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Current, drift velocity and Ohm law

Formulas and units, JEE Main. Status: Reviewed on 2026-11-20.

Result	Formula	Units or note
Current	I = dq/dt; q = I t (steady) Valid when: q = I t only for a steady current	A (C)
Current and drift speed	I = n A e v_d Valid when: uniform conductor with one type of carrier; n in per m^3	A (n in m^-3, A in m^2, v_d in m/s)
Current density	J = I/A = n e v_d Valid when: current uniform over the cross-section and along the area normal	A/m^2
Mobility	mu = v_d/E = e tau/m Valid when: drift speed under a uniform field E; tau is mean free time	m^2/(V s)
Conductivity	sigma = n e mu = n e^2 tau/m; rho = 1/sigma Valid when: metallic conductor with free electrons, constant tau	S/m (ohm m)
Microscopic Ohm law	J = sigma E Valid when: ohmic isotropic material at constant temperature	A/m^2
Ohm law	V = I R (constant temperature) Valid when: ohmic conductor at constant temperature	V (A, ohm)
Static and dynamic resistance	R_static = V/I; R_dyn = dV/dI Valid when: any conductor; the two are equal only for ohmic ones	ohm
Electrons crossing in time t	N = I t/e (e = 1.6 x 10^-19 C) Valid when: steady current of elementary charge carriers	dimensionless

Full lesson with worked examples:
https://www.engineeringrise.in/learn/learn/jee-main/physics/current-electricity/current-drift-velocity-and-ohm-law

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