4.1 Current and Charge

Basic Ideas

- An **electric current** is the rate of flow of charge.
- The charge is carried by particles known as **charge carriers**.
- In metals, the charge carriers are **free electrons**, (otherwise known as conduction electrons or delocalized electrons).
- In electrolytes, the charge carriers are **ions**.
- To create an electric current, there must be a complete **circuit** around which the carriers can flow and there must be a source of **potential difference** such as a battery.

The amount of charge ΔQ flowing in a time Δt is given by:

$$\Delta Q = I\Delta t$$

where I is the current.

Charge is measured in coulombs (C) and current in amperes (A).
$1\ ampere = coulomb\ per\ second$ $(1A = 1Cs^{-1})$

Current can be expressed as the *rate of flow of charge*, (although this is not how current is defined).

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

Insulators, Semiconductors, Conductors

In insulating materials, (such as polythene, glass and paper), the electrons are firmly attached to their atoms and cannot move through the material. If a potential difference is applied across an insulator, no current will flow.

In conducting materials, (metals), the electrons are delocalized, meaning that they are not attached to any particular atom. We call them “free” electrons or conduction electrons. They can move through the material. When a p.d. is applied across a metal, a current will flow through it.

In semiconductors, (such as silicon, germanium or graphite), some electrons are firmly attached to their atoms but some are free to move. A current will flow when a p.d. is applied across a semiconductor but not as large as it would be in a metal. When a semiconductor is warmed, more electrons break free to become conduction electrons and the current will rise. The resistance of a semiconductor therefore falls as its temperature rises.