GCE Physics Unit 2.1 Conduction of Electricity

Charge:

Particles can be neutral, positively or negatively charged. The unit of charge is the Coulomb (C).

If an object is charged it has gained or lost electrons. A positively charged object has lost electrons and a negatively charged object has gained electrons.

An electron has a very small charge, 1.6×10^{-19}C (given in the data booklet), therefore a charge of **1C is equivalent to**:

$$\frac{1}{e} = \frac{1}{1.6\times10^{-19}} =$$

6.25 x 10^{18} **electrons**.

Conduction:

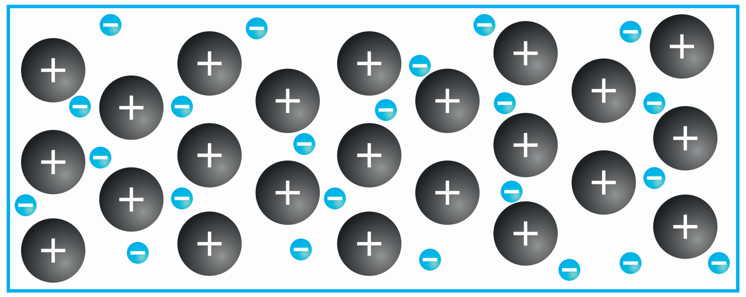
A current flowing through a conductor means there are charged particles moving through it. The current is defined as the rate of flow of charge.

Current can be calculated using the following equation:

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

Using S.I. units this will give a current in A which is equivalent to Cs^{-1}.

Conduction in metals:



Metals consist of a lattice of **ions and free electrons** which can move around. When no potential difference is applied these electrons **move around at random** in all directions very **quickly**. However, when a potential difference is applied these electrons are made to accelerate in one direction between collisions and therefore have a **slow drift** in **one direction**.

Area under an I-t graph:

The equation for current can be rearranged to calculate the charge. This idea can be used to calculate the charge flow directly from an I-t graph.

The area under the graph will give the charge.

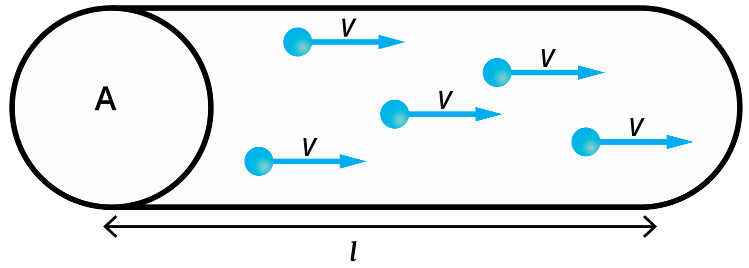
Area of a circle:

When using the equation, I = nAve, remember to calculate the area in m^2 correctly. If the cross section is **circular** you can use the following equation.

$$A = \pi\frac{d^2}{4}$$

Remember to be consistent with units, **convert the diameter to meters** before calculating the area when required.

I = nAve:



When a potential difference is applied across a wire the electrons will move a distance l along the wire in a certain time. This can be used to calculate the **drift velocity** of the electrons.

Remember, rearranging the equation for velocity will give the displacement l as vt.

The following steps can be used to derivate the equation above.

Step 1: calculate the **volume** of the cylindrical wire.

Volume = $A \times vt$

Step 2: calculate the **number of free electrons** in the wire.

Number of free electrons = $n \times Avt$

Where n = the number of free electrons **per m³.**

Step 3: calculate the total **charge**

Charge,Q **=** $nAvt \times e$

Where e is the charge of 1 electron (= 1.6 x 10^{-19}C.)

Step 4: calculate the current (I)

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

Q = charge in Coulombs (C) | I = current in Amperes (A) | t = time in s | v = drift velocity in ms^{-1} | n = number of free electrons per m^{-3} | A = area in m^2