CLASS 12 PHYSICS — FORMULA SHEET

Chapter 3 : Current Electricity (NCERT)

3.1 Electric Current & Drift

Concept	Formula
Electric current	$I = Q \div t$; SI unit ampere (A) = C/s
Instantaneous current	$I = dQ/dt$
Current & drift velocity	$I = n A e v_d$ (n = electron density, A = area)
Drift velocity	$v_d = (eE \div m)\,\tau = (eV) \div (mL)\,\tau$ (τ = relaxation time)
Mobility	$\mu = v_d \div E$; unit $m^2\,V^{-1}\,s^{-1}$
Current density	$J = I \div A = n e v_d = \sigma E$

3.2 Ohm's Law & Resistance

Concept	Formula
Ohm's law	$V = I R$ (at constant temperature)
Resistance	$R = V \div I$; SI unit ohm (Ω)
Resistance & dimensions	$R = \rho L \div A$ (ρ = resistivity, L = length, A = area)
Resistivity	$\rho = (m) \div (n e^2 \tau)$; unit ohm·metre
Conductivity	$\sigma = 1 \div \rho = n e^2 \tau \div m$
Microscopic Ohm's law	$J = \sigma E$
Conductance	$G = 1 \div R$; unit siemens (S)

3.3 Effect of Temperature

Concept	Formula
Resistance vs temperature	$R_T = R_0(1 + \alpha\,\Delta T)$
Resistivity vs temperature	$\rho_T = \rho_0(1 + \alpha\,\Delta T)$
Temperature coefficient α	$\alpha = (R_T - R_0) \div (R_0\,\Delta T)$
Conductors	Resistance INCREASES with temperature (α positive)
Semiconductors / insulators	Resistance DECREASES with temperature (α negative)

3.4 Combination of Resistors

Arrangement	Formula
Series	$R_{eq} = R_1 + R_2 + \ldots$ (same current I through all)
Parallel	$1/R_{eq} = 1/R_1 + 1/R_2 + \ldots$ (same voltage V across all)
Two in parallel	$R_{eq} = (R_1 R_2) \div (R_1 + R_2)$
n equal resistors in series	$R_{eq} = nR$

Arrangement	Formula
n equal resistors in parallel	$R_{eq} = R \div n$

3.5 EMF, Internal Resistance & Cells

Concept	Formula
EMF and terminal voltage	$V = \varepsilon - I r$ (r = internal resistance)
Current in circuit	$I = \varepsilon \div (R + r)$
Internal resistance	$r = (\varepsilon - V) \div I = R[(\varepsilon/V) - 1]$
Cells in series	$\varepsilon_{eq} = \varepsilon_1 + \varepsilon_2 + \dots$; $r_{eq} = r_1 + r_2 + \dots$
Cells in parallel (identical)	$\varepsilon_{eq} = \varepsilon$; $r_{eq} = r \div n$
Terminal voltage (charging)	$V = \varepsilon + I r$

3.6 Kirchhoff's Laws & Power

Concept	Formula / Statement
Kirchhoff's current law (KCL)	$\Sigma I = 0$ at a junction (charge conservation)
Kirchhoff's voltage law (KVL)	$\Sigma V = 0$ around a loop (energy conservation)
Electric power	$P = VI = I^2R = V^2 \div R$
Electrical energy	$W = VIt = I^2Rt$; commercial unit kWh
Heat produced (Joule's law)	$H = I^2R\,t$
Max power transfer	When $R = r$ (external = internal resistance)

3.7 Wheatstone Bridge & Potentiometer

Concept	Formula
Wheatstone balance condition	$P/Q = R/S$ (no current through galvanometer)
Meter bridge	$R \div S = l \div (100 - l)$ (balancing length l)
Potentiometer principle	$V \propto l$ (potential drop proportional to length)
Potential gradient	$k = V \div L$ (volt per unit length)
Comparing EMFs	$\varepsilon_1 \div \varepsilon_2 = l_1 \div l_2$
Internal resistance (potentiometer)	$r = R[(l_1 - l_2) \div l_2]$

★ QUICK MEMORY AIDS & TRICKS

Ohm's law	$V = IR$. Resistance $R = \rho L/A$ — longer/thinner wire → more resistance.
Drift velocity	$I = nAev_d$. Tiny drift speed (about mm/s) but current flows fast (field sets up instantly).
Series vs parallel	Series: add R. Parallel: add reciprocals (R drops below the smallest).
EMF vs terminal V	Discharging: $V = \varepsilon - Ir$. Charging: $V = \varepsilon + Ir$.

Power trio	$P = VI = I^2R = V^2/R$. Pick the form matching your known quantities.
Kirchhoff	KCL = charge conservation (junctions) ; KVL = energy conservation (loops).
Wheatstone	Balanced when $P/Q = R/S$; galvanometer reads zero.
Potentiometer	Measures EMF without drawing current — more accurate than a voltmeter.