

# Magnetic Connections

## Primary Electricity Set

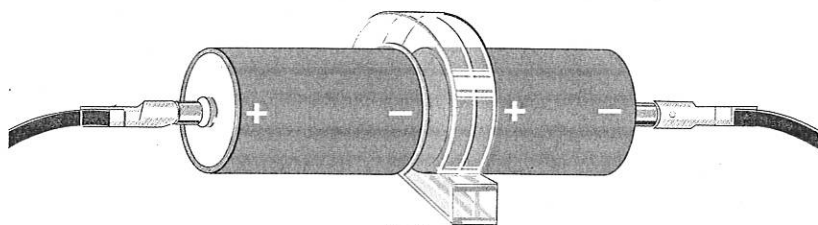
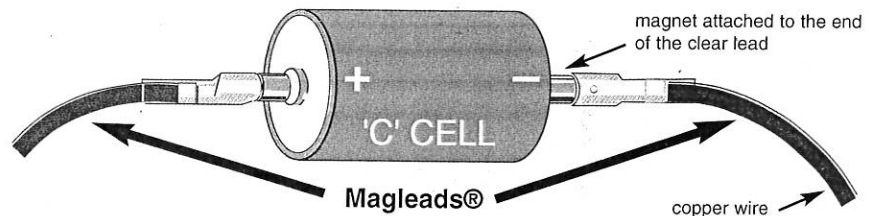
Thank you for purchasing the 'Magnetic Connections Primary Electricity Set'.

### Making circuits quickly and reliably . . .

The components in this Magnetic Connections Electricity Set are compatible so that they will give long and reliable service and provide a good foundation for the understanding of basic electricity. You will find all of the components required to make numerous circuits, excluding the batteries (4 x 'C' cell batteries required). To make a connection the Magleads® provided have a small but strong Neodymium magnet at each end to make it easy to connect them to component bases. The transparent component bases have an aluminium block (at both ends) which has three holes to accept the magnetic leads enabling circuits to be made easily.

### Making Circuits

Magleads® will connect straight on to a battery because battery cases are made from mild steel which is magnetic.



Battery Connector

This is helpful where a single battery is being used, but if you need to connect several together to gain more power, then you will find a special battery connecting component in the set.

#### NOTE:

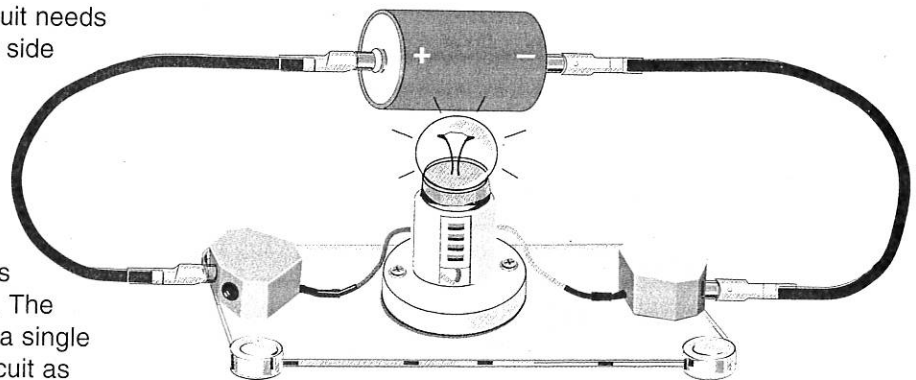
The battery connector component is designed to be used with 'C' cells.

The bulbs in this set are rated at 2.5 volt. The 'C' cell battery only provides 1.5 volt so the bulb will not glow very brightly. To make it glow brighter try adding several batteries together using the battery connector.

### Simplest 'Closed' Circuit

For electricity to flow a complete circuit needs to be made with a connection to one side of the battery to a component and then back to the other side of the battery. In this situation the current will flow around the circuit and the circuit will work.

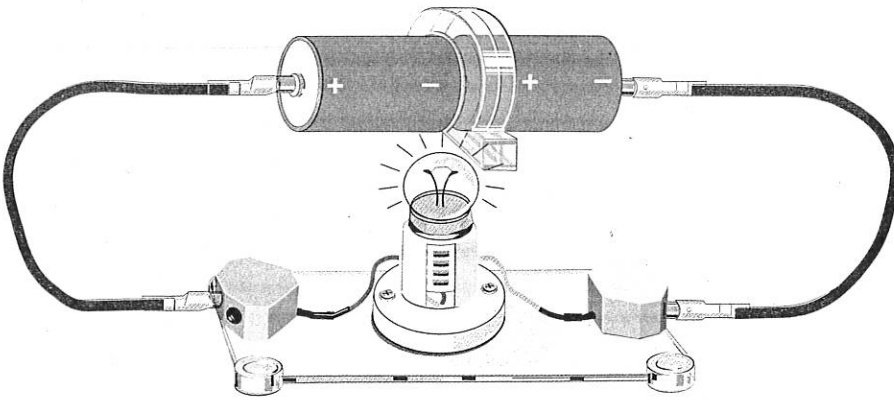
The bases in the kit enable numerous simple circuits to be made with ease. The simplest is a circuit from a battery to a single light bulb. This is called a 'closed' circuit as there is no switch. Closed circuits allow the flow of electricity to move around the circuit without interruption.



Simplest closed circuit

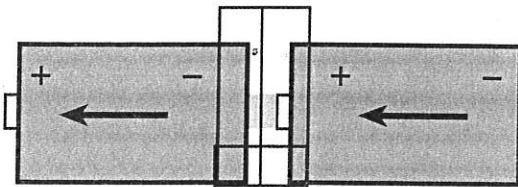
## More Power

Adding another battery will increase the voltage in the circuit and will make the bulb glow brighter. To connect batteries together, the Connections Electricity Kit uses a special clear battery connector component which employs a tiny Neodymium magnet to pull the ends of the battery into contact.

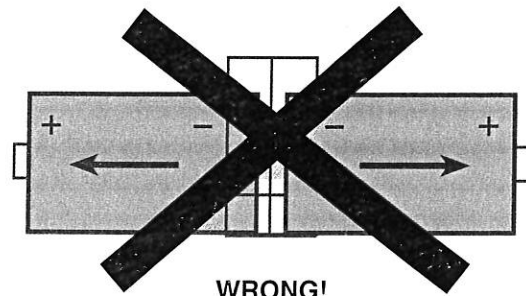


Remember when connecting batteries together they all need to face the same way. To increase voltage the + of one battery connects to the - of the other battery and so on (see the diagram). Let children experiment by putting the batteries the wrong way round to see what happens.

Two batteries give more power ( $1.5V + 1.5V = 3V$ ) and the bulb will glow more brightly.



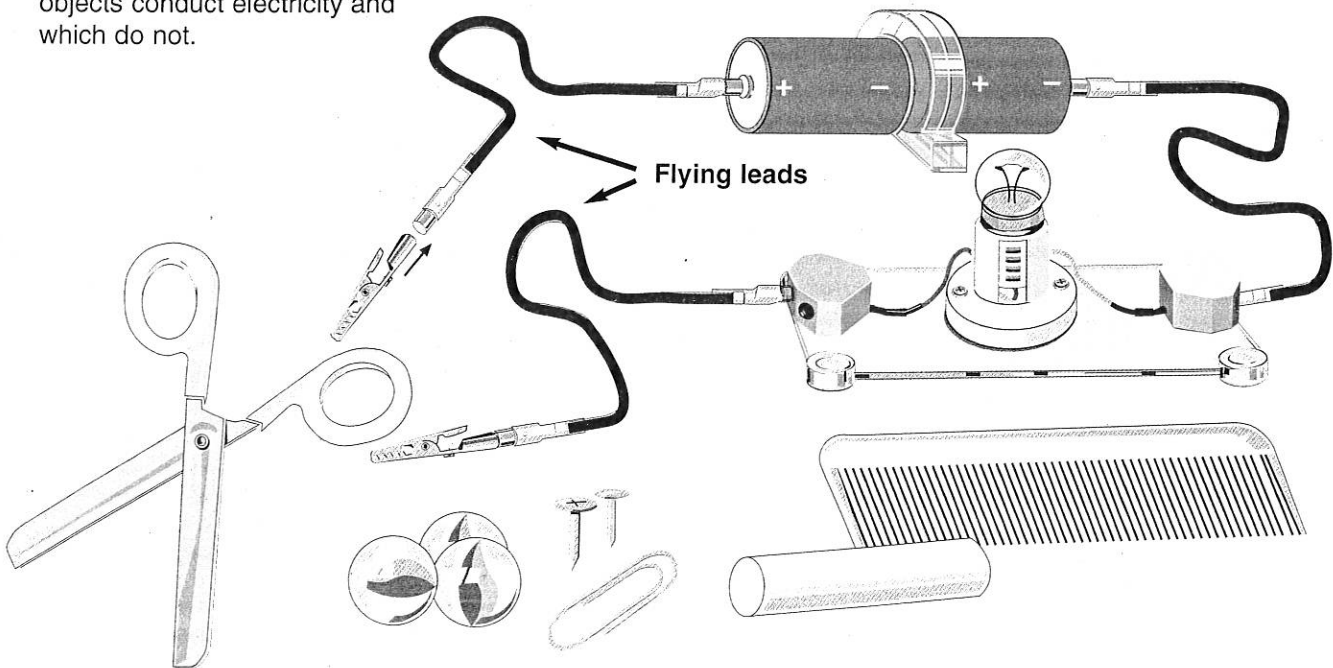
Adding battery power together.  
Both batteries face the same way.



**WRONG!**  
Batteries facing in opposite directions

## Conductors and Insulators

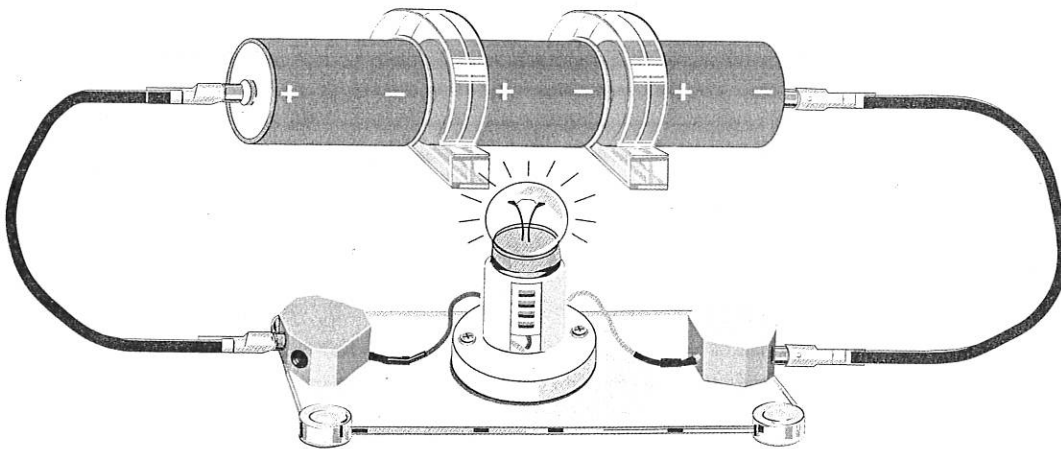
If you break open this circuit by disconnecting a Maglead® and hold it slightly away from its connection, even with a tiny air gap you will see that the light bulb goes out. If you place items or objects into this gap you can see if the light bulb will light up again. This experiment is a good way for children to discover which objects conduct electricity and which do not.



**NOTE:** The crocodile clips can be attached to the ends of the Magleads® providing a connection to items which are not magnetic – but may or may not be conductors – such as non-ferrous metals, plastic and other materials.

## Even More Power

The light bulbs in this set are rated at 2.5 volt. They will glow if connected to a 1.5 volt battery ('C' cell), but will glow brighter each time the voltage is increased when additional batteries are added (however, you should be aware that this will shorten the life expectancy of the bulb!).

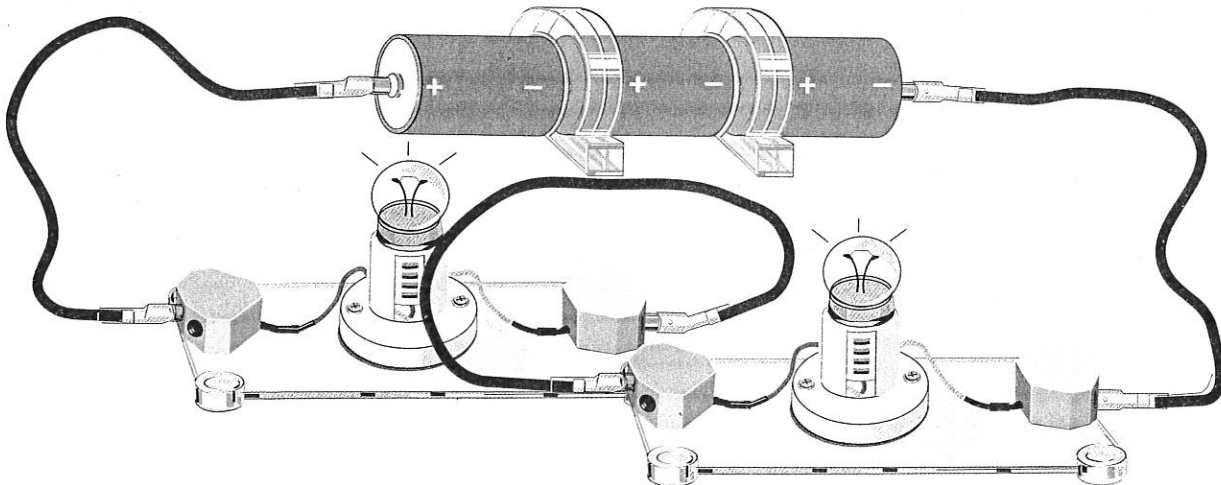


**NOTE:** The life expectancy of a bulb will be shortened by using too high a voltage, so try to use the correct voltage. Two 'C' cell batteries (1.5 volt + 1.5 volt = 3 volt) for each bulb (rated at 2.5 volts) are ideal.

**Too much power (4.5 volts powering a 2.5 volt bulb)**

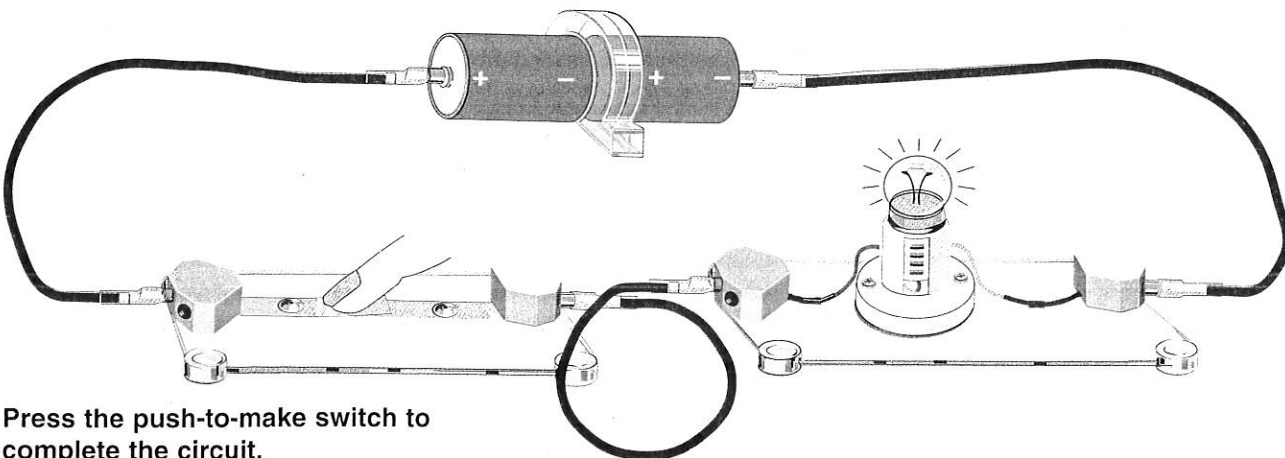
## More Bulbs, Less Bright

Adding another bulb into a circuit will share the voltage between them, so in the illustration below we have 3 batteries (1.5 x 3 = 4.5 volt) and two bulbs (2.5 x 2 = 5 volt) so each bulb will receive 2.25 volt each (half of the available voltage provided by the three batteries). Try some experiments with this circuit, adding and subtracting batteries and bulbs and noting the effect.



## Control

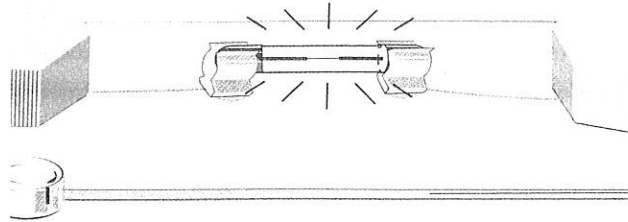
Adding a switch gives an element of control over the circuit. It is not possible to get an electric shock from the switch.



**Press the push-to-make switch to complete the circuit.**

## Festoon Bulb

The Festoon bulb is like a normal light bulb, but with the filament laid out in a straight line. Being in-line will help children to see the path of electricity flowing through the circuit. When the current squeezes through the tiny metal filament it causes it to glow red hot.



**NOTE:** The Festoon bulb is rated at 6 volt so by using one or two batteries together it will just make it glow without it getting too bright. Children can observe it getting hot and glowing inside its glass tube. They can use a magnifying glass or microscope to see the coil of wire glowing red hot more clearly.

## Dimmer circuit

Find the supplied length of very thin shiny Nichrome wire, sometimes called 'resistance wire' because it is a not very conductive. By making the circuit shown it is possible to make the bulb go dim by increasing the length of Nichrome wire between the crocodile clips.

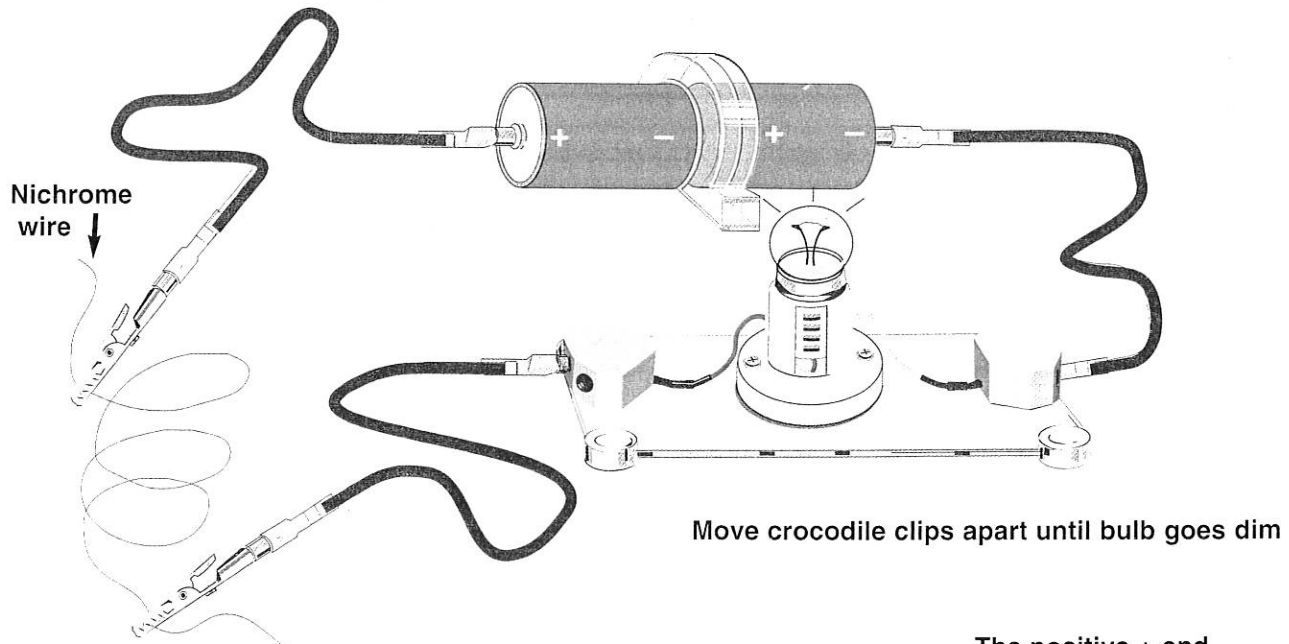
### Some things to be aware of when doing this experiment:

When making a connection with the crocodile clips to the Nichrome wire be careful not to pull the Magleads® off the battery or away from the light bulb. A disconnection will switch off the light bulb and give a confusing result.

Try attaching the wire to a metre rule with sticky tape, or wind it around a card tube to make it easier to use in this experiment. If you decide to wind the Nichrome around a tube, be careful not to let the coils of wire touch each other as this will cause the circuit to be shorted out and the effect lost.

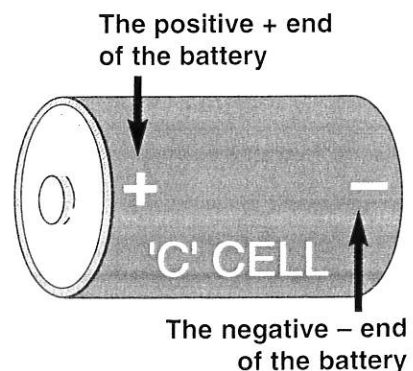
**WARNING:** If too many batteries are used and the resistance wire is very short it could get hot.

**Note:** The dimming effect will be dependent upon the number of batteries you use and the power they have in them. By moving the crocodile clips apart, you should be able to get to a point where the bulb is only just lit.



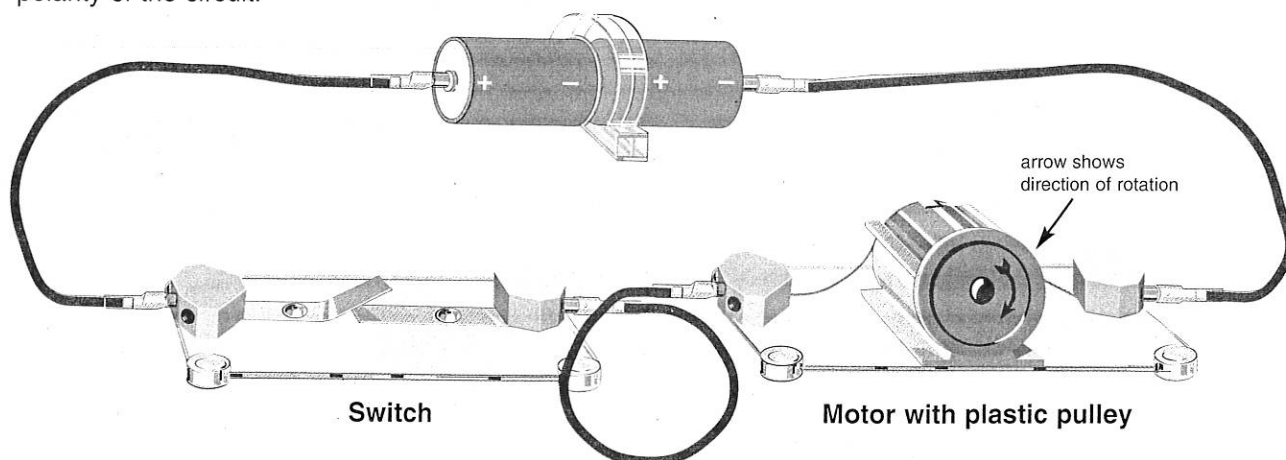
## Polarity

So far we have made circuits where the polarity of the circuit has no effect, they all work well. The polarity is the way in which the battery faces in the circuit. In conventional circuits, the current can be considered to flow from the positive (+) to the negative (-) side of the battery but a light bulb will still light up whichever way round it is connected. However, with some components the polarity is more important. With a motor, changing the polarity will change the direction that the motor spindle will rotate and a buzzer will only work if connected the right way round.



## Motor Power

Connect the circuit as shown to make a motor spin when the switch is pressed. Note the direction that the spindle rotates by observing the little arrow on the plastic pulley. Now switch the batteries around and connect the circuit up again, this time the motor will rotate in the other direction. This is called changing the polarity of the circuit.

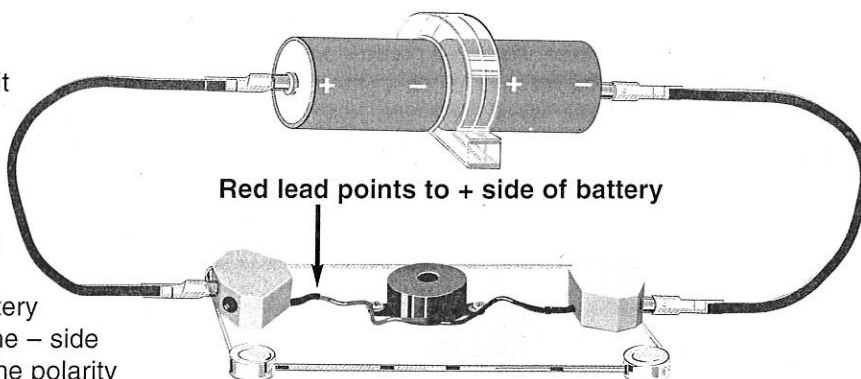


Now remove the Magleads® from the battery and connect them the other way round, i.e. the lead that was connected to the + should now be connected to the - and visa versa. You will find that the motor spindle now rotates the other way. This is a good example of seeing something happen as a direct result of changing the polarity which makes the current flow the opposite way.

**NOTE:** The pulley will accept a small rubber band and can be fitted to a mechanical toy to make it spin.

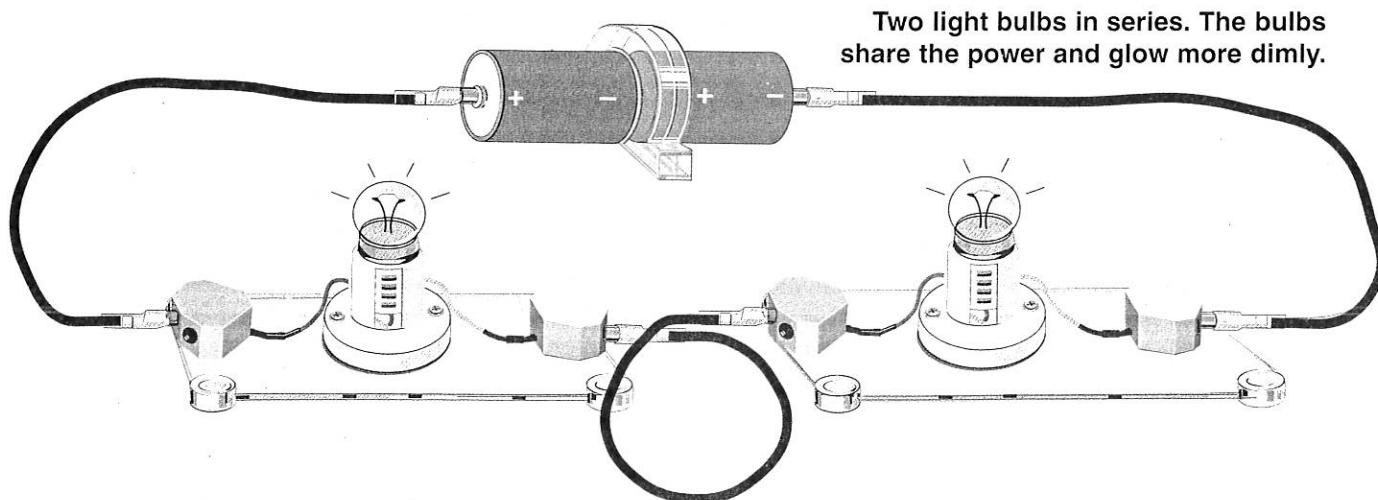
## Making Noise

The buzzer has a tiny electrical circuit inside the case and will only sound if it is connected the right way round. Look carefully at the clear plastic base which holds the buzzer and you will see that it has a red and black lead coming from it, the red must connect to the + side of the battery and the black lead must connect to the - side of the battery. With this component, the polarity must be the right way round for it to work.

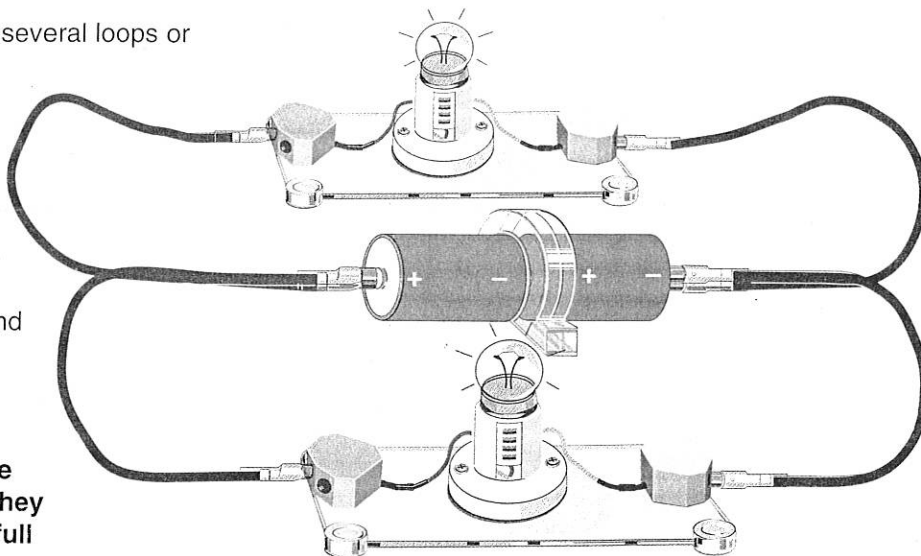


## Series and Parallel

**Series** – A series circuit is one where all of the current flows around a single loop and through all of the components. In a series circuit the components share the available voltage between them. Two light bulbs in a series circuit will glow more dimly; three light bulbs will be even dimmer!



**Parallel** – A parallel circuit has several loops or routes through which the electricity can flow. This means that each component will be subject to all of the available voltage. In a parallel circuit with 2 bulbs they will each shine as brightly as if they were connected individually. Try connecting 3 bulbs in parallel and see what happens.

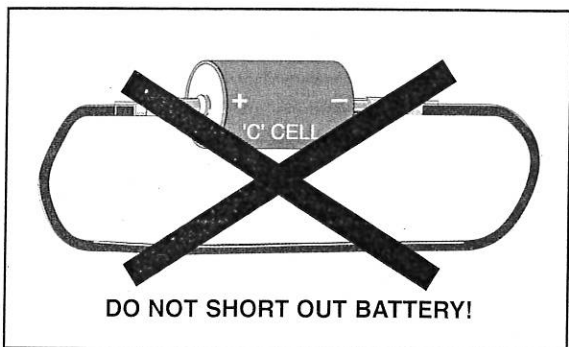


**Two light bulbs in parallel. The bulbs glow brightly because they are both subject to the same full voltage.**

## General Information

Anyone who has taught very young children about the fundamentals of understanding electricity will know that they learn best when they are making the circuits themselves using individual components. This 'hands on' approach is essential and there are no short cuts to this process or indeed any better way for children to learn.

This set is based upon this principle and children should be encouraged to try things out for themselves without any fear of electric shock or making a short circuit. The components are matched for voltage and current so that they and the children can come to no harm. Having said that, there are a few things that children should be warned about:



- 1) DO NOT connect a Maglead® from one side of a battery to the other side thus connecting both poles together. This shorts out the battery and will quickly remove all of its power. It could also heat up the lead because there is very little resistance in the leads and so the current flows around the circuit very quickly. This is especially the case with Alkaline batteries and Rechargeable cells. For this reason, we strongly advise that Rechargeable cells are not used with this kit.

- 2) Be careful with the bulbs as they are made from glass. They are in fact very robust and even dropping them onto a hard floor should not ordinarily break them, but glass is brittle and sharp if broken so take care.
- 3) Do not use too many batteries in the resistance wire experiment, one or two is enough.

Apart from that, there is very little to go wrong with these components, but don't forget as part of the learning process, things that don't work are just as important if not more important than things that work correctly! So let children experiment and make mistakes too!

One final point is that to get the most benefit from this set, children should be encouraged to do their own fault finding.

### Here are some fault finding tips to give to children:

- If the circuit isn't working, check all of the connections carefully, wiggle them around to make sure there is a good contact.
- Check that the battery is connected correctly, with the Maglead® connected to the raised part of the + and the middle of the – side of the battery.
- If you have added batteries together make sure they are connected the right way round. To add power they need to be connected with the + of one battery connecting to the – of the next one and so on.
- If you have a buzzer in the circuit check that the red lead faces towards the + side of the battery.
- Any circuit with a switch in it will not work unless the switch is pressed down.

### HAVE FUN!

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