Electricity.
Teacher/Parent Notes.

Caution.

The yellow fan.

If this is used with 6 Volts, the fan will fly into the air with some force so it is advisable to keep faces well away from it!

Batteries.

Please take great care not to directly connect the two battery terminals together either directly or through a circuit. If this happens, the batteries will get extremely hot and could burn skin if touched.

If you kit has fused battery holders the fuse will blow if the battery terminals are directly connected to each other. This state is indicated by the little LED close to the fuse shining red. This is a safety measure to protect the user. To carry on using the batteries, replace the fuse with a new one. Be careful not to repeat the mistake that caused to fuse to blow in the first place.
Replacement fuses can be purchased from most retail electrical outlets. Take the old fuse with you or ask for a 20mm. 250volt fuse rated at 2amps.

Electricity, What is it?

Electricity is a flow of electrons. An electron is the smallest part of an atom and rotates around the nucleus binding the atoms together.

It is very important to point out to children the dangers of using mains electricity. None of the ideas as shown in any of these kits should ever be attempted using mains voltage.

The Battery.

A battery is a store of electrons produced by the reaction between the metal of the case and a chemical inside the case. When the positive and negative terminals are connected as in an electric circuit, electrons flow around the circuit. The voltage is a measure of the pressure with which the electrons flows. The Amperage is a measure of the amount of electrons that flow.

In materials that conduct electricity, like metals, there is an electron that is easily pushed out of orbit from the first atom and into the orbit of the next atom. This in turn knocks an electron from the second atom into the third atom and so on. This is the way electricity flows around the circuit and because of this, there is no measurable time delay in the movement of electrons between one end of the circuit and the other.

Direction of the flow of electricity.

Electricity flows from positive to negative, however electrons flow from negative to positive. This contradictory state of affairs exists because the direction of flow of electricity was decided long before scientists discovered the electron. To-day, the standard flow of electricity is accepted as being from positive to negative. It is however important for students to know the facts, it is up to individuals to decide when to introduce the concept of electron flow.

Electricity as a producer of light and heat.

When electrons are forced through a thin wire as in the filament of a bulb or the element of an electric fire, so much heat is generated by friction created when the electrons brush past each other, that the filament glows red or white hot.

Electricity as a producer of movement.

When electricity flows through a wire, it produces the effect of a magnet. If the wire is coiled around a nail, it produces a powerful magnetic effect. This electro magnetic force is the basis on which the electro magnet and electric motor works.

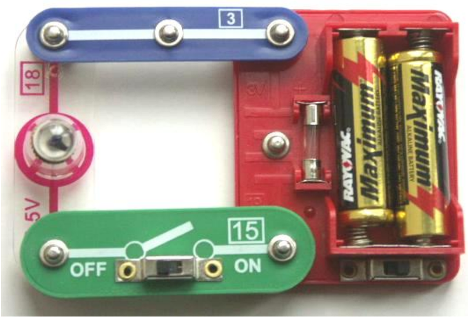
Bulbs in Series and Parallel.

When bulbs are connected together in series, the electricity has to flow through the filaments of both bulbs before it can get back to the battery.
The filaments in series act as a high resistance to the flow and this slows down the speed at which the electrons travel. The brightness of both bulbs will be only half as bright as one bulb on its own.
If the bulbs are connected in parallel, the electrons have to still flow through the filaments of both bulbs but, wired in parallel, they offer a low resistance to the flow and so the bulbs glow with the same brightness as one bulb on its own.

Before we really get going, let's do a little revision of electric circuits.

Experiment 1. A Complete Circuit?

Start by making this circuit.



Slide the switch 15 to the ON position, the bulb should light up. If it does not, first check that the bulb is screwed properly into the bulb holder and if this does not work, try some fresh batteries.

With the bulb still alight, remove the top blue connector 3. Note what happens to the bulb. Replace the top blue connecter 3 and now slowly unscrew the bulb from its holder, again note what happens to the bulb. Screw the bulb back into its holder and switch off.

You have just proved that if electricity is to flow around a circuit, the circuit must be complete. If there is a break in the circuit for any reason, like removing the blue connector or unscrewing the lamp, the electricity is unable to flow and the bulb will not light up.

Just in case you wondered, look on the under side of the blue connecter 3 and you will see a piece of wire connecting the two press-studs together.

The next question is, can we use just anything to connect up a circuit?

Experiment 2. Will just anything do to make a circuit?

In this section, we need to find out if materials other than metal can be used to make a electric circuit.

You will need something made of wood, plastic and metal. Rulers are often made of wood or plastic and so are pencils and pens. A piece of baking foil will do for the metal or perhaps a hair slide, scissors, a paper clip or a piece of silver paper.

Using the same circuit, switch on to check that the bulb lights up and then remove the blue connector 3.

Now, in place of the blue connector, try the wood, plastic and metal. Make certain that the wood, plastic or metal touches the pres-studs on the bulb holder and the battery at the same time. If the bulb lights up, put a Yes in the second column of the table below.

Material	Did the bulb light up?	Conductor	Insulator
String	No		
Wood			
Plastic			
Metal			

You may like to try some other things like paper or, if you can find it, a length of pencil led.
Materials like string, do not allow electricity to flow, they are called ‘Insulators’.
If it did allow electricity to flow, then it would be called a ‘conductor’.

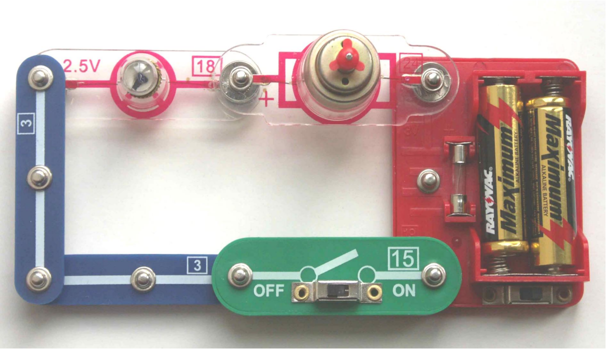
When is a Battery not a Battery?

In this circuit, you are using a battery made up of two 1.5 Volt cells so the voltage of the battery is 3 Volts. The cells are connected together in series, so the voltage is the sum of the voltages of both cells. As scientists, we must get used to using the correct names for the parts we use.

Experiment 3. Series or Parallel?

In this experiment you are going to use the same bulb and motor in each circuit. In the first circuit, they will be connected in series and in the second circuit they will be connected in parallel. We need to find out the advantages and disadvantages of each circuit.

First make up the series circuit like this.



It is called a series circuit because the electricity has to go through each of the components before it can get back into the battery so in this circuit, the motor and the lamp share the 3 Volts.

Switch on; does the bulb light up and the motor run? If they do, Switch off.
What about the brightness of the bulb and the speed of the motor?

To help answer this question, take another blue connector 3 out of the box.
Switch on again and remove the motor, quickly clip the blue connector 3 in its place.
Does the bulb get brighter? Brightness is quite easy to judge, but what about the speed of the motor?
The best way to judge the speed of the motor is to listen the noise it makes. The higher the pitch of the sound, the faster it is rotating

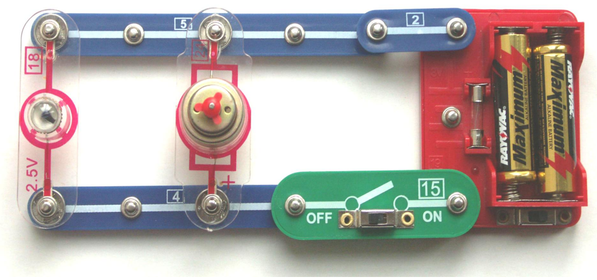
To test the speed of the motor, swap over the positions of the bulb and the motor in the circuit and then repeat the test as you did for the bulb. Did you find that the motor turned faster without the bulb in the circuit?

One more experiment to try. Put the bulb back into the circuit and switch on. Now unscrew the bulb and note what happens to the speed of the
motor then screw the bulb up again and switch off.

From our experiments, this is what we found out.
When connected in *series*, bulbs light up less brightly and motors rotate more slowly,

this is because the electricity has to flow through one
component and then the other so they share the voltage. If one component breaks, the other components will not work because the electricity can not flow back to the battery

Now its time to experiment with Parallel circuits.
Make up this circuit.

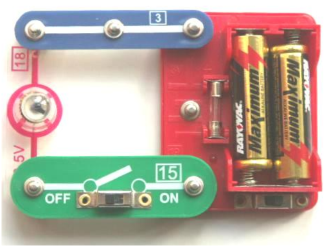


Switch on, look at the brightness of the bulb and listen to the speed of the motor, how do they compare with the series circuit? About the same brightness and speed or brighter and faster?
Remove the motor, what happens to the bulb? Replace the motor and remove the bulb, does the motor still run?
If you need to check anything, make up the series circuit again and check it out.

So we can say this about a parallel circuit.
When connected in *parallel*, bulbs light up brightly and motors run faster than when connected in series.
If one component brakes, the others will continue to work as the electricity is still able to flow back into the battery. All components in a parallel circuit get the full battery voltage.

Experiment 4. Switches.

Switches are used to control an electric circuit. When a circuit is not being used, the switch should always be in the off position. Make up the circuit shown below.



The switch simply turns the bulb on and off. Removing the blue connector would do the same but it is not so convenient!

This switch is called a slide switch but there are many other types. At home or in your classroom the lights are turned on and off with a rocker switch. Your torch may have a press switch to make it flash.

In your kit there is a new type of switch, called a reed switch, it is part number 13, take it out and have a look at it. In side the glass or plastic envelope, there are two thin pieces of metal that do not touch each other, however when a magnet is brought close to them they are forced together and electricity can flow through it.

Remove the slide switch and replace it with the reed switch. Use the circular magnet from the kit and slide it past the reed switch, the bulb should flash on and off as the magnet passes the reed switch. If you listen carefully, you should be able to hear the switch working.

This type of switch could be used to switch a light on when a door is opened, very much like a refrigerator light comes on when the door is opened and goes off when the door is closed.

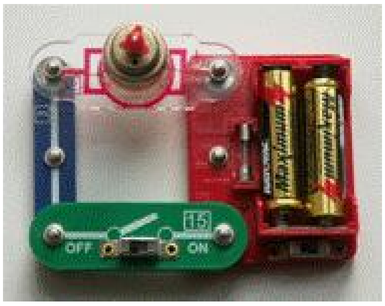
Experiment 5. LED's (Light emitting diodes)

An LED is a polarised device. This means that it is sensitive to the direction of the flow of electricity. To see what this means, use the LED 17 in place of the bulb in the last circuit. The positive end (the end with the + sign) should be connected to the blue connector. Switch on to check your LED lights up. If it does not, swap the LED around and try again. The LED will only give out light when the electricity is flowing from positive to negative (+ to -).
Because it uses very little electricity, it is often used as an indicator light to show that something is working.

Experiment 6. Electric Motors, forwards and reverse.

You have already used an electric motor but we did not take any notice of which way it rotated. Electric motors can rotate both ways depending on which way the electricity flows through it. This is very useful if we want to make something go backwards as well as forwards!

Make up this circuit. Clip the positive terminal of the motor to the positive terminal on the battery.



Switch on, note down which way it rotates. Turn the motor around, and again note the direction of rotation.

As you will have seen, when the + terminal on the motor is connected to the + terminal on the battery, the motor runs clockwise and when the - terminal on the motor is connected to the + terminal on the battery, the motor runs anti-clockwise.