

Drift Velocity of Electrons

$$I = nev_d A$$
$$v_d = a\tau = \frac{eE}{m_e} \tau$$
$$I = \frac{e^2 n \tau}{m_e} A E = \sigma A E = \frac{\sigma A}{\ell} V$$

τ is time between collision of free electron and atoms

Ohm's Law

$$I = \frac{\sigma A}{\ell} V \Rightarrow V = I \frac{\ell}{\sigma A} = I \frac{\rho \ell}{A} = IR$$

Electric Power

$$P = VI$$

Electromotive Force (e.m.f.)

$$\varepsilon = \frac{E}{q} \quad (E \text{ is work done by non - electric field force})$$

Cells in series

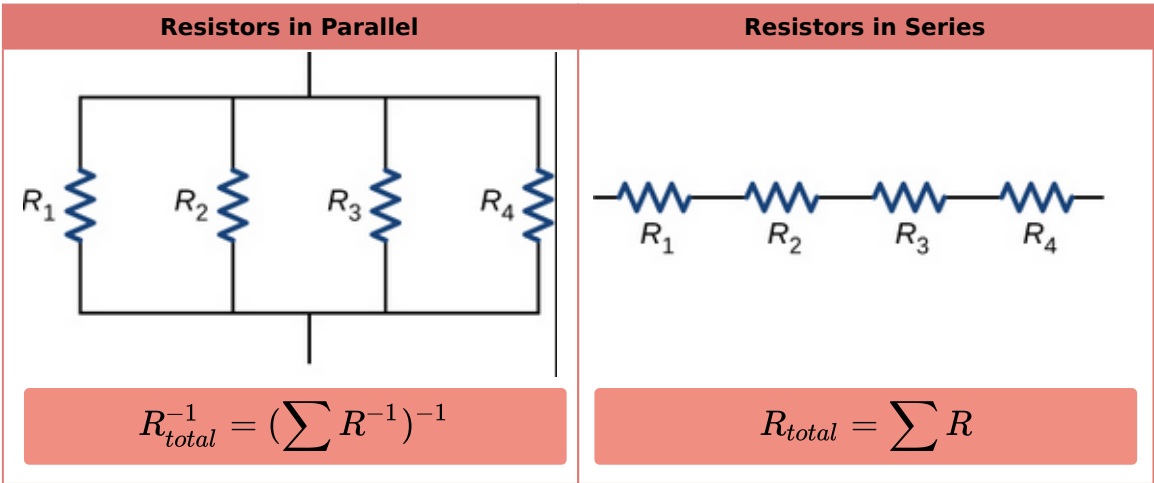
$$\varepsilon_{total} = \sum \varepsilon$$

Cells in Parallel

$$\varepsilon_{total} = \varepsilon_1 = \varepsilon_2 = \dots = \varepsilon_n$$

Internal Resistance

$$\varepsilon = V + Ir = I(R + r)$$
$$V = \frac{\varepsilon}{R + r}$$
$$P = \left(\frac{\varepsilon}{R + r} \right)^2 R \quad \text{when } \frac{dP}{dR} = 0 \Rightarrow R = r$$



Kirchoff's Laws

Spherical Symmetry

$$\sum I_{in} = \sum I_{out}$$

In any closed loop, the total voltage drop is equal to the total emf. (Conservative fields)

First Law - Junction Theorem

$$\sum I_{in} = \sum I_{out}$$

Total current flowing into the junction is equal to the total current flowing out of it.

Potential Divider

$$V_1 = \frac{R_1}{R_1 + R_2} V = \frac{R_1}{R_1 + R_2 + r} \varepsilon$$

Circuits

Applications

Current Electricity

Current