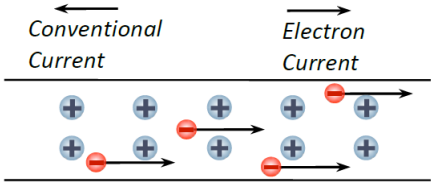
14 Current of Electricity

Electric Current



The **charge** that passes through a given point is the product of the steady current flowing past the point and the time during which the current flows, i.e. $Q = It$ [unit: Coulomb (C)]
If current is not constant, the amount of charge can be found by finding the area under the current-time graph, i.e. $Q = \int I.dt$.

Important formula: $I = nAV_dq$ (given but need to know how to derive) where n is the number density of charges per unit volume, A is the cross-sectional area, V_d is the drift velocity and q is the charge on the carrier.

Potential Difference

The **potential difference** (p.d.) between two points is the amount of electrical energy converted to other forms of energy per unit charge flow between the points, i.e. $V = \frac{W}{Q}$ Given that W = Power x time and $Q = It$, $V = \frac{P}{I}$

Resistance and Resistivity

The **resistance *R*** of a conductor is defined as the ratio of the p.d. V across it to the current I through it, i.e. $R = \frac{V}{I}$ [unit: ohm (Ω)]
Combining the equations $P = IV$ and $V = IR$, we can obtain $P = I^2R$ and $P = \frac{V^2}{R}$.

Determining Resistance

At a given temperature, the **resistance R** of a conductor is determined by $R = \rho\frac{L}{A}$.

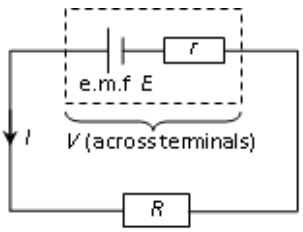
I-V Characteristic Graphs

Ohm's Law: the current flowing through a metallic conductor is directly proportional to the p.d. V between its ends, provided that all other physical conditions are kept constant.
The resistance R of an ohmic conductor such as a metallic conductor at constant temperature is constant since $\frac{V}{I}$ is constant.
Non-ohmic conductors: filament lamp, semiconductor diode, thermistor

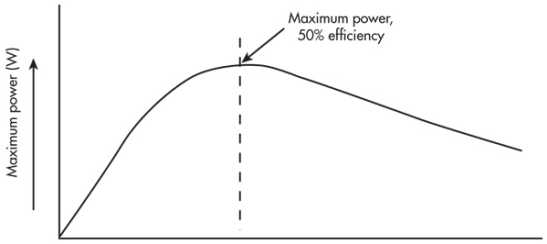
Sources of Electromotive Force

The **electromotive force** (e.m.f.) of a source is the energy converted into electrical energy from other forms per unit charge in driving charges round a complete circuit, i.e. $E = \frac{W}{Q}$.
In practice though, the source has **internal resistance *r*** and thus not all electrical energy generated is available to the external load R.

Terminal Potential Difference



The terminal p.d. is equal to the sum of the e.m.f. and potential drop across internal resistance r, and to p.d. across external resistance R, i.e. $V = E - Ir = IR$



Maximum power theorem: A given source of e.m.f. delivers the maximum amount of power to a load when $R = r$.