Current Electricity

Class 12 · Physics · Quick Revision · **chapternotes.in**

NEET: 2-3 Qs (~8-12 marks) | Boards: 7-9 marks

Scan: practise free

Charge in motion: how current flows, what resists it, how cells drive it, and the rules (Ohm, Kirchhoff) that solve any circuit.

1. Current, Drift & Ohm's Law

Current = rate of charge flow; drift velocity links it to electrons.

$I = q / t$
SI: ampere (A) - scalar

$I = n A e v_d$
microscopic current

$v_d = (e E / m) \tau$
τ = relaxation time

$V = I R$
Ohm's law

$J = I/A = \sigma E$
current density

- Conventional current is opposite to electron flow.

MUST KNOW Drift velocity is tiny (~mm/s) yet the bulb lights instantly - the field sets up at ~c.

- Mobility $\mu = v_d / E = e\tau/m$.

2. Resistance, Resistivity & Temperature

Resistance depends on material (ρ), geometry, and temperature.

$R = \rho L / A$
geometry

$\rho = m / (n e^2 \tau)$
microscopic resistivity

$R_T = R_0 (1 + \alpha \Delta T)$
α = temp. coeff.

MUST KNOW Resistivity ρ is a material property; resistance R is not (depends on L, A).

MUST KNOW Metals: ρ rises with temperature ($\alpha > 0$). Semiconductors/insulators: ρ falls ($\alpha < 0$).

MUST KNOW On stretching a wire n times, R becomes n^2 times (volume constant).

3. Series & Parallel Combinations

Add resistances in series; add reciprocals in parallel.

Series: $R = R_1 + R_2 + \ldots$
same current

Parallel: $1/R = 1/R_1 + 1/R_2 + \ldots$
same voltage

- Series: current same, voltage divides. Parallel: voltage same, current divides.

MUST KNOW Parallel R is always less than the smallest resistor.

4. EMF, Internal Resistance & Cells

A real cell has emf ε and internal resistance r.

$\varepsilon = I (R + r)$
single cell

$V = \varepsilon - I r$
terminal voltage (discharge)

Series: $\varepsilon = \Sigma\varepsilon_i$, $r = \Sigma r_i$
n cells

Parallel (identical): $\varepsilon_{eq} = \varepsilon$, $r_{eq} = r/n$

MUST KNOW Terminal V < ε while discharging; V > ε while charging; V = ε in open circuit.

MUST KNOW Max power transfer to load when R = r ($P_{max} = \varepsilon^2/4r$).

5. Kirchhoff, Wheatstone & Potentiometer

KCL + KVL solve any circuit; bridge & potentiometer are the classic instruments.

KCL: $\Sigma I = 0$ (junction)
charge conservation

KVL: $\Sigma V = 0$ (loop)
energy conservation

Wheatstone balance: $P/Q = R/S$
no galvanometer current

Potentiometer: $\varepsilon \propto l$
balancing length

MUST KNOW At Wheatstone balance, no current flows through the galvanometer - bridge is independent of the cell.

MUST KNOW Potentiometer draws NO current at balance, so it measures true emf (unlike a voltmeter).

- Meter bridge = Wheatstone on a 1 m wire; balance: $R/S = l/(100 - l)$.

6. Electrical Power & Heating

Power dissipated and heat produced in a resistor.

$P = V I = I^2 R = V^2/R$
pick by what's constant

$H = I^2 R t$
Joule heating

1 unit = 1 kWh = 3.6×10^6 J
commercial energy

MUST KNOW Series bulbs: same I, so higher-R bulb glows brighter. Parallel: same V, so lower-R bulb glows brighter.

- A bulb rated (P, V) has $R = V^2/P$ - use rated values to find R.

Series vs Parallel

	Series	Parallel
Current	Same in all	Divides
Voltage	Divides	Same across all
Net R	Sum (largest)	< smallest
Use	Current control	Constant voltage

Terminal Voltage of a Cell

State	Relation
Discharging	$V = \varepsilon - Ir$ ($V < \varepsilon$)
Charging	$V = \varepsilon + Ir$ ($V > \varepsilon$)
Open circuit	$V = \varepsilon$ ($I = 0$)

Mnemonic - Resistor colour code 0-9: Black Brown Red Orange Yellow Green Blue Violet Grey White
B B ROY of Great Britain had a Very Good Wife

Common traps

- Drift velocity is small, but current and the field travel near light-speed - don't confuse the two.
- Ammeter = LOW resistance, in SERIES. Voltmeter = HIGH resistance, in PARALLEL. Swapping them is the classic blunder.
- Resistivity ρ is intrinsic (no L or A). Only resistance R changes with shape.
- Internal resistance r is in series with the load - forgetting it gives wrong I.

Most asked in NEET » Drift velocity / mobility · Stretched-wire R → n² · Wheatstone & meter bridge balance · Potentiometer (emf vs voltmeter) · Combination of cells · Bulb brightness in series/parallel