🌟 CURRENT ELECTRICITY – FULL STUDY GUIDE (CLASS 12)

🎯 *Easy → Visual → Exam-Focused → Beginner-Friendly*

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1. THEORY IN SIMPLE WORDS (WITH VISUALS)

🌈 1.1 What is Electric Current?

Electric current = **flow of electric charges (electrons)** in a conductor.

Symbol:

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

Analogy:

Think of electrons as **water** flowing in a pipe.

Visual:

```
Battery → → → Electrons → → → Bulb
```

🌈 1.2 Electric Current Direction

- Electrons flow **from – to +**
- Conventional current is taken **from + to –**

Visual:

```
+ → → → conventional current
     ← ← electrons
```

🌈 1.3 Drift Velocity

Average velocity with which electrons move in a conductor under electric field.

$$v_d = \frac{I}{nAe}$$

Where:
n = number density of electrons

A = area of cross section
e = charge of electron

Analogy:
Like students slowly drifting toward the exit after school.

🌈 1.4 Mobility (μ)

How easily electrons move.

$$\mu = \frac{v_d}{E}$$

🌈 1.5 Ohm's Law

$$V = IR$$

Meaning:
Voltage ∝ Current (if temperature constant)

Visual:

```
More R = harder for charges to pass (thin pipe)
Less R = easier (thick pipe)
```

🌈 1.6 Resistance (R)

Opposition to the flow of charges.

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

Where ρ = resistivity (property of material)

🌈 1.7 Resistivity (ρ)

- Depend on material only
- Unit: Ωm
- Metals → low ρ
- Insulators → high ρ

🌈 1.8 Temperature Dependence

For metals:
Temperature ↑ → resistance ↑

For semiconductors:
Temperature ↑ → resistance ↓

Visual:

```
Heat = vibrations = electrons hitting atoms more = more resistance
```

🌈 1.9 Electrical Power

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

🌈 1.10 EMF & Potential Difference

EMF (E):

Work done per unit charge in maintaining current in circuit.

Potential Difference (V):

Energy used by charge between two points.

Difference:

- EMF → source/battery
- PD → used by components

🌈 1.11 Internal Resistance

Resistance inside battery.

Visual:

```
(Battery) [r] ---- external circuit
```

Terminal voltage:

$$V = E - Ir$$

🌈 1.12 Series & Parallel Combination of Resistors

Series:

$$R_s = R_1 + R_2 + \ldots$$

Parallel:

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$$

Visual:

```
Series: one path
Parallel: multiple paths
```

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2. KEY CONCEPTS & FORMULAS TABLE

Concept	Formula	Trick
Current	$I = Q/t$	"Flow per sec"
Drift velocity	$v_d = I/(nAe)$	**I on top**
Mobility	μ = v/E	"Velocity per field"
Ohm	V = IR	TRIANGLE: V on top
Resistance	$R = \rho L/A$	Long ↑ = R↑, Thick ↑ = R↓
Resistivity	ρ = RA/L	Material only
Power	$P = VI, I^2R, V^2/R$	V = IR transform
EMF relation	V = E – Ir	Loss in battery
Series	R = R1 + R2	add directly
Parallel	1/R = 1/R1 + 1/R2	"Cross-multiply shortcut"
Conductance	G = 1/R	reciprocal

🌈 Mnemonics

For Ohm's Law Triangle

```
   V
I   R
```

For Resistance: "L over A"

- Longer → harder
- Wider → easier

For series/parallel:

RES-SER, CAP-PAR
(Resistors add in Series)

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3. SOLVED NUMERICAL PROBLEMS

⭐ Type 1: Ohm's Law

Example:

A 10Ω resistor is connected to 5V. Find current.

$$I = V/R = 5/10 = 0.5A$$

⭐ Type 2: Resistance using ρ

Example:

A wire of length 2m, area $1 \times 10^{-6} m^2$, resistivity $2 \times 10^{-6} \Omega m$.
Find resistance.

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

$$= 2 \times 10^{-6} \cdot \frac{2}{1 \times 10^{-6}}$$

$$= 4\Omega$$

⭐ Type 3: Power

Example:

Current = 3A, R = 4Ω. Find power.

$$P = I^2R = 9 \cdot 4 = 36W$$

⭐ Type 4: EMF & internal resistance

Example:

E = 12V, r = 1Ω, current = 2A. Find terminal voltage.

$$V = E - Ir = 12 - 2 = 10V$$

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4. PAST YEAR BOARD QUESTIONS (SOLVED)

(Based on common CBSE trends)

✔ Q1 (2023)

State Ohm's law. Define resistance.

Ans: V ∝ I if temperature constant; V = IR.
Resistance = opposition to flow of current.

✔ Q2 (2022)

Explain drift velocity and relation with current.

Ans:

$$I = nAve_d$$

✔ Q3 (2021)

Derive equivalent resistance in series.

(Write voltages add, current same → sum of resistances.)

✔ Q4 (2020 – Numerical)

A 5Ω and 10Ω resistors connected in parallel. Find equivalent R.

$$\frac{1}{R} = \frac{1}{5} + \frac{1}{10}$$

$$R = 3.33\Omega$$

✔️ Q5 (2019)

Define EMF and terminal voltage.

(Write definitions + formula V = E – Ir.)

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5. QUICK REVISION NOTES (1–2 PAGE STYLE)

🌟 Current

- Flow of charges
- I = Q/t
- Direction: + → – (conventional)

🌟 Drift Velocity

- Slow movement
- I = nAve_d

🌟 Resistance

- R = ρL/A
- ρ depends on material

🌟 Temperature Effect

- Metals: R ↑ with T ↑
- Semiconductors: R ↓ with T ↑

🌟 Ohm's Law

- V = IR
- Straight line V–I graph

🌟 Power

- P = I^2R (useful in numericals!)

🌟 EMF & Internal Resistance

- V = E – Ir
- Terminal voltage < EMF unless I = 0

🌟 Series/Parallel

- Series → R increases
- Parallel → R decreases

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6. PREDICTED / LIKELY QUESTIONS (2025 BOARD TREND)

Short Questions

- Define drift velocity
- Define mobility
- Write relation between current & drift velocity
- State Ohm's law
- What is resistivity?

Long Questions

- Derive R = ρL/A
- Derive series/parallel formulas
- Discuss temperature dependence of resistance

Important Numericals

- Ohm's law (easy scoring)
- Power & energy
- Using ρ to calculate R
- EMF & internal resistance

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7. EXAM TIPS & TRICKS

✔️ Tip 1:

Always check units (most marks lost here!)

✔️ Tip 2:

Convert mm^2 → m^2 (area unit mistakes common in ρ problems).

✔️ Tip 3:

For parallel resistors (two only), use shortcut:

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

✔️ Tip 4:

Draw V–I graph when asked: straight line through origin = Ohmic conductor.

✔️ Tip 5:

In EMF problems, first find current, then terminal voltage.

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8. VISUAL & KID-FRIENDLY MEMORY TOOLS

🎨 Visual 1: Resistance

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Thin wire → high R
Thick wire → low R
```

🎨 Visual 2: Current Flow

```
River flow → electrons flowing
```

🎨 Visual 3: Parallel vs Series

```
Series:   one road
Parallel: many roads
```

🎨 Visual 4: Power

“More current = more heat”

```
🔥 P = I²R
```