ChapterNotes

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CHAPTER NOTES

Electricity Class 10 Notes I CBSE Chapter 11 Science

Electricity Class 10 Notes | CBSE Chapter 11 Science

Electricity is Chapter 11 of CBSE Class 10 Science. This chapter covers electric current, potential difference, Ohm's law, resistance, circuits, and the heating effect of electric current. It also introduces the concept of electric power and how electricity is measured for household consumption.

This is one of the most important chapters for board exams — expect 8–10 marks. Ohm's law, series and parallel circuits, numericals on resistance and power, and the heating effect of current are heavily tested.

Key Concepts

1. Electric Current

Electric current is the flow of electric charge (electrons) through a conductor.

Formula: I = Q/t

- I = current (in Amperes, A)
- Q = charge (in Coulombs, C)
- t = time (in seconds, s)

1 Ampere = 1 Coulomb of charge flowing per second.

Direction convention: Conventional current flows from positive (+) to negative (–) terminal. Actual electron flow is from negative to positive (opposite direction).

Ammeter: Instrument used to measure current. Always connected in **series** in the circuit. Has **low resistance**.

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2. Electric Potential and Potential Difference

Electric potential at a point is the work done in bringing a unit positive charge from infinity to that point.

Potential difference (V) between two points is the work done in moving a unit positive charge from one point to another:

V = W/Q

- V = potential difference (in Volts, V)
- W = work done (in Joules, J)
- Q = charge (in Coulombs, C)

1 Volt = 1 Joule of work done per Coulomb of charge.

Voltmeter: Instrument used to measure potential difference. Always connected in **parallel** across the component. Has **high resistance**.

A **battery or cell** provides the potential difference that drives current through a circuit.

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3. Ohm's Law

Ohm's Law: The current flowing through a conductor is directly proportional to the potential difference across it, provided the temperature remains constant.

V = IR

- V = potential difference (Volts)
- I = current (Amperes)
- R = resistance (Ohms, Ω)

The **V-I graph** for an ohmic conductor (one that obeys Ohm's law) is a **straight line** passing through the origin. The slope of this line gives 1/R.

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4. Resistance

Resistance is the opposition offered by a conductor to the flow of electric current.

Unit: Ohm (Ω). R = V/I

1 Ohm = resistance of a conductor when a potential difference of 1 V produces a current of 1 A.

Factors Affecting Resistance

R = ρl/A

Factor	Effect on Resistance
Length (l)	R ∝ l — longer wire = more resistance
Cross-sectional area (A)	R ∝ 1/A — thicker wire = less resistance
Material (ρ — resistivity)	Different materials have different resistivity. Copper has low ρ (good conductor); Nichrome has high ρ (used in heating elements)
Temperature	For metals: R increases with temperature. For semiconductors: R decreases with temperature

Resistivity (ρ) is a material property. Unit: Ω·m (ohm-metre).

Material	Resistivity (Ω·m)	Use
Silver	1.60×10^{-8}	Best conductor (but expensive)
Copper	1.62×10^{-8}	Electrical wires
Nichrome	1.10×10^{-6}	Heating elements (high resistivity)
Rubber	10^{13} to 10^{16}	Insulator

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5. Combination of Resistors

a) Series Combination

Resistors connected end-to-end (one after another). Same current flows through all resistors.

- **Total resistance:** $R = R_1 + R_2 + R_3 + \ldots$
- Total resistance is **greater** than the largest individual resistance
- **Current:** Same through all resistors ($I = I_1 = I_2 = I_3$)
- **Voltage:** Divides across resistors ($V = V_1 + V_2 + V_3$)
- If one component fails, the entire circuit breaks (like old Christmas lights)

b) Parallel Combination

Resistors connected side by side (both ends connected to the same two points). Same voltage across all resistors.

- **Total resistance:** $1/R = 1/R_1 + 1/R_2 + 1/R_3 + \ldots$
- Total resistance is **less** than the smallest individual resistance
- **Voltage:** Same across all resistors ($V = V_1 = V_2 = V_3$)
- **Current:** Divides among resistors ($I = I_1 + I_2 + I_3$)
- If one component fails, others continue to work (household wiring uses this)

Comparison Table

Feature	Series	Parallel
Current	Same through all	Divides among branches
Voltage	Divides across resistors	Same across all
Total R	$R = R_1 + R_2 + \ldots$ (increases)	$1/R = 1/R_1 + 1/R_2 + \ldots$ (decreases)
If one fails	Circuit breaks	Others still work
Used in	Series circuits, resistor chains	Household wiring, appliances

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6. Heating Effect of Electric Current

When current flows through a resistor, electrical energy is converted to **heat energy**. This is called the **heating effect of current** (also called Joule heating).

Joule's Law of Heating:

$H = I^2Rt$

- H = heat produced (in Joules)
- I = current (in Amperes)
- R = resistance (in Ohms)
- t = time (in seconds)

Also: $H = VIt = V^2t/R$

Applications of Heating Effect

- **Electric heater, iron, toaster:** Use nichrome wire (high resistivity, high melting point, doesn't oxidise easily)
- **Electric bulb:** Tungsten filament (melting point ~3380°C) glows white-hot; filled with inert gas (argon/nitrogen) to prevent oxidation
- **Electric fuse:** Short piece of wire with low melting point. If current exceeds the rated value, the fuse wire melts and breaks the circuit — protecting appliances. Common fuse ratings: 1A, 2A, 3A, 5A, 10A, 15A

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7. Electric Power and Energy

Electric Power

Power is the rate of doing work or the rate of consuming electrical energy.

$P = VI = I^2R = V^2/R$

Unit: Watt (W). 1 W = 1 J/s. Also: 1 kW = 1000 W

Electric Energy

E = P × t = VIt

Commercial unit of energy: kilowatt-hour (kWh)

1 kWh = 1 unit of electricity = 3.6×10^6 J (3600 kJ)

This is the "unit" mentioned in electricity bills. If a 1000 W heater runs for 1 hour, it consumes 1 kWh = 1 unit.

Important Definitions

Term	Definition
Electric current	Flow of electric charge through a conductor; I = Q/t; unit: Ampere (A)
Potential difference	Work done per unit charge between two points; V = W/Q; unit: Volt (V)
Resistance	Opposition to flow of current; R = V/I; unit: Ohm (Ω)
Ohm's law	V = IR (at constant temperature)
Resistivity	Property of a material that determines its resistance; ρ = RA/l; unit: Ω·m
Electric power	Rate of electrical energy consumption; P = VI; unit: Watt (W)
Kilowatt-hour	Commercial unit of electrical energy; 1 kWh = 3.6×10^6 J
Fuse	Safety device that breaks the circuit when current exceeds a safe limit

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Solved Examples (NCERT-Based)

Example 1

A current of 0.5 A flows through a conductor when a potential difference of 10 V is applied. Find the resistance of the conductor.

Answer: Using Ohm's law: R = V/I = 10/0.5 = **20 Ω**

Example 2

Three resistors of 2 Ω, 3 Ω, and 6 Ω are connected in parallel. Find the total resistance.

Answer: $1/R = 1/2 + 1/3 + 1/6 = 3/6 + 2/6 + 1/6 = 6/6 = 1$

R = **1 Ω**

(As expected, total resistance in parallel is less than the smallest resistor.)

Example 3

An electric iron consumes energy at the rate of 840 W when the voltage is 220 V. Find the current and resistance.

Answer: $P = VI \rightarrow I = P/V = 840/220 =$ **3.82 A**

$R = V/I = 220/3.82 =$ **57.6 Ω** (or $R = V^2/P = 220^2/840 = 57.6\ \Omega$)

Example 4

How much energy does a 100 W bulb consume in 10 hours? Express in kWh and Joules.

Answer: $E = P \times t = 100\ W \times 10\ h = 1000\ Wh =$ **1 kWh** (1 unit)

In Joules: $1\ kWh = 3.6 \times 10^6\ J =$ **3,600,000 J**

Example 5

A wire of resistance 10 Ω is stretched to double its length. What is the new resistance?

Answer: When stretched to double length: $l' = 2l$. Volume remains constant, so $A' = A/2$.

$R' = \rho l'/A' = \rho(2l)/(A/2) = 4(\rho l/A) = 4R = 4 \times 10 =$ **40 Ω**

Resistance becomes 4 times when length is doubled (with same volume).

Important Questions for Board Exams

1-Mark Questions

1. State Ohm's law.
2. What is the SI unit of electric power?
3. Why is an ammeter connected in series?
4. What is 1 kWh in Joules?
5. Name the material used for making the filament of an electric bulb. Why?

2-Mark Questions

1. What is the difference between resistance and resistivity?
2. Why are household appliances connected in parallel rather than series?
3. Calculate the resistance of a wire of length 2 m, cross-sectional area 0.5 mm^2, and resistivity 1.6×10^{-8} Ω·m.
4. What is a fuse? How does it protect electrical appliances?
5. A 5 Ω and 10 Ω resistor are connected in series to a 12 V battery. Find the current.

3-Mark Questions

1. Derive the formula for equivalent resistance when resistors are connected in (a) series and (b) parallel.
2. State Joule's law of heating. A coil of resistance 50 Ω carries a current of 2 A for 30 seconds. Find the heat produced.
3. Draw a circuit diagram showing three resistors R_1, R_2, and R_3 connected in parallel with a battery and ammeter.
4. How does the resistance of a conductor depend on (a) its length, (b) its cross-sectional area, and (c) its material?
5. Two resistors of 6 Ω and 12 Ω are connected in parallel. A 6 V battery is connected. Find the total current drawn from the battery and the current through each resistor.

5-Mark Questions

1. What is Ohm's law? Draw a V-I graph for an ohmic conductor. Three resistors of 5 Ω, 10 Ω, and 15 Ω are connected in series with a 30 V battery. Find the current, total resistance, and potential difference across each.
2. Explain the heating effect of electric current. State Joule's law. Give three applications. Why is nichrome used in heating elements?

Quick Revision Points

- Current $I = Q/t$ (unit: Ampere); Potential difference $V = W/Q$ (unit: Volt)
- Ohm's law: $V = IR$; V-I graph is a straight line for ohmic conductors
- Resistance $R = V/I$ (unit: Ohm); $R = \rho l/A$ (depends on length, area, material)
- Series: $R = R_1 + R_2 + \ldots$; same current; voltage divides
- Parallel: $1/R = 1/R_1 + 1/R_2 + \ldots$; same voltage; current divides
- Household appliances: connected in parallel (independent operation, same voltage)
- Heating effect: $H = I^2Rt = VIt = V^2t/R$
- Nichrome: high resistivity + high MP + doesn't oxidise → used in heaters
- Tungsten: very high MP (3380°C) → used in bulb filaments
- Fuse: low MP wire; melts when excess current flows → breaks circuit
- Power: $P = VI = I^2R = V^2/R$; unit: Watt (W)
- Energy: $E = Pt$; 1 kWh = 1 unit = 3.6×10^6 J

- Ammeter: series, low R; Voltmeter: parallel, high R

Previous Chapter: Chapter 10 — The Human Eye and the Colourful World
Next Chapter: Chapter 12 — Magnetic Effects of Electric Current