

Kirchhoff's laws, the bridges built on them, and the null-deflection potentiometer

Junction, loop, branch

- **junction**: point where two or more conductors meet
- **loop**: any closed conducting path in a network, also called a mesh
- **branch**: part of the network lying between two junctions
- a network too complex for series/parallel rules needs Kirchhoff's two laws

Kirchhoff's first law: current law (junction law)

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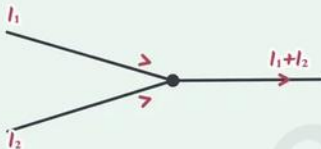
algebraic sum of currents at a junction is zero

$$\sum_i I_i = 0$$

sign convention

current arriving = +, current leaving = -

in = out at the junction



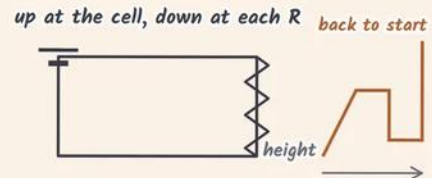
currents meeting at a point: whatever comes in must leave

equivalently, total current flowing IN equals total current flowing OUT of any junction. This law is nothing but **conservation of charge**: charge can't pile up or vanish at a point

Kirchhoff's second law: voltage law (loop law)

sum of IR drops and emfs around any closed loop is zero

$$\sum IR + \sum \mathcal{E} = 0$$



potential drawn as a height over the loop: up across the cell, down across each resistor, back to the start tracing **WITH** the assumed current across a resistor counts that IR as negative, tracing **AGAINST** it counts positive; tracing a cell from - to + inside it counts the emf as positive, from + to - counts it negative. This law is **conservation of energy** applied to a loop

Steps for solving a network

- choose a direction for every unknown current, label it
- reduce variables using the junction law at each meeting point
- identify the independent loops in the network
- apply the voltage law to each independent loop
- solve the resulting equations simultaneously
- a negative current just flows opposite to the chosen direction