The Thomas Alleyne Academy

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Knowledge Organiser - Electricity & Magnetism

Science Department

KPI 8PE 1: define current, and describe its behaviour in series and parallel circuits

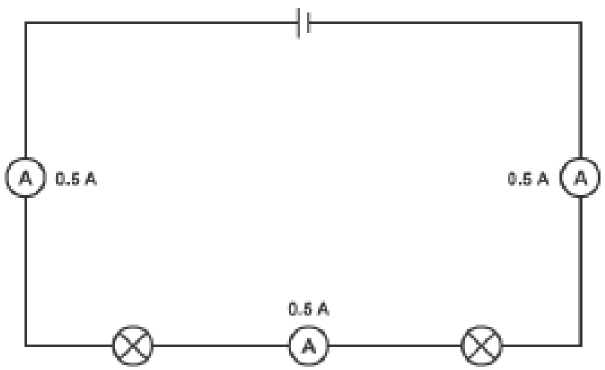
Some particles carry an electric charge. In electric wires these particles are electrons. We get an electric current when these charged particles move from place to place.

An electric current is a flow of charge, and in a wire this will be a flow of electrons.

Current is a measure of how much electric charge flows through a circuit. The more charge that flows, the bigger the current.
Current is measured in amperes (amps). The symbol for ampere is A.

Current in series circuits

The current is the same everywhere in a series circuit. It does not matter where you put the ammeter, it will give you the same reading.



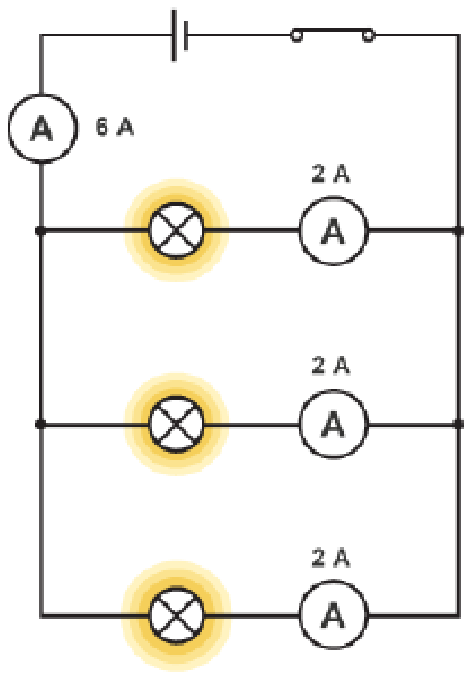
Current in series circuits continued…

The current in a series circuit depends upon the number of cells. If you make the cells face in the same direction, the **more cells you add, the greater the current.**

If you put more lamps into a series circuit, the lamps will be dimmer than before because less current will flow through them.
You might think that the current gets less as it flows through one component after another, but it is not like this - the current isn't used up!

Current in parallel circuits

Current is shared!
When two components are connected in parallel, the current is shared between the components. The current is shared when it reaches the branches, then adds again where the branches meet.



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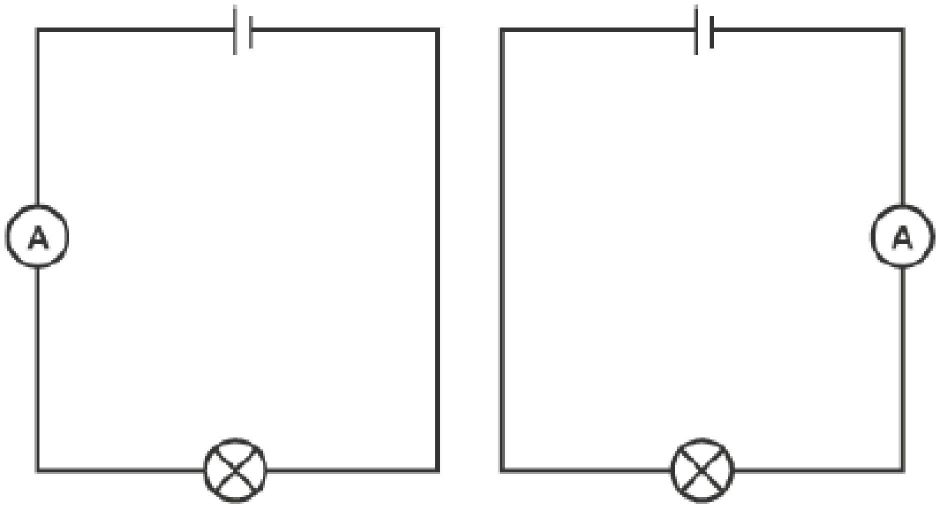
KPI 8PE 2: correctly use apparatus to measure current and potential difference

Measuring current

A device called an ammeter is used to measure current. To measure the current flowing through a component in a circuit, you must connect the ammeter in series with it – look at the diagram to see what is meant by this.

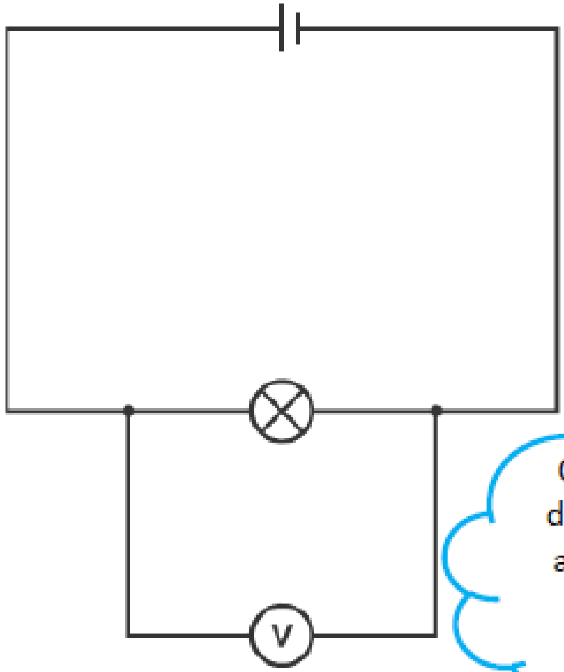


Can you remember what each circuit symbol means?

Potential difference

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. The symbol for volts is V. Some people use the term voltage instead of potential difference but this is less accurate.

Potential difference is measured using a device called a voltmeter. Unlike an ammeter, you must connect the voltmeter in parallel to measure the potential difference across a component in a circuit.



Can you see the difference in how an ammeter and voltmeter are positioned?

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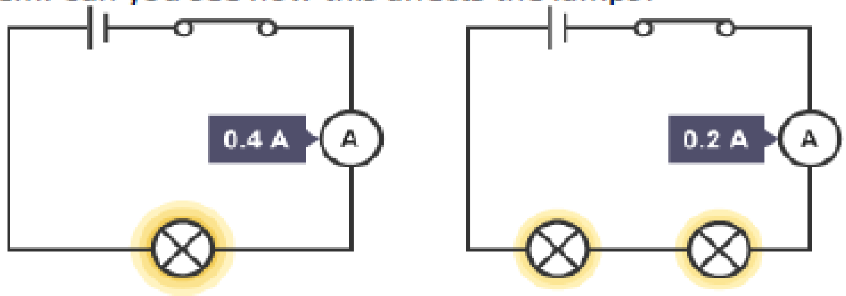
KPI sPE 3: identify conductors and insulators and calculate resistance values using appropriate units

Resistance

The wires and the other components in a circuit reduces the flow of charge through them. This is called resistance.
The unit of resistance is the ohm, and it has the symbol Ω (an uppercase Greek letter omega).

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. Can you see how this affects the lamps?



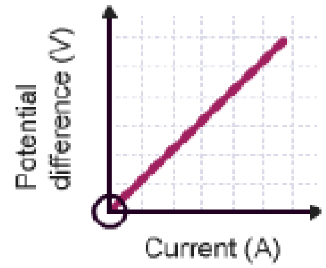
Calculating resistance

To find the resistance of a component, you need to measure:
the potential difference across it
the current flowing through it
The resistance is the ratio of potential difference to current. We use this equation to calculate resistance:

resistance = potential difference ÷ current

E.g. 3A flows through a 240 V lamp. What is the resistance of the lamp? resistance = 240 ÷ 3 = 80 Ω

Resistance represents the ratio of potential difference to current. Therefore, if you plot a graph of current against potential difference for a wire, you get a straight line.



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

The table lists some examples of conductors and insulators:

Conductors	Insulators
Metal elements	Most non-metal elements, e.g. sulfur, oxygen
Graphite (a form of carbon, a non-metal element)	Diamond (a form of carbon, a non-metal element)
Mixtures of metals, e.g. brass, solder	Plastic
Salt solution	Wood
Liquid calcium chloride	Rock

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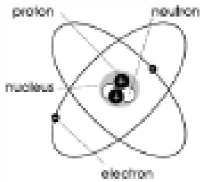
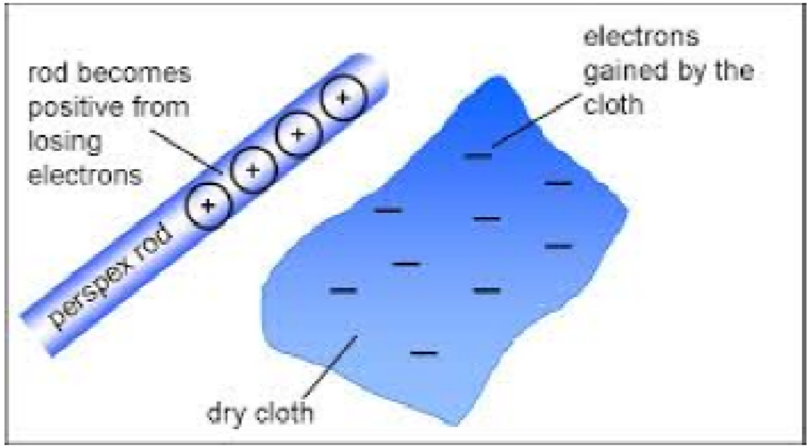
KPI 8PE 4: explain how insulators are charged by friction, and describe the forces between charged objects

All substances are made of atoms. These are often called particles. An atom is electrically neutral - has no overall electrical charge. However, each atom contains even smaller particles called electrons. (remember, these are negatively charged)

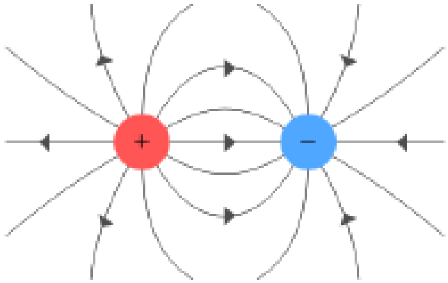


- If an atom gains an electron, it becomes negatively charged.
- If an atom loses an electron, it becomes positively charged.

Electrons can move from one substance to another when objects are rubbed together. You may have done this with a party balloon: if you rub a balloon on your sweater, you can get the balloon to stick to the wall or to your hair. This is because of static electricity.



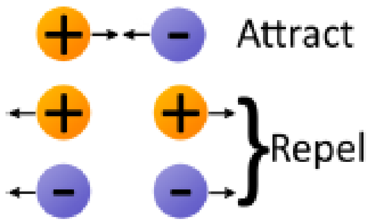
A charged object creates an electric field. You cannot see an electric field, but it surrounds the charged object. If another charged object is moved into the electric field, a force acts on it. The force is a non-contact force because the charged objects do not have to touch for the force to be exerted.



These lines show the electric field that we can't see. Can you tell from the lines whether these charged objects are attracting or repelling?

Two charged objects will:

- repel each other if they have like charges (they are both positive or both negative)
- attract each other if they have opposite charges (one is positive and the other is negative)



Charged objects will also attract small, uncharged objects. This is why a charged plastic comb or ruler, or a party balloon, can pick up small pieces of paper.

The only way to tell if an object is charged is to see if it repels another charged object.

KPI sPE 5: draw and interpret simple magnetic field diagrams

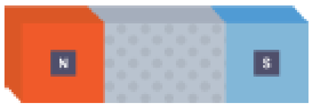
Most materials are not magnetic, but some are. A magnetic material can be magnetised or will be attracted to a magnet. These metals are magnetic:

iron
cobalt
nickel

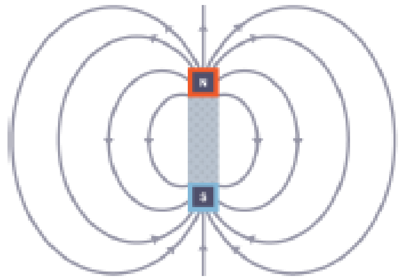
Steel is mostly iron, so steel is magnetic too.

A bar magnet is a permanent magnet. This means that its magnetism is there all the time and cannot be turned on or off. A bar magnet has two magnetic poles:

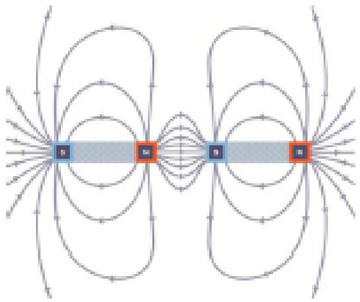
- north pole (or north-seeking pole)
- south pole (or south-seeking pole)



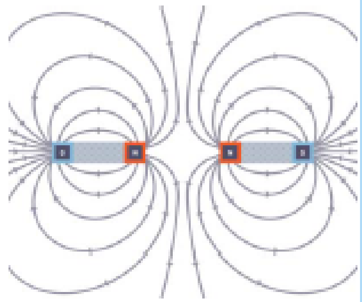
A north pole will attract a south pole on a magnet. But two like poles will repel.



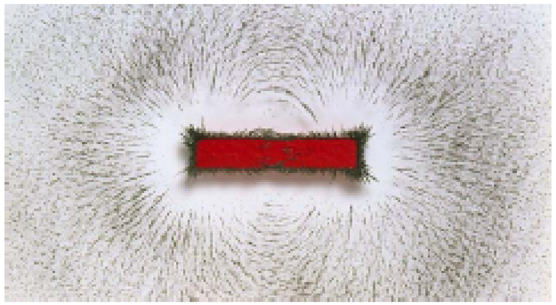
You may have also used plotting compasses to determine the *direction* of the field lines. A completed diagram would look like this. (make sure you can reproduce it accurately)
The magnetic field is strongest at the poles, where the field lines are most concentrated.



These images show two magnetic fields interacting. Can you tell which magnets are attracting and which are repelling?

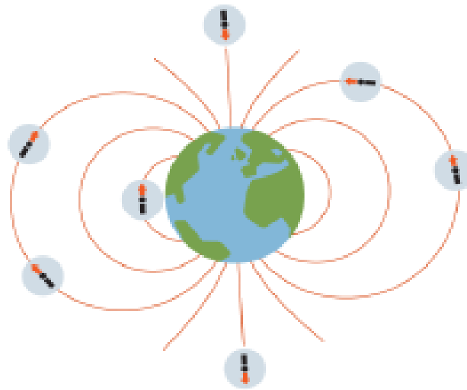


A magnet creates a magnetic field around it. You cannot see a magnetic field, but you can observe its effects. A force is exerted on a magnetic material brought into a magnetic field. The force is a non-contact force because the magnet and the material do not have to touch each other.

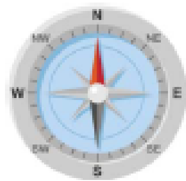


You will have used iron filings to create an image like this in your lesson. The filings show the shape of the field lines.

Due to the Earth's structure it acts like a giant magnet. Can you see how the image looks similar to a bar magnet?



This allows us to use a compass to navigate as the magnetic needle will always point towards the North pole.



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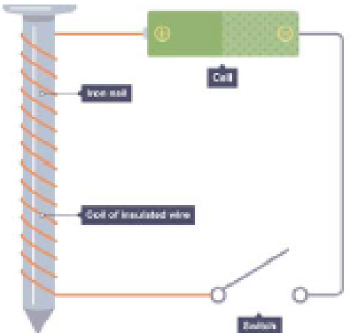
KPI sPE 6: describe how electromagnets and direct current motors work

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.

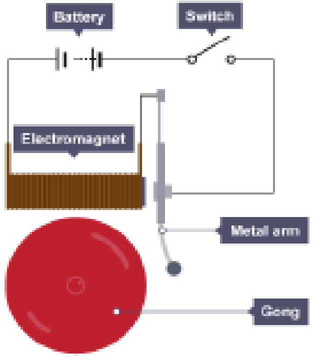


You can make an electromagnet stronger by doing these things:

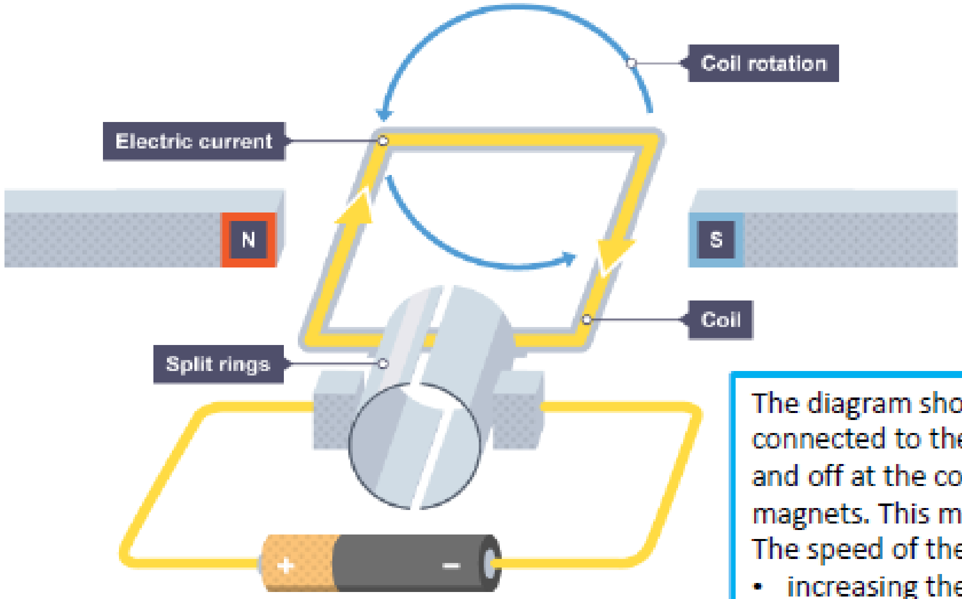
- wrapping the coil around a piece of iron (such as an iron nail)
- adding more turns to the coil
- increasing the current flowing through the coil

There is a limit to how much current can be passed safely through the wire because the resistance of the wire causes heating.

Electromagnets are particularly useful because the magnetism can be turned on and off and the strength can be varied.



Can you see how the switch would control the bell?



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.

The split rings make electrical contact with the coil and reverse the current every half turn. When an electric current flows through the coil, a force is exerted on the coil, causing it to spin.

The diagram shows: the coil of wire has an electrical current running through it because it is connected to the cell. This generates a magnetic field around the wire. The current is turned on and off at the correct time so the magnetic field of the wire interacts with that of the two magnets. This makes the coil rotate.

The speed of the motor can be increased by:

- increasing the strength of the magnetic field
- increasing the current flowing through the coil