Electric Currents

Current

- A moving charge creates an electric current.
- Electric current is the amount of charge that moves through the cross-sectional area of a wire per unit interval of time.

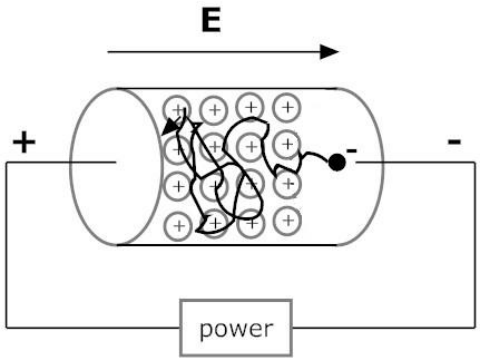
$$I = \frac{\Delta q}{\Delta t}$$

Unit: Ampere, Amp (A)

(fundamental unit)

Electric Currents

- In a conductor, the “free” electrons move randomly.
- The presence of an electric field inside the conductor forces the electrons to accelerate in a direction opposite to the electric field
- The electrons bounce off the stationary nuclei of the atoms that make up the conductor, losing energy and then accelerating again from the reduced speed



- The overall average forward velocity of the electrons is known as the drift velocity
- For a typical wire with 1 A of current the drift velocity is 6×10^{-4} ms^{-1}

Resistance

- Resistance is defined as the ratio of potential difference (voltage) to current.

$$R = \frac{V}{I}$$

Units: VA^{-1} = Ohms (Ω)

- Resistance depends on:
  - Length
  - Cross-sectional area
  - Material
  - Temperature
- We can calculate resistance as follows:

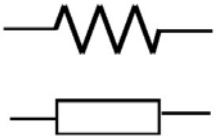
$$R = \frac{\rho L}{A}$$

ρ – resistivity (depends on material)

L – length

A – cross-sectional area

- There are special electronic devices called resistors



- Resistors are designed to resist electron flow (not how many, but how much energy they have)
- The electrons lose energy (and therefore potential) when passing through a resistor
- So there is a potential difference across the resistor

Ohm's Law

- Ohm's law is a rewriting of the definition of resistance:

$$\boxed{V = IR}$$

- If something follows Ohm's law it is said to be *ohmic*.

$$I \propto V$$

- Most materials obey Ohm's law at low temperatures.