charges stay on surface and do not flow continuously.
Ex-ample:
- Rubbing a plastic rod with wool → becomes negatively charged.
- Rubbing a glass rod with silk → becomes positively charged.

Lesson 2: Coulomb's Law
- Coulomb's Law: Describes the force between two point charges.
- Formula:

- **Formula:**

$$F = k\frac{q_1 q_2}{d^2}$$

Where:

- F: Force in Newtons (N)
- $k = 9 \times 10^9\ \mathrm{N \cdot m^2/C^2}$
- q_1, q_2: Charges in Coulombs (C)
- d: Distance in meters (m)

Notes:
- Like charges repel, unlike charges attract.
- Force is inversely proportional to the square of the distance.

Lesson 3: Repulsive and Attractive Forces
- Repulsion: Between same charges (+ & +) or (– & –).
- Attraction: Between opposite charges (+ & –).

Lesson 4: Electric Field
- Electric Field (E): Region around a charge where it exerts force on other charges.
- Electric Field Intensity:

$$E = \frac{F}{q} = k\frac{q}{d^2}$$

Measured in: N/C.
- Direction:
  - Away from positive charges.

-Toward negative charges.

Lesson 5: Electric Capacitor
- Capacitor: Two conducting plates separated by an insulator.
- Capacitance (C): Ability to store electric charge.

$$C = \frac{Q}{V}$$

- Measured in Farads (F).
- Series Connection:

$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \cdots$$

- Parallel Connection:

$$C_{eq} = C_1 + C_2 + \cdots$$

Unit 2: Dynamic Electricity

Lesson 1: Basic Concepts
- Electric Current (I): Flow of electric charge.

$$I = \frac{Q}{t}$$

- Measured in Amperes (A).

- Potential Difference (V): Work done per unit charge.

$$V = \frac{W}{Q}$$

- Measured in Volts (V).
- **Resistance (R): Opposition to current flow.

$$R = \frac{V}{I}$$

- Measured in Ohms (Ω).

Lesson 2: Ohm’s Law
- Ohm’s Law:

$$V = IR$$

- Linear relationship at constant temperature.
- Graph of V vs. I is straight line with slope = R.

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🔧 Lesson 3: Ohmic Resistance

- **Factors Affecting Resistance:**

$$R = \rho \frac{l}{A}$$

Where:

  - ρ: Resistivity (Ω·m)
  - l: Length
  - A: Cross-sectional area

- **Conductivity (σ):**

$$\sigma = \frac{1}{\rho}$$

Lesson 4: Ohm's Law for Closed Circuit
- EMF (Electromotive Force): Total energy per unit charge supplied by cell.
- Internal Resistance (r): Resistance inside the cell itself.
- Terminal Voltage:

$$V = \text{EMF} - Ir$$

- Total Current :

$$I = \frac{\text{EMF}}{R + r}$$

Lesson 5: Connections of Resistors
- Series Connection:
  - Same current through all resistors.
  - Total resistance:

$$R_{\text{eq}} = R_1 + R_2 + R_3 + \cdots$$

- Parallel Connection:
  - Same voltage across all resistors.
  - Total resistance:

$$\frac{1}{R_{\text{eq}}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \cdots$$

Formula Sheet (Quick Revision)

CONCEPT	FORMULA
Coulomb's Law	$F = k\frac{q_1 q_2}{d^2}$
Electric Field	$E = \frac{F}{q}$ or $E = k\frac{q}{d^2}$
Capacitance	$C = \frac{Q}{V}$
Series Capacitors	$\frac{1}{C_{\text{eq}}} = \frac{1}{C_1} + \frac{1}{C_2} + \cdots$
Parallel Capacitors	$C_{\text{eq}} = C_1 + C_2 + \cdots$
Electric Current	$I = \frac{Q}{t}$
Ohm's Law	$V = IR$
Resistance	$R = \rho\frac{l}{A}$
Terminal Voltage	$V = \text{EMF} - Ir$
Power	$P = VI = I^2R = \frac{V^2}{R}$

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Practice Questions (With Answers)

MCQ Questions

1. What happens when two like charges are brought close together?
   a) They attract
   b) They repel ✓
   c) Nothing happens
   d) They cancel each other

2. Which of the following is a good conductor?
   a) Plastic
   b) Rubber
   c) Wood
   d) Copper ✓

3. What is the SI unit of electric current?
   a) Volt
   b) Ohm
   c) Ampere ✓
   d) Coulomb

4. In a series circuit, which quantity remains the same?
   a) Voltage
   b) Resistance
   c) Current ✓
   d) Power

5. Ohm's law states that:
   a) V = I/R
   b) V = IR ✓
   c) I = V/R
   d) Both b and c

Problem-Solving Questions

1. Two charges, $q_1 = +4\mu C$ and $q_2 = -6\mu C$, are placed 2 cm apart. Calculate the electrostatic force between them.

   Answer:
   Using $F = k\frac{q_1 q_2}{d^2}$:
   $F = 9 \times 10^9 \times \frac{(4\times10^{-6})(6\times10^{-6})}{(0.02)^2} = 540N$

2. A resistor has a resistance of 10 Ω and a current of 2 A flows through it. Find the potential difference across it.

   Answer:
   $V = IR = 2 \times 10 = 20V$

Conceptual Questions

1. Why does static electricity occur?
   Answer: Due to transfer of electrons between materials during rubbing/friction.

2. What is the difference between conductors and insulators?
   Answer: Conductors allow charges to move freely, while insulators restrict movement.

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