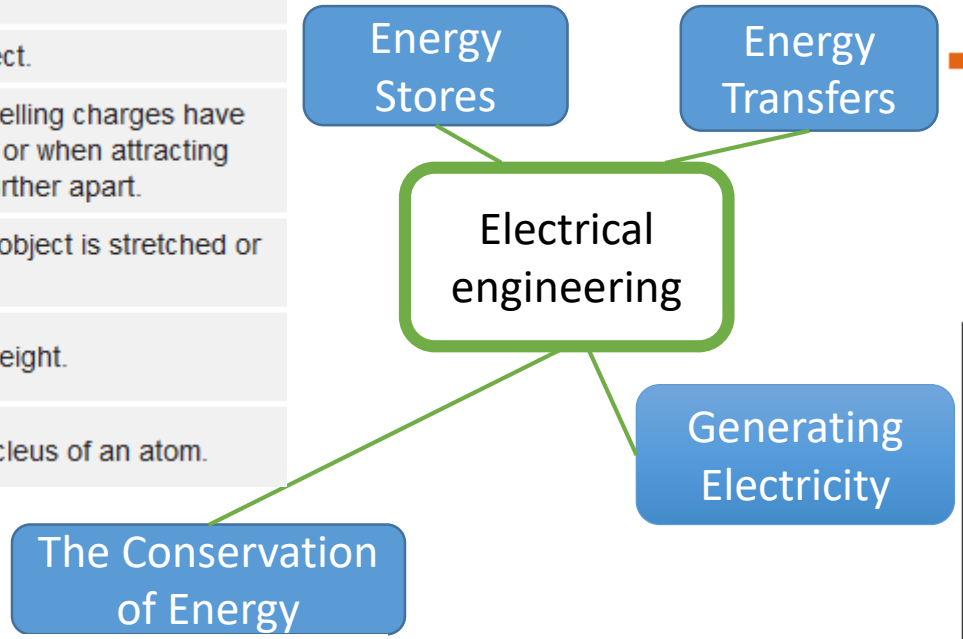
Energy store	Description
Magnetic	The energy stored when repelling poles have been pushed closer together or when attracting poles have been pulled further apart.
Internal (thermal)	The total kinetic and potential energy of the particles in an object, in most cases this is the vibrations - also known as the kinetic energy - of particles. In hotter objects, the particles have more internal energy and vibrate faster.
Chemical	The energy stored in chemical bonds, such as those between molecules.
Kinetic	The energy of a moving object.
Electrostatic	The energy stored when repelling charges have been moved closer together or when attracting charges have been pulled further apart.
Elastic potential	The energy stored when an object is stretched or squashed.
Gravitational potential	The energy of an object at height.
Nuclear	The energy stored in the nucleus of an atom.



Transferring energy

In each of these examples, energy is **transferred** by one of the following four types of energy transfer:

- mechanical work - a force moving an object through a distance
- electrical work - charges moving due to a **potential difference**
- heating - due to temperature difference caused electrically or by chemical reaction
- radiation - energy tranferred as a wave, eg light and infrared - light radiation and infrared radiation are **emitted** from the sun

Energy resource	Energy store	Renewable?
Fossil fuels	Chemical	Non-renewable
Nuclear fuels	Nuclear	Non-renewable
Bio-fuel	Chemical	Renewable
Wind	Kinetic	Renewable
Hydroelectricity	Gravitational potential	Renewable
Geothermal	Internal (thermal)	Renewable
Tides	Kinetic	Renewable
Sun	Nuclear	Renewable
Water waves	Kinetic	Renewable

The conservation of energy

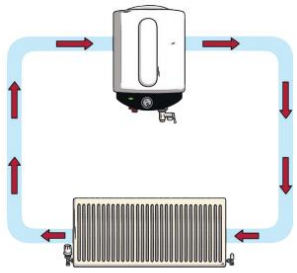
Energy can be **transferred** usefully, stored or **dissipated**, but it cannot be created or destroyed.

Keyword	Definition
Ammeter	A device used to measure electric charge.
Ampere	Unit of current. E.g. The current in the bulb is 4 amps or amperes (A).
Cell	A store of internal energy that can be transferred as an electric current in a circuit.
Conductor	A material which allows charge to move easily through it.
Electron	Sub atomic particle which flows in a circuit carrying a negative charge.
Series Circuit	A circuit connected in a way that the same current flows through each component in turn.
Parallel Circuit	In a parallel circuit, the current divides into two or more paths before recombining to complete the circuit.
Insulator	A material that does not allow charge or heat to pass through it easily.
Ohms	The unit of electrical resistance. Unit is Ω
Resistance	The opposition in an electrical component to the movement of electrical charge through it. Resistance is measured in ohms.
Potential Difference	The potential difference (or voltage) of a supply is a measure of the energy given to the charge carries in a circuit.
Volt	Unit of voltage. E.g. the voltage across the lamp was 6 volts (V).
Voltmeter	A device used to measure potential difference or voltage.
Repulsion	**When two or more things are forced apart, eg the north pole of a magnet is repelled by the north pole of another magnet.**
Magnetic Field	Area surrounding a magnet that can exert a force on magnetic materials.

Electrical engineering

Keywords

Model

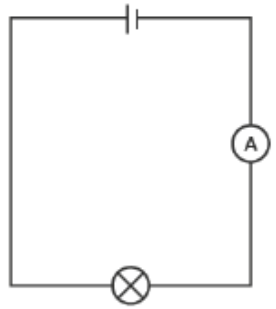


In the boiler and radiator model, the pump pushes the water around the system. It does a similar job to a **battery** pushing the **charges** around a circuit. The pipes carry the flow of water around the system, like the **charge** flowing through wires in a circuit. The radiator is similar to a bulb because it transfers **energy** supplied by the system to the surroundings.

Current

Current

Current is measured in amperes (A). 20A is a bigger current that 10A. An ammeter is used to measure the current. The ammeter must be connected in series.



Charge

Electric Charge

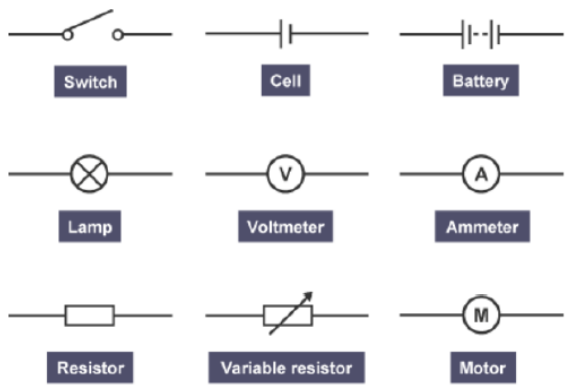
Some particles carry an electric charge. In electric wires these particles are called electrons. An electric current is a flow of charge, and in a wire this will be a flow of electrons.

For an electric current to flow we need:

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

Circuit symbols

Circuit Symbols



Magnets

Magnetism is a **non-contact force**. Magnetic materials can be magnetised or will be attracted to a magnet. There are three magnetic metals: **iron, nickel** and **cobalt**. Steel is also magnetic because it contains iron.

A bar magnet is a permanent magnet. It has a **north pole** and a **south pole**.

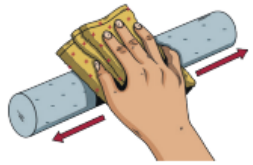
Like poles repel. This means that the two poles push each other away.

Opposite poles **attract**. This means that the invisible magnetic force between the magnets pulls the poles towards each other.

Electrical engineering

Static electricity

Static electricity occurs when a material either loses or gains **electrons**. Electrons are negatively charged, so objects that **lose** electrons become **positively charged** overall, while objects that **gain** electrons become **negatively charged** overall.

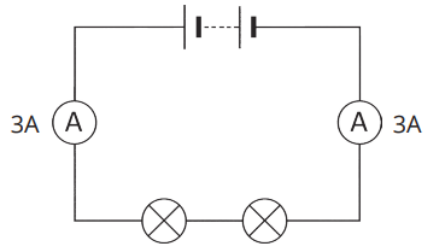


When a polythene strip is rubbed with a cloth, electrons move from the cloth to the strip. The strip becomes negatively charged and the cloth becomes positively charged.

When you rub a balloon against your hair, electrons are transferred from your hair to the balloon. The balloon and your hair have opposite charges so your hair is attracted to the balloon, making it stand on end.

Series

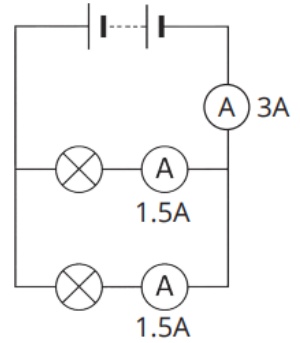
In a series circuit, the components are connected end to end in a loop as shown in the diagram below. If one bulb breaks, none of the bulbs will be lit as the circuit is no longer complete.



The **current is the same** everywhere in a series circuit. It doesn't matter where you put the ammeter, it will always show the same reading. The more cells or batteries you add, the greater the current. Current is **not** used up.

Parallel

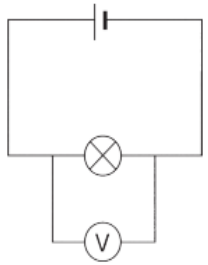
In a parallel circuit, the components are connected on separate branches as shown in the diagram below. This gives the current several different paths to flow down. If one bulb stops working, the other bulbs will remain lit as the circuit is still complete.



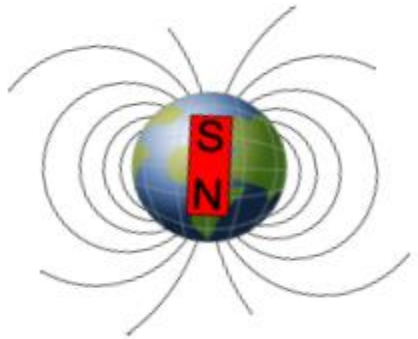
The **current is split** between the branches in a parallel circuit.

Resistance

Potential difference tells us how hard the battery 'pushes' the electrons around the circuit: the larger the potential difference, the bigger the 'push'. Potential difference is measured in **volts (V)** using a **voltmeter**. A voltmeter is connected in **parallel** with the component.



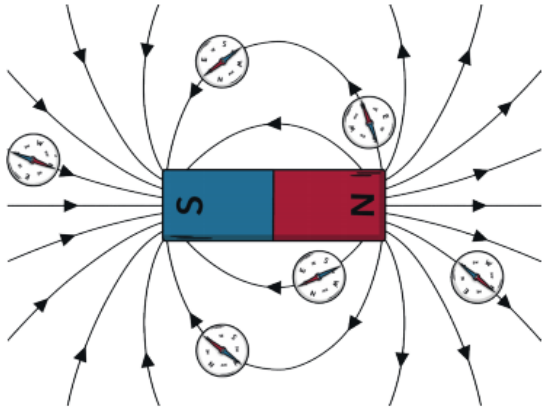
Magnetic field lines



The *Earth* behaves as if it contains a giant magnet.

The magnetic field around a magnet can be shown as a series of lines around the magnet. The magnetic field lines can be plotted using a plotting compass.

The compass will always point towards to the south pole, wherever the compass is placed near the magnet. The arrows show the direction of the magnetic field.



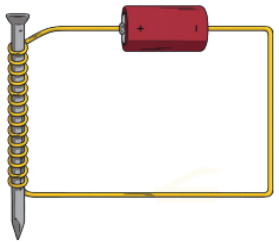
Electrical engineering

Key words

independent variable	The variable you change in an investigation to see how it affects the dependent variable.
dependent variable	The variable you measure or observe.
control variable	A variable that could affect the dependent variable so must be kept the same.

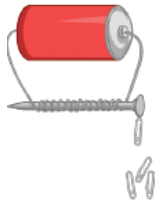
Electromagnets

When electrical charge flows in a wire, a magnetic field is created around the wire. The larger the current, the stronger the electromagnet. The strength of the magnetic field can be increased by wrapping the wire around a magnetic material, such as iron.



Independent variable – number of coils of wire
Dependent variable – number of paperclips picked up
Control variables – current supplied to the circuit, core material, width of wire, length of wire, potential difference of the battery or power pack

The **greater the number of coils**, the **stronger the electromagnet** and the more paperclips it will pick up.

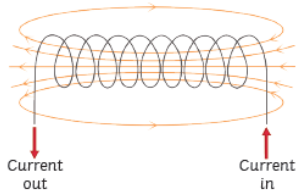


A circular **magnetic field** is produced when a current is passed through a conducting wire. This produces an **induced magnet**.

Switching off the current causes the magnetism to be lost.

The strength of the magnetic field can be increased by increasing the current flowing through the wire. The strength of the magnetic field is stronger closer to the wire.

Coiling the wire to form a **solenoid** will also increase the strength of the magnetic field. The strength of the magnetic field created by a solenoid is strong and uniform throughout.

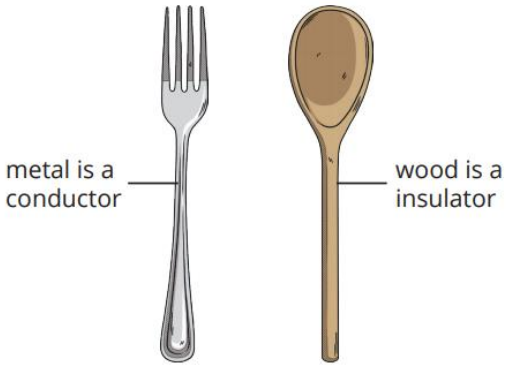


Electromagnets are useful because they can be switched on and off. This makes them suitable for sorting scrap metal at a recycling centre.

Resistance of a wire

Conductors have **low resistance** so they allow current to pass through them easily.

Insulators have **high resistance** so it is difficult for current to flow through them.



Factors that can affect the resistance through a wire include:

- temperature
- width of wire
- length of wire
- type of material

- As **temperature increases, resistance increases**. This is because the metal ions have more kinetic energy so they vibrate more, making it more difficult for electrons to flow.
- As the **width of the wire increases, resistance decreases** because there is more space for the electrons to flow.
- As the **length of the wire increases, resistance increases** because the electrons collide with more metal ions as they flow through the wire.
- Some materials are better **conductors** of electricity than others; they have **lower resistance** so they