Unit VIII - Circuits

Voltage - potential difference (V)

- cause of current (flow of charge)

Current (I) - the rate of flow of charge

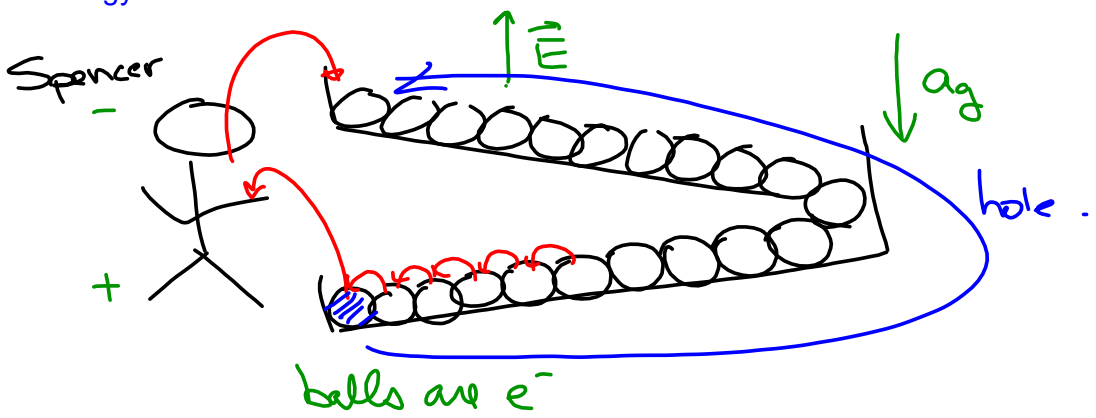
$I = \frac{dQ}{dt} = \frac{Q}{t}$ ← (Iave)

(charge passing by a point per unit time)

equal for direct current.

Current is defined as moving from + to −

A Current Analogy



Resistance - (R) The opposition to the flow of current

$R = \frac{V}{I}$ units $\frac{V}{C/s} = \frac{J/s}{C^2} = \Omega$ ohm

$\frac{1}{\Omega} = \Omega^{-1}$ = mho ∴

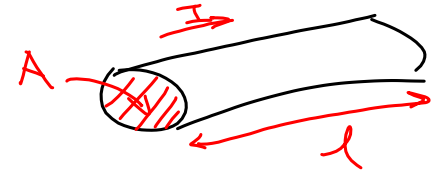
Factors that affect resistance

1. Substance - resistivity - $\rho (\Omega \cdot m)$ ↑ρ ⇒ insulator ↓ρ ⇒ conductor

$R \propto \rho$ ↑ proportional to

2. Length (ℓ) - $R \propto \ell$
3. Cross-sectional area (A)

$R \propto \frac{1}{A}$



4. Temperature (T) - for Most substances

↑T ⇒ ↑R

(semiconductors are the exception) - for s.c.

resistivity is a function of T

$\rho(T) = \rho_0 (1 + \alpha \Delta T)$

ρ_0: value of ρ at some T. α: temp coefficient p.535

If ΔT is small this equation holds.

This is a 1st order approximation

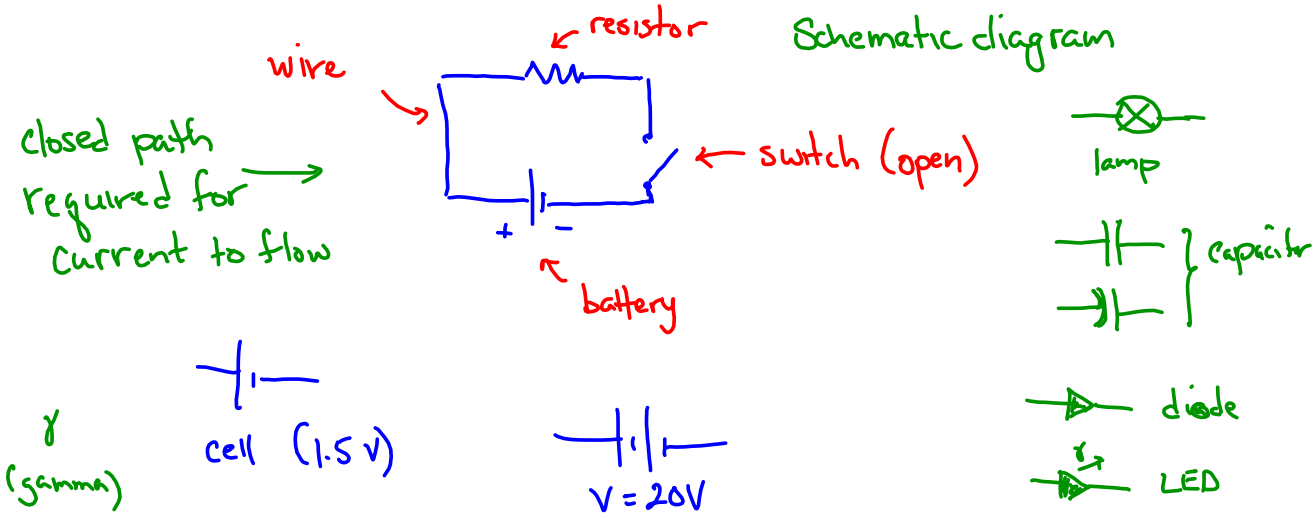
$\left(\rho = \rho_0 (1 + \alpha \Delta T + \beta (\Delta T)^2 + \gamma (\Delta T)^3 + \ldots \right)$

$$R = \frac{\rho(T)\ell}{A}$$

A Simple Circuit - 3 components + 1 optional

required
1. Source - provides potential difference (energy)
2. Sink - uses the energy
3. Path - allows the motion of current from source to sink and back

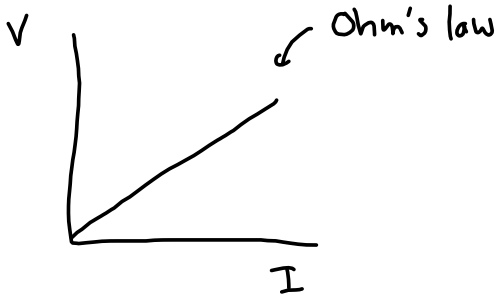
optional
4. Control Switch - opens/closes the path



Ohm's Law

Georg Simon Ohm found that for metal conductors at constant temperature

$$R = \frac{V}{I} = \text{constant.}$$



Most substances