EngineeringRise

Cells, Kirchhoff laws and bridges

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

Result	Formula	Units or note
Terminal voltage (discharging)	V = E - I r = E R/(R + r) Valid when: cell is delivering current to an external resistance R	V
Short-circuit current	I_sc = E/r Valid when: external resistance zero (terminals shorted); r constant	A
Internal resistance from two readings	r = R (E - V)/V Valid when: R is the external resistor and V the terminal voltage while it is connected	ohm
n identical cells in series	E_eq = n E; r_eq = n r Valid when: identical cells in series with same polarity	V (ohm)
m identical cells in parallel	E_eq = E; r_eq = r/m Valid when: identical cells in parallel with same polarity	V (ohm)
Grid of m rows of n cells	I = n E/(R + n r/m) Valid when: m identical rows in parallel, each of n cells in series, driving external R	A
Kirchhoff junction law	sum of currents at a node = 0 Valid when: steady currents; no charge builds up at the node	A
Kirchhoff loop law	sum of emfs = sum of I R around a loop Valid when: closed loop, steady currents; emf sign by direction of travel	V
Junction voltage (two-node network)	V = (sum E_k/r_k)/(sum 1/r_k) Valid when: two nodes joined by branches each with an emf and a series resistance	V
Wheatstone bridge balance	P/Q = R/S Valid when: bridge balanced so no current flows in the middle arm	dimensionless
Metre bridge	X/R = l/(100 - l) Valid when: null point on a uniform wire; X in left gap, R in right gap	ohm (l in cm)

Full lesson with worked examples:
https://www.engineeringrise.in/learn/learn/jee-main/physics/current-electricity/cells-kirchhoff-laws-and-bridges

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