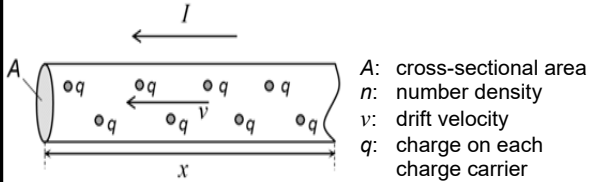


Electric Current

Electric current is the rate of flow of charge.

- For a steady current, $I = \frac{Q}{t}$
- Conventional current is defined as the direction of flow of positive charge (i.e. opposite flow of negative charge)

Derivation of $I = nAvq$



total charge in volume = $nAxq$

time interval, $t = x / v$

$$\text{current, } I = \frac{\text{charge}}{\text{time}} = \frac{Q}{t} = \frac{nAxq}{x/v} = nAvq$$

Charge

$$Q = It = \text{Area under } I - t \text{ graph} = Nq$$

e.m.f. and p.d.

The electromotive force **e.m.f.** of a source is the energy converted from other forms to electrical energy per unit charge.

The **potential difference** between two points in a circuit is the electrical energy converted to other forms of energy per unit charge.

$$V = \frac{W}{Q}$$

energy converted in joules
charge in coulombs

Current of Electricity

Resistance

The **resistance** of a circuit component is the ratio of the potential difference across the component to the current flowing through it.

$$V = IR$$

Resistance and resistivity

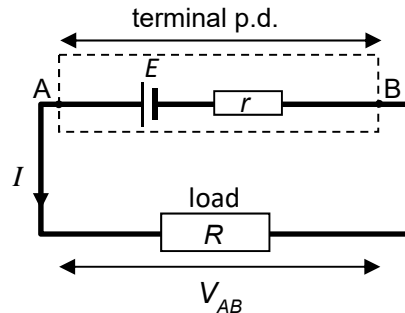
$$R = \frac{\rho l}{A}$$

A: cross-sectional area
l: length
 ρ : resistivity

Power

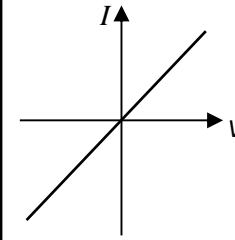
$$P = VI = I^2 R = \frac{V^2}{R}$$

Effects of internal resistance



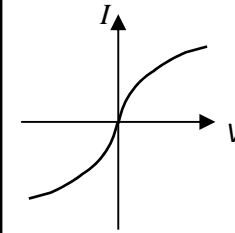
- Terminal p.d.** $V_{AB} = IR = E - Ir$
- A battery delivers **maximum power** to a circuit when the load resistance of the circuit is equal to the internal resistance of the battery

I-V characteristics of electrical components



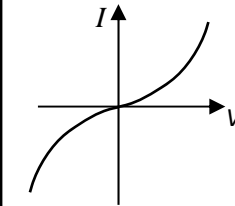
Metallic ohmic resistor at constant temperature

- magnitude of vibration of lattice ions remains the same
- rate of collision of electrons with lattice ions is constant
- Resistance is constant, so ratio of V to I is constant



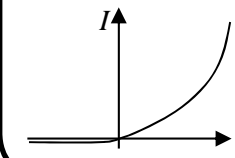
Filament lamp

- As V and I increase, energy dissipated as heat increases. Temperature increase.
- Lattice ions vibrate with greater amplitude. Rate of collision between free electrons and lattice ions increase.
- Resistance increases



Thermistor

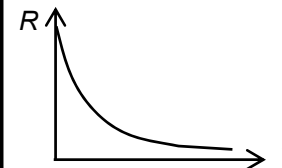
- As V and I increase, number of charge carriers increase at higher temperature.
- Effect of increase in number density of charge carriers outweighs the effect of increase in collision between electrons and lattice ions.
- Resistance decreases.



Semiconductor diode

- Low resistance when the diode is in forward bias
- Very high resistance when the diode is in reverse bias

Temperature characteristics of NTC thermistor



Resistance decreases with increasing temperature due to an increase in number of mobile charge carries