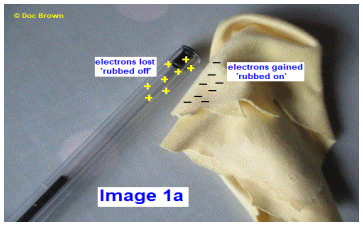
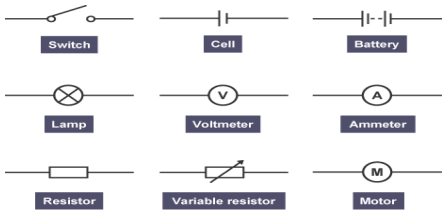
Electricity and Magnetism

Static electricity –All substances are made of **atoms**. These are often called particles. An atom is electrically neutral - has no overall electrical **charge**. When two objects are rubbed together, electrons are transferred from one object to the other. One object becomes positive and the other negative. A non-contact force exists between charged objects. Two charged objects will **repel** each other if they have like charges (they are both positive or both negative). Two charged objects will **attract** each other if they have opposite charges (one is positive and the other is negative).





We use **circuit symbols** to draw diagrams of electrical circuits, with straight lines to show the wires. The diagram shows some common circuit symbols.

Conductors and insulators of electricity

Different materials have different resistances:

- an electrical **conductor** has a low resistance
- an electrical **insulator** has a high resistance.

You can easily find out which materials are conductors and which are insulators using a simple circuit. You set up a series circuit with a cell, lamp and wires. Leave a gap in the circuit between two of the wires. Then connect the two wires using pieces of each material and see if the lamp lights up:

- it will light up if the material is a conductor
- it will not light up if the material is an insulator.

Electric current

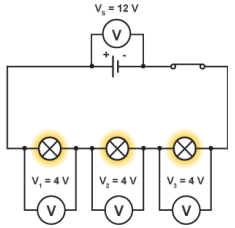
An **electric current** is a flow of charge, and in a wire this will be a flow of electrons. We need two things for an electric current to flow:

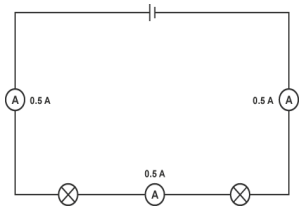
- something to transfer energy to the electrons, such as a cell, battery or power pack
- a complete path for the electrons to flow through (an electric **circuit**).

A simple complete circuit is a light bulb, a cell and two wires. To measure the current we have to add an ammeter to the circuit.

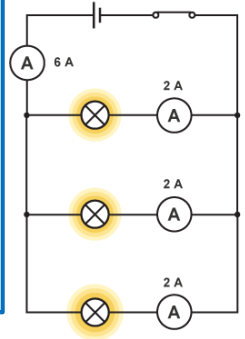
Potential difference is a measure of the difference in energy between two parts of a circuit. The bigger the difference in energy, the bigger the potential difference. Potential difference is measured in **volts**.
Potential difference is measured using a device called a **voltmeter.** However, unlike an ammeter, you must connect the voltmeter **in parallel** to measure the potential difference across a component in a circuit.

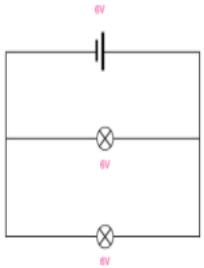
In **series circuits** the electrical components are connected one after the other. The current can take one path only.





In a **parallel circuit** the components are connected in branches or in parallel so the current can pass through more than one path. Parallel circuits are used in house wiring.





Resistance is a measure of how easy or difficult it is for charges to pass through a component in a circuit. The unit of **resistance** is the **ohm**, or Ω.
The resistance increases when you add more components in series. For example, the resistance of two lamps is greater than the resistance of one lamp, so less current will flow through them.

Resistance can be calculated:

$$potential\ difference = current \times resistance$$

Magnets

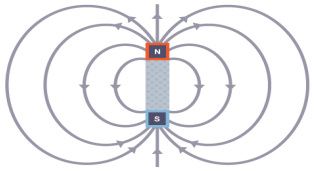
A bar magnet is a **permanent magnet**. A bar magnet has two magnetic poles: **north pole** (or north-seeking pole) and **south pole** (or south-seeking pole). Like poles attract, opposite poles repel.

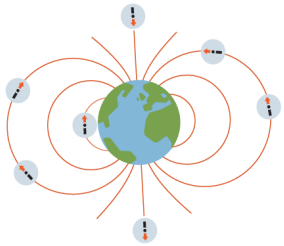
A magnetic material can be magnetised or will be attracted to a magnet.

The magnetic elements are iron, cobalt and nickel. Steel is an alloy containing mainly iron, so it is also magnetic.

A magnet creates a **magnetic field** around it. You cannot see a magnetic field, but you can observe its effects. A force is exerted on a magnetic material brought into a magnetic field. The force is a **non-contact force** because the magnet and the material do not have to touch each other.

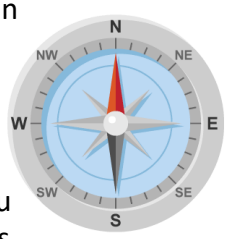
The magnetic field can be drawn around a magnet with the help of a **compass.**





The Earth behaves as if it contains a giant magnet. It produces a magnetic field in which the field lines are most concentrated at the poles. This magnetic field can be detected using magnetic materials or magnets.

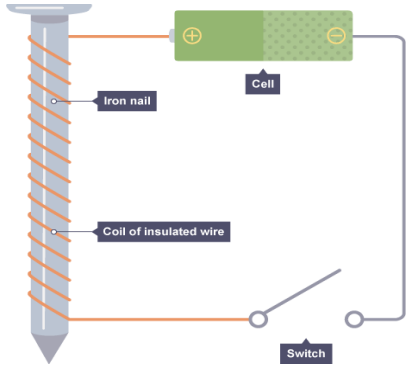
1. A compass is made from:
- a magnetic needle mounted on a pivot (so it can turn freely)
- a dial to show the direction.



2. The north pole (north-seeking pole) of the compass needle points towards the Earth's north pole. If the needle points to the N on the dial, you know that the compass is pointing north. This lets you navigate outdoors using a map.

Electromagnets

When an electric current flows in a wire, it creates a magnetic field around the wire. This effect can be used to make an **electromagnet**. A simple electromagnet comprises a length of wire turned into a coil and connected to a battery or power supply.



You can make an electromagnet stronger by doing these things:
- wrapping the coil around a piece of iron (such as an iron nail)
- adding more turns to the coil
- increasing the current flowing through the coil.

Electromagnets have some advantages over permanent magnets. For example:
- they can be turned on and off
- the strength of the magnetic field can be varied.

These properties make electromagnets useful for picking up scrap iron and steel in scrapyards.

DC motors

Electric motors use the forces produced by magnetic fields to produce a turning motion. If you put a length of wire in a magnetic field and pass a **DC current** through it (such as from a battery), the wire will move. This is called the **motor effect**.

To make a simple **DC motor**, you need:
- two bar magnets
- a coil of wire wrapped around something to support it
- an axle for the coil of wire to spin around
- two half rings ('split rings').