Primary Science Using Electricity
Teacher/Parent Notes

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 the metal copper, 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 time delay in the movement of electrons between one end of the circuit and the other.
It is recommended that rechargeable batteries are not used because they can get very hot if shorted out.

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. An electron is the smallest part of an atom. In an atom of the metal copper there are 29 electrons. Most electrical wiring is made of copper.
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 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.

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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.

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! The circuit should be used on a level surface to prevent the fan from flying off at an angle.

For unit 4F section 3, you will need some items made of metal, such things as nails or even aluminium foil could be used.

For unit 6G,some very thin wire is used which easily gets lost. If you are unable to get fuse wire, an easy way to get new supplies, is to strip the insulation off a 20cm. length of lighting flex and untwist the strands of wire. It would be a good idea to test one strand and see if it makes the bulb dimmer. If it doesn't, the wire is not thin enough. This in not ni-chrome wire but it still works if the wire is thin enough. You will also need a supply of steel wool to provide an alternative to the copper wire.
The steel wool makes excellent demonstration fuses but be careful as they will get very hot!

The blue 3 connector without a wire.

This 3 connector is provided to enable extra components like resistors to be used. It can also be used when testing wires in 6G unit 3.
The connector can be identified easily as it has no white line on the top.

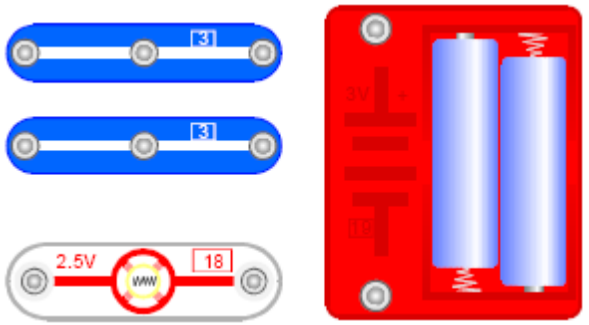
Fuses.

If your kit has fused battery holders, the fuse will blow if the batteries are shorted out. The fuse is there to protect the user and if the batteries are shorted out they could get very hot, hot enough to be very painful. If the fuse blows, the red LED next to the fuse will light. Try to determine what caused the fuse to blow. The only way to continue is to change the fuse for a new one. There is a spare in the kit but they are obtainable from most electrical outlets, take the old fuse with you or ask for a 20mm glass fuse rated at 250Volts 2Amps.

Primary Science Unit 2F. Using electricity.
Unit 4 making a circuit 1

Learning Objectives. Children should learn
To make connections in a circuit to the positive and negative terminals of a battery.
To make a complete circuit using a battery, wires and a bulb.
To explore how to make a bulb light, explaining what happened, using drawings to present results.

In this experiment you are going to try to make a bulb light using the parts shown opposite.



From your BrainBox kit, pick out the parts shown in the drawings.
You will need -
1 x red battery unit.
2 x blue connectors (part number 3)
1 x bulb holder and bulb (part number 18)

Now see if you can connect the parts together and make the bulb light. You must use **all** the parts! ***Do not*** *connect a blue three connector across the battery terminals. This will blow the fuse and the kit will not work until the fuse is replaced with a new one.*
The battery terminals are the ends of the battery where you connect the wires. The quickest way to build the circuit is to clip the batteries and the bulb holder onto the baseboard first, then connect the two three connectors.

When you have found out how to make the bulb light, take away one of the blue links. Does the bulb still light up?

To make the bulb light, the bulb must be connected to both terminals of the battery, but do we need metal wires?
Do you think you could use anything else instead of the blue connector? What about your pencil or a piece of paper? Go on, try it!
Did you expect it to work? Try the buzzer, (part number 65) in place of the bulb. The buzzer gives an audible sound instead of a light which would be better for blind people.

To make the bulb light or the buzzer sound, we need a complete circuit so that electricity can flow all the way round and light the bulb and then flow back into the battery. When you have finished, draw the circuit in your exercise book.

Learning Outcomes.
To make working circuits using bulbs and/or buzzers and make drawings of these.

New words.
Battery Bulb Connector Terminals Positive Negative

Primary Science Unit 2F Using Electricity

Unit 4 Making a circuit 2

Learning Objectives.
To make connections in a circuit to the positive and negative terminals of a battery.
Explore how to make a bulb light, explaining what happened using drawings to present results.

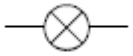
We have seen that a bulb when connected to a battery, gives out light, but why does the bulb light up?
To answer this question we must first find out about a battery.
A battery is a store of electricity, it has a positive terminal marked with a + sign and a negative terminal marked with a - sign.

The end with the small cap is the positive terminal  the other end is the negative terminal.

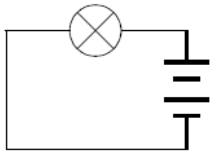
Electricity flows from the positive terminal, through the circuit and back into the negative terminal. Once all the electricity in the battery has flowed through the circuit, the battery will not work any more.

If you look carefully at the glass part of a bulb you will see that it has a curly bit of very thin wire in the middle, this is called the filament. Because the wire is so thin, the electricity finds it hard to flow through the filament this makes the filament glow red or white hot and give out light. There is no air inside the bulb, so the filament does not burn out.

So that we can draw electric circuits quickly, we need an easy way to draw the parts that make up the circuit. Instead of drawing the parts, we draw symbols.
Instead of drawing a battery like this  we draw this symbol 

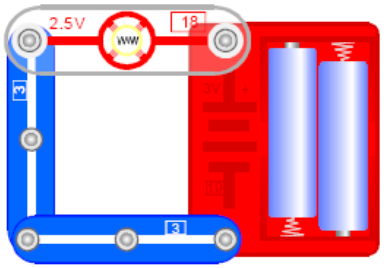
For a bulb, instead of this  we draw this symbol 

and for a wire, instead of this  we draw this symbol

This is the circuit using symbols 

These are the standard circuit symbols but, at this stage, you do not have to use them. If you wish to use symbols, you could design you own.

This is the circuit made from the parts



New Words. Filament Symbol

Primary Science Unit 2F Using Electricity

Unit 4 Making a circuit 3

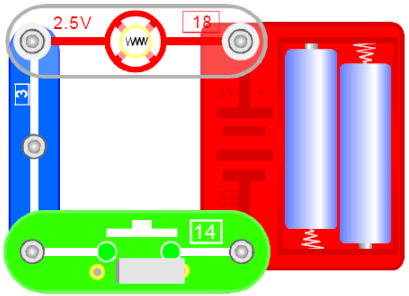
The only problem with the last circuit is that to switch the lamp off, you have to take away part of the circuit, so lets add a switch.

This is a press switch. 

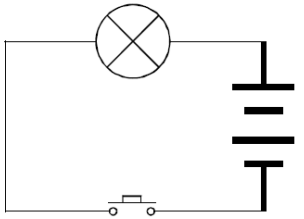
It is part number 14 and the circuit symbol is drawn on it. When the switch is pressed, electricity can flow through the switch because both the press studs are connected together.

Connect the parts together like this.

The parts are -
1 x Battery unit
1 x Bulb unit
1 x Press switch
1 x Connector 3



Make up the circuit exactly as shown in the picture

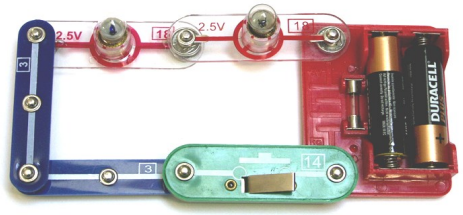


This is the circuit diagram

When you press the switch, the lamp will light and when you release the switch, the lamp will go off.

Does electricity only give us light? Try holding the bulb with your fingers when it has been lit up for a short while, do you notice anything? Does the bulb feel warm? You could use the buzzer in place of the bulb. The buzzer is useful to give an audible warning.

Here is another circuit for you to try. If you do not have two bulb units in your box, ask your teacher for another one.



To make this circuit you will need -
1 x Battery unit
2 x Bulb unit 2.5V
2 x Connector number 3
1 x Press switch

Replace one of the bulbs with the buzzer, check that the + sign on the buzzer is on the right.

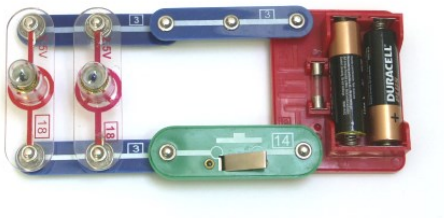
Look at the brightness of the bulbs. Are they both as bright as the bulb in the first circuit or are they brighter or dimmer? If you can not decide, replace one of the bulbs with a 3 connector. This arrangement is called bulbs in series and the electricity flows through the first bulb and then through the second. Now unscrew one of the bulbs and press the switch. What happens to the other bulb? Unscrewing a bulb causes a break in the circuit so the electricity can not flow.

New Words. Press switch Brighter Dimmer Series

Primary Science Unit 2F Using Electricity

Unit 5 Investigating circuits

Here is another circuit that uses two bulbs but very different from the last circuit.



To make this circuit you will need -
1 x Battery unit
2 x Bulb units and bulbs
3 x Connector number 3
1 x Press switch
2 x 2.5V bulbs

Press the switch and decide on how bright the bulbs are. Bulbs connected like this are known as bulbs in parallel.

Unscrew one of the lamps. Does the other bulb go off? This is because the electricity flows through both bulbs at the same time. If one is unscrewed, it does not break the circuit so the electricity continues to flow.

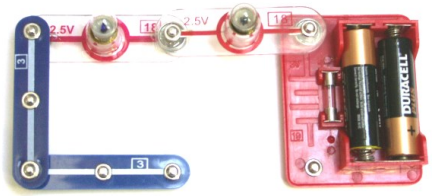
The brightness of the other bulb is what is called 'normal brightness'.

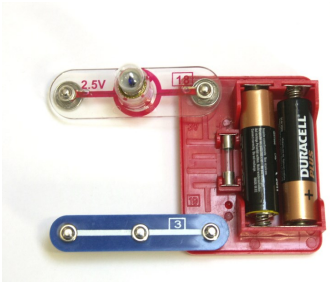
Bulbs are judged to be normal, brighter than normal or less bright than normal. Sometimes in place of less bright, we say dimmer than normal, they both mean the same.

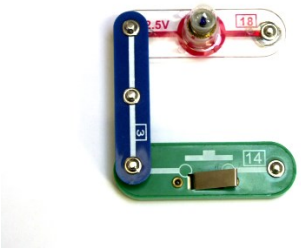
Now replace one of the bulbs with the buzzer. Notice that the buzzer has a + sign on it. This + sign should be connected to the top 3 connector. If your buzzer does not sound, take it off and turn it round.

New word. Parallel

Here are some circuits that do not work. For each circuit, explain why it will not work and then build each circuit adding the missing parts so that it will work.







Primary Science Unit 2F Using Electricity

Section 6 Making useful circuits

How good are you at designing your own circuits? Here are two circuits for you to design.

1. In the office, we have a cupboard that contains all the paper and books we use every day. It is very dark in the cupboard so people have to put the light on. Unfortunately they often forget to turn the light off and this wastes electricity.

Can you design a circuit that will sound a warning when the light is on?

2. My house has an outside light that comes on when the house lights are on. The outside light does not need to be on all the time and is just a waste of electricity.

Can you design a circuit for my house with two bulbs, one inside and one outside so that both of them can be switched on together or just the inside bulb on and the outside bulb off?

Learning outcomes for unit 2F

1. To make a bulb light or a buzzer sound, the circuit must be complete.

2. The wires must be made of metal.

3. Electricity flows from the positive end of the battery, through the circuit and back into the negative end of the battery.

4. A bulb gives out light and heat.

5. Bulbs wired in series will be dimmer than normal. If one bulb is unscrewed, the other bulb will also go off.

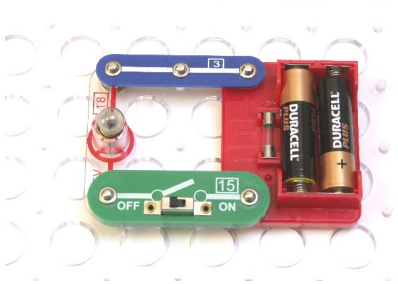
6. Bulbs wired in parallel will be at normal brightness. If one bulb is unscrewed, the other bulb will stay on.

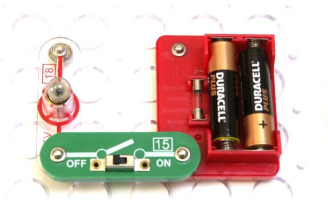
Primary Science Unit 4F Circuits and Conductors

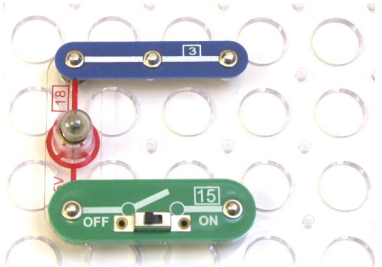
Unit 1 Making circuits that work

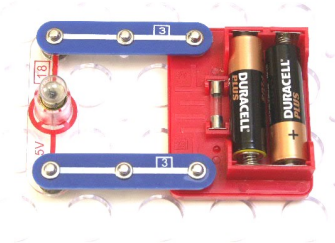
Learning Objectives. *Children should learn*
That a circuit needs a power source.
That a complete circuit is needed for a device to work.

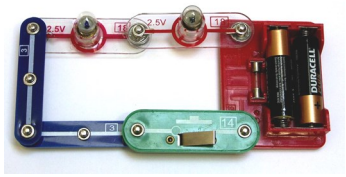
Look at the circuits below. Decide and explain which will work and which will not.

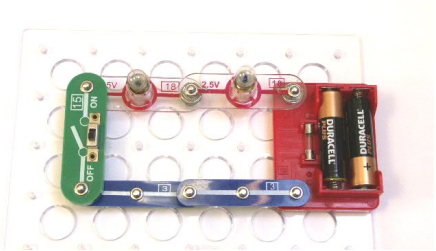
1 

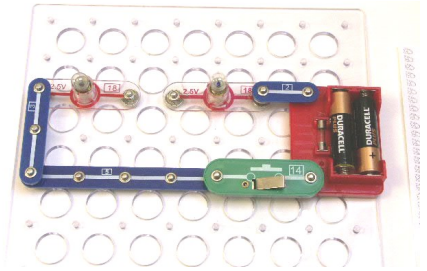
2 

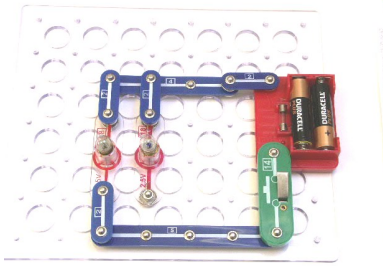
3 

4 

5 

6 

7 

8 

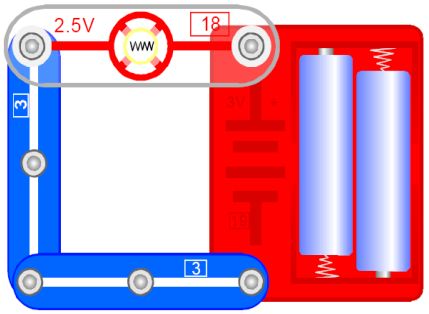
9 Now make a circuit which will work, record it by making a drawing and label each part to say what it does, e.g. the battery provides the electricity.

Primary Science Unit 4F Circuits and Conductors

Unit 3 Conducting Electricity

Learning Objectives. *Children should learn*
That some materials are better conductors of electricity than others.
How to find out which materials allow electricity to pass through them.
To use results to draw conclusions about which materials conduct electricity.

In this section we are going to find out which materials can be used to make an electric circuit.
To test different materials we must build a circuit like the one shown below.



The most common materials are wood, plastic and metal, but which of them could be used to make a complete circuit and the bulb light?
You could use the buzzer in place of the bulb.

Once you have built the circuit and know that the bulb lights, remove the bottom blue connector.
Use the materials in place of the blue connector by touching the two terminals with the material.
For each material, note if the bulb lights or not.

You could test anything that you find around you like your ruler, comb, pencil, pen or a paper clip also try silver paper or baking foil. It is the material we are interested in not the object. Your ruler could be made of plastic, wood or metal so try to find at least two of each material to test.

Make up a table like the one below to show your results.

Object	Material	Did the bulb light?	Conductor or Insulator
Exercise book	Paper	No	Insulator
Watch strap	Leather	No	Insulator

From the results, you can see that paper and leather would not be any good for making an electric circuit as the bulb did not light.
They are not conductors of electricity. Materials that do not conduct electricity are called insulators
From your results decide which type of materials are conductors of electricity and would be best to complete the circuit.

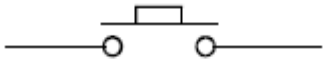
New words. Materials Conductors Insulators

Primary Science Unit 4F Circuits and Conductors
Unit 5 Switches

Learning Objectives. *Children should learn*
That a switch can be used to make or break a circuit to turn things on or off..

Looking at a switch from the outside it is difficult to see how it works. It would be nice to have x-ray eyes, then we could see inside it!

Have a look at the green press switch (number 14) from your kit of parts, the circuit symbol gives you a clue as to how it works.

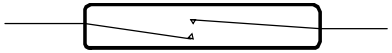


When the button is not pressed, the two wires are not connected and electricity will not flow.

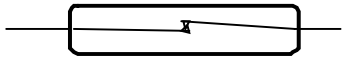
When the button is pressed, the two wires are connected and electricity can flow.

All switches work in the same way connecting two wires together, some may be press switches whilst others may slide to make the contact like the green switch number 15.
Try making you own switch using a paper clip, drawing pin or foil. See if you can use it to switch a bulb on and off.
Draw your circuit and say how the switch works.

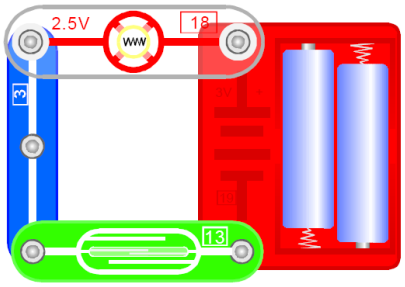
The Dry Reed switch
This is a new type of switch, its called a dry reed switch or relay and in your kit it is number 13. Inside the glass envelope there are two metal arms called reeds that do not touch each other so the switch is off and electricity does not flow.
To make it switch on, bring a magnet up to the glass envelope, this makes the two reeds touch and so it switches on. To make it switch off, take the magnet away again.



Reeds open, electricity does not flow. The switch is off.



A magnet makes the reeds touch so electricity can flow. The switch is on.



Make this circuit and see if you can make the bulb light.

The magnet is under the yellow fan.

Can you think of a use for this type of switch?
Why do we need switches at all?

SAFETYNOTE
You must never use switches like any of these with mains electricity.

Primary Science Unit 4F Circuits and Conductors

Unit 6 Adding batteries

Learning Objectives. *Children should learn*
To make predictions about the effect of adding additional batteries in a circuit.
That care needs to be taken when components in a circuit are changed to ensure that bulbs/motors do not burn out.

The battery was invented in 1886 by a French scientist called George Leclanche and has mainly remained unchanged ever since.
We use the word battery to cover all types but this is not really correct. The AAA, AA and D batteries should be called cells. A cell has a voltage of 1.5 Volts. However most people still call them batteries.
A battery is a number of cells connected together in series. A 3 Volt battery has two cells and a 4.5 Volt battery has three cells connected in series.
The word Volt has a capital V because it is a persons name, it is named after an Italian scientist whose name was Volta.

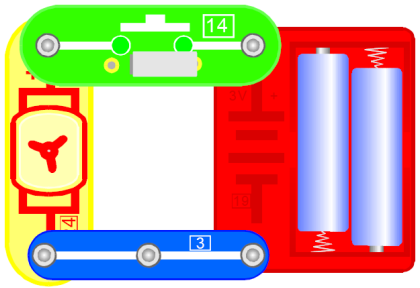
This is a cell  it has a voltage of 1.5 Volts.

This is a 3 Volt battery. It is made up of two 1.5 Volt cells and is the same as the batteries in your kit. The only difference is that the battery in your kit is folded up to save space.

Most components like electric motors and bulbs are designed to be used with batteries of a particular voltage. If you use a higher voltage, the motor will run faster or the bulb burn brighter but may well burn out!
The bulbs supplied in the kit is marked as being 2.5 Volts and should be used with the 3 Volt battery, if you use a higher voltage than this the bulb will be very bright but will soon burn out.
The electric motor should normally be run on 3 Volts but it will run on 6 Volts for very short periods. To test the motor, make up the circuit below.

This is the symbol for the electric motor.
Notice the + sign.

When you have made up the circuit, press the switch and listen to the sound of the motor.
The sound it makes is a good way of judging its speed.
If another battery is now added, will the motor run faster?
See unit 7 for the answer.

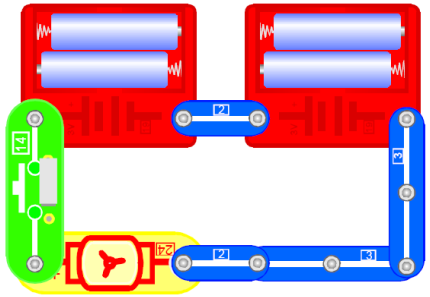


Primary Science Unit 4F Circuits and Conductors

Unit 7 Changing Circuits

Learning Objectives. *Children should learn*
How to change the brightness of bulbs and the speed of a motor in a circuit.

Make up this circuit. What is the total voltage of the battery?



Press the switch and listen to the sound of the motor. Do you think it is going faster than it would on 3 Volts? If you are unable to decide, make up a circuit with 3 Volts and listen once more.
Does the motor run faster on 6 Volts than on 3 Volts?

Do not run the motor for too long on 6 Volts as it is designed to run on 3 Volts and will burn out quickly on 6 Volts.

Replace one of the blue 3 connectors with a bulb. What difference does this make to the speed of the motor?. If you now replace the motor with a bulb, what will be the brightness of the two bulbs?

Which way does the motor turn? Design a circuit to find out. It will be easier if you use just one battery unit.
Look for the + sign on the motor and clip this terminal to the + sign on the battery. Make the rest of the circuit, press the switch and see which way the motor turns. Does it turn clockwise or anti-clockwise?
Now turn the motor round and try again.
Complete this sentence. If the + on the motor is connected to the + on the battery, the motor will turn.....

This would be a good time to use the yellow fan! Use the circuit on a level surface.
Make up the 6 Volt motor circuit again and carefully place the yellow fan on the motor spigot. Just place it on, do not push it down.
Keep your face well out of the way and switch on. The yellow fan may fly off with considerable force so be careful.
If the fan does not fly, try turning the motor round as it may be blowing air upwards like a fan.

How could you make the motor run more slowly?

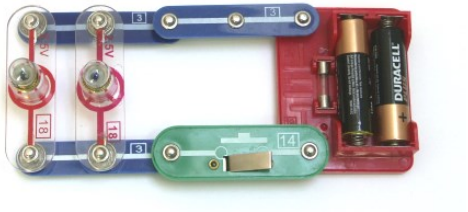
Primary Science Unit 4F Circuits and Conductors

Unit 8 Review of electric circuits

In this section you have the chance to show what you have learnt.
Before you start work, read through the instructions below. Think about what you are going to do, like will you have your bulbs in series or parallel .

Draw each circuit your exercise book and write down what you expect to happen!

Exercise 1.



Construct this circuit. Check that you use the correct switch.

Are the bulbs in series or parallel?
What is the brightness of each bulb?
What is the voltage of the battery?

Without moving either of the bulbs, can you make them less bright than normal?
It is important to only make one change in the circuit at a time.

Exercise 2.
Construct a simple circuit using one bulb and one battery unit with a press switch. When you press the switch, the bulb lights with normal brightness.
Now add a second bulb so that both bulbs are dimmer than normal and if one bulb is unscrewed, the other bulb will also go off.
Without changing the layout of the bulbs, how can you make both bulbs light with normal brightness?
Draw the circuit and explain why the bulbs are at normal brightness.

Exercise 3.
Construct a circuit using 6 Volts to power an electric motor.
All you have to do now is to make the motor turn more slowly still using the 6 Volt battery. No, you are not allowed to use your finger to slow the motor down!
Think about how you made bulbs light less brightly. Draw the circuit in your exercise book and say how it works.

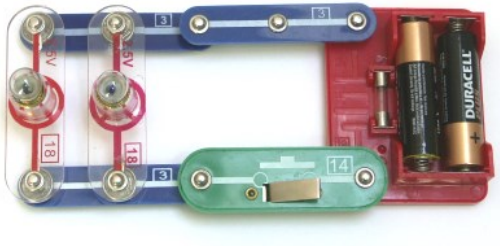
Learning outcomes of unit 4F

1. Metals (iron, copper, aluminium etc.) are good conductors of electricity.
2. Non metals (paper, wood, plastic etc.) do not conduct electricity.
3. A switch allows us to turn a bulb or motor on or off.
4. The dry reed switch uses a magnet to turn it on or off.
5. A cell has a voltage of 1.5 Volts.
6. A battery is a number of cells connected in series.
7. If batteries are connected in series, the voltage is the sum of the two batteries.
8. An electric motor will run faster on 6 Volts than it will on 3 Volts.
9. If the + terminal on the motor is connected to the + terminal on the battery, the motor will turn clockwise.
10. If the - terminal on the motor is connected to the - terminal on the battery, the motor will turn anti-clockwise.

Primary Science Unit 6G Changing Circuits

Unit 1 Changing circuits

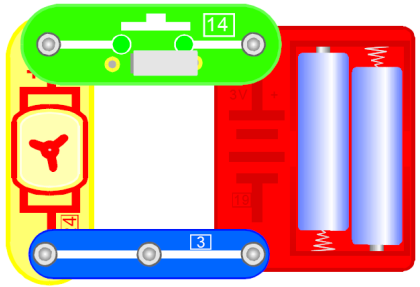
Learning Objectives. Children should learn
That a complete circuit is required for a device to work.
That switches can be used to control devices.
That metals are usually good conductors of electricity and that plastics are poor conductors.
That the brightness of bulbs or the speed of motors in a circuit can be changed.



This circuit uses two bulbs in parallel and powered by a 3Volt battery, the bulbs will be at normal brightness.
Without moving either of the bulbs, can you make them less bright than normal? An answer is to replace the top blue 3 connector with the motor.
It is important to only make one change in the circuit at a time.
In the original circuit, how would you make the bulbs brighter that normal? The answer is to add another battery unit making 6Volts. Just press the switch and let go quickly or the bulbs may burn out!

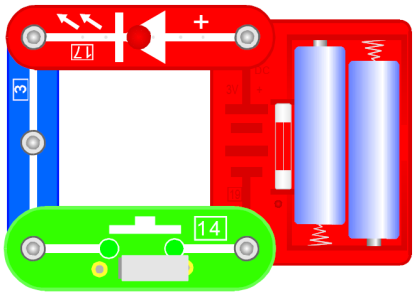
You must remember at all times not to overload any of the components for more than a few seconds.

In the last circuit, a motor was used to make two bulbs light less brightly. In this circuit, there is a motor running from a 3 Volt battery and you have to find a way to make the motor run more slowly.



Draw the new circuit showing how you would do this and say how the changes make the motor run more slowly.

Now, make two circuits one with two dim bulbs and another where a buzzer can be switched on and off.

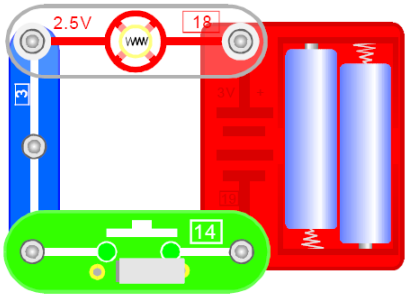


Here is a new component for you to experiment with. It is called a light emitting diode or LED for short. It is part number 17 in your kit.
Make up the circuit and press the switch to light the LED. Now remove the LED, turn it round and replace it. Press the switch, the LED does not light up this time. The LED will only work when the electricity flows through it in the correct direction. This is when the + sign on the LED is connected to the + terminal on the battery. If you look on the underside of the LED you will see a component called a resistor, this slows down the flow of electricity and prevents the LED from burning out much in the same way as the bulbs were made to shine less brightly and the motor made to run more slowly.

Primary Science Unit 6G Changing Circuits

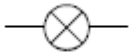
Unit 2 Drawing circuits with symbols

Learning Objectives. Children should learn
That there are conventional symbols for components in circuits and these can be used to draw diagrams of circuits.
That circuit diagrams, using these symbols, can be understood by anyone who knows the symbols and can be used for constructing and Interpreting circuits.



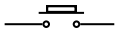
This is a circuit made from parts in your kit. Now draw this circuit using your own design of symbols to represent the parts.
Imagine the problems we would have if everybody used their own symbols to draw circuits!
We have to have some standard circuit symbols that can used by everyone.

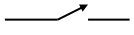
These are the standard circuit symbols for use by everyone.


Bulb

Wire

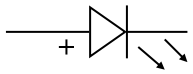

Battery or cell


Press switch


Switch

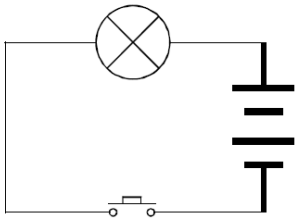

Buzzer

Electric motor

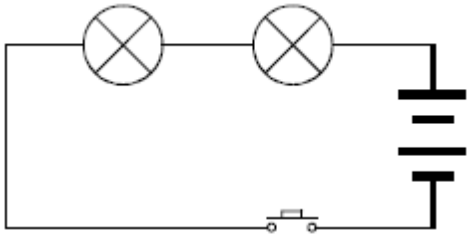


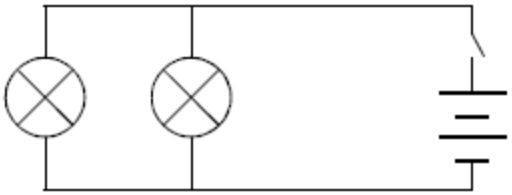
LED


Loud speaker



This is the above circuit drawn with circuit symbols





Construct these two circuits from the circuit diagrams shown opposite.

Primary Science Unit 6G Changing Circuits

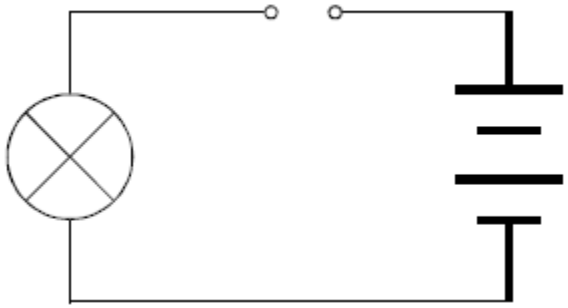
Unit 3 Testing circuits

Learning Objectives. Children should learn
That the brightness of bulbs in a circuit can be changed by changing the wires in a circuit.
To suggest a question to investigate, to decide what to do and what equipment to use to test this.

In this section we are going to test an idea. Someone has suggested that putting very thin wire into a circuit will alter the brightness of bulbs.
So how can we test this idea and what should we test? What questions do we need to ask? The simple ones are -
1.Does the thickness of the wire affect the brightness of the bulb?
2.Does it make a difference what the wire is made of, Copper, Iron or Nickel?
3.Does the length of the wire affect the brightness of the bulb?

The first thing we will need is some thin wire made of copper. The easy way to get this is to strip plastic from a length of flex and unravel the strands. If the wire looks a silver colour, this is because it has been coated with tin.
Because the type of metal may effect the brightness, we will also need some steel wool. Thin, individual strands, can easily be pulled out of the bundle.
Some wire is provided in your kit, it is under the yellow fan. This is a high resistance wire called ni-chrome it is made of a metal called nickel and it makes it very difficult for electricity to flow through it. The longer the length of wire in the circuit, the dimmer the bulb.

So to test our ideas, we must build a circuit.

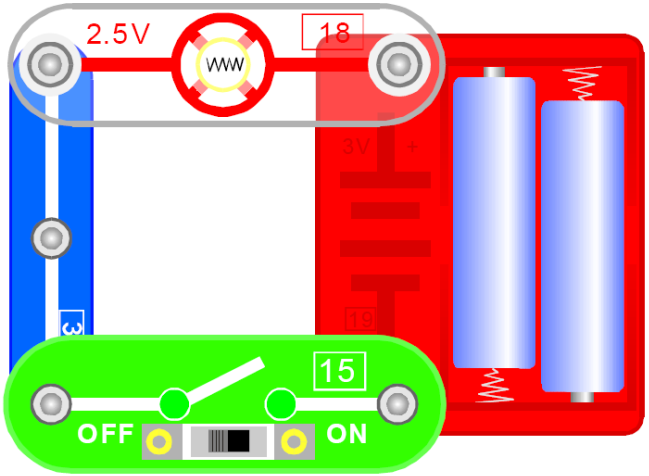


The circuit could look like this. The gap in the circuit is for the thin wire.

To hold the thin wire in place, use the blue 3 connector without a wire on it (it does not have a white line on top of it). Wind one end of the thin wire around one of the studs on the connector and then hold it in place with a single press stud.
The other end can be touched onto the other stud of the connector.
Now we can begin to experiment!
The wires may get hot so be careful when you touch them!

In any scientific experiment we must make the experiment fair. For example, in experiment 2 we must try to find two bits of wire that are the same thickness and the same length.

There are three things to think about, what the wire is made of, the thickness of the wire and the length of the wire.
After you have done all the experiments, you should be able to make generalisations e.g. the thinner the wire, the dimmer the bulb.

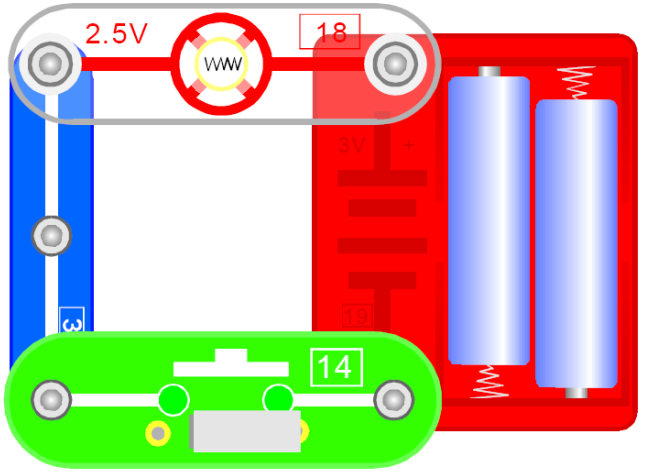


In this section there are 44 different circuits designed to use the knowledge you have gained and to increase your understanding of electric circuits.

1. Lighting a bulb.
Construct the circuit by clipping all the parts to the base board. Be careful not to use too much force when screwing the bulb into the bulb holder as the glass may break. Slide switch 15 to the on position and the bulb 18 will light up. Switch off and the bulb will go out.

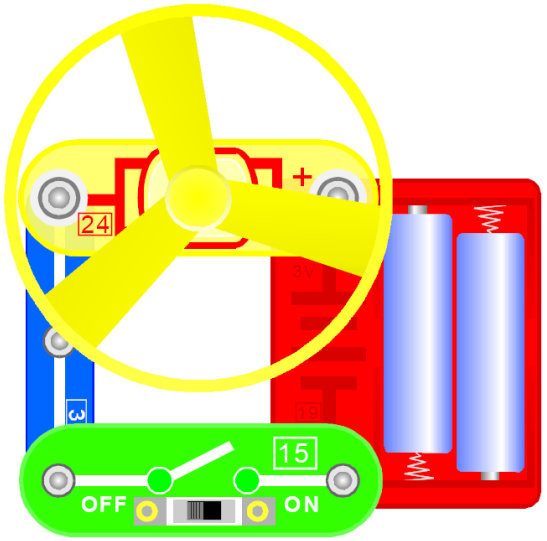
It is easy to follow the flow of electricity around this circuit. The electricity flows out of the positive end of the battery (marked with a + sign), through the bulb, then through the switch and so back into the negative end of the battery. See what happens if you unscrew the bulb and then screw it up again. This happens because the flow of electricity has been temporally stopped.

2. Bulb controlled by a press switch.
A press switch only makes the circuit work whilst it is pressed.
Press the press switch ant the lamp will light. Release the switch and the lamp will go out.



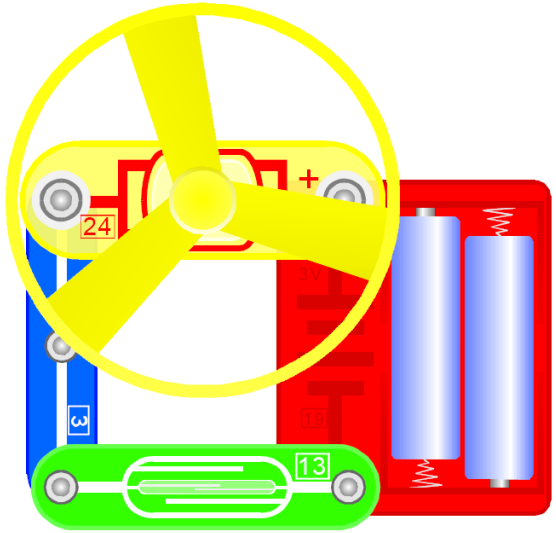
3. Bulb controlled by a magnet.
Replace switch 15 with the dry reed switch 13. Bring the magnet close to the dry reed switch and the bulb 18 will light.
Remove the magnet and the bulb will go out.

How the Dry Reed Switch works.
Inside a glass tube, two thin steel blades are held apart so that they do not touch each other. When a magnet is brought close, the two blades are forced to touch each other so allowing electricity to flow. When the magnet is removed, the blades spring apart so stopping the flow of electricity. See Worksheet 4F Unit 5.

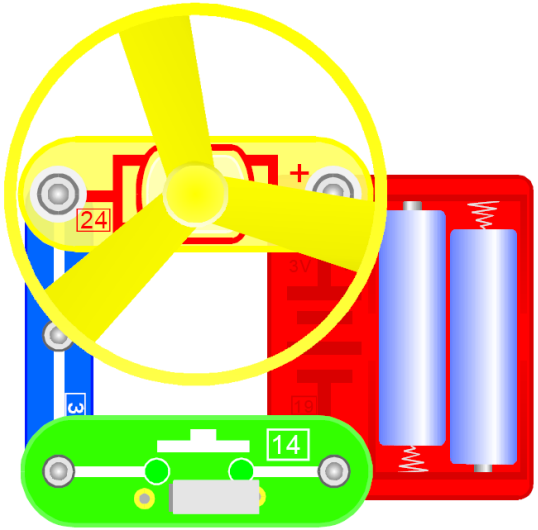


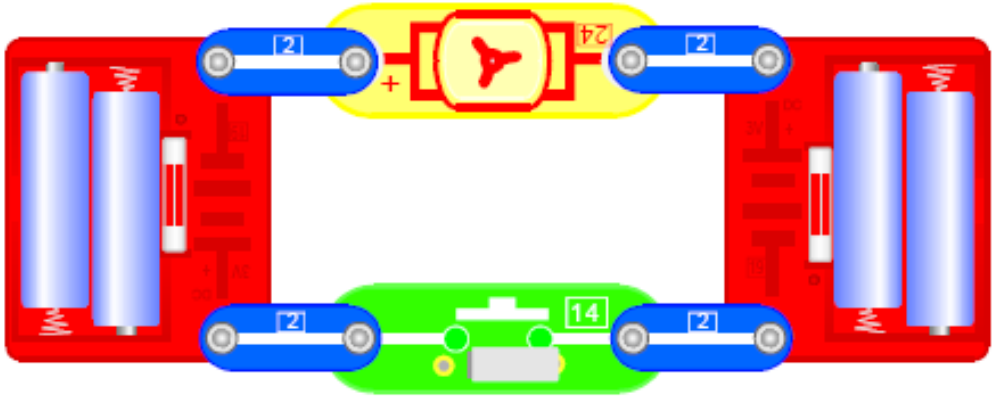
4. Making an electric fan.
Make up the circuit as shown. Be careful to connect the + end of the motor to the top + connector of the battery. The yellow fan should be placed on the motor spigot and not pushed down. Slide switch 15 to the on position and the fan will rotate. Do not lean over the fan as it may fly off!
Switch off and the fan will stop rotating.

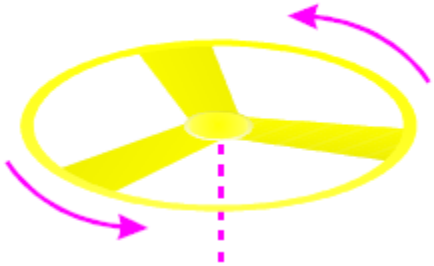
5. Magnet controlled fan.
Replace the slide switch 15 with the dry reed switch 13. Bring the magnet close to the dry reed switch and the fan will rotate. Remove the magnet and the fan will stop rotating.



6. Fan controlled by a press switch.
A press switch only makes the circuit work when it is pressed.
Press the press switch ant the fan will rotate.
Release the switch and the fan will stop rotating.

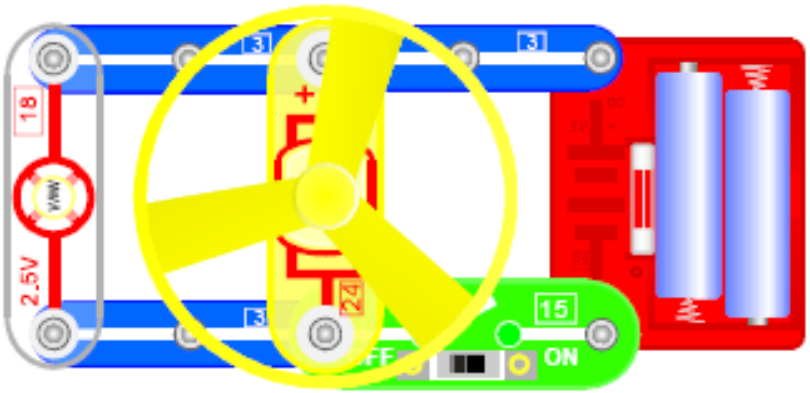






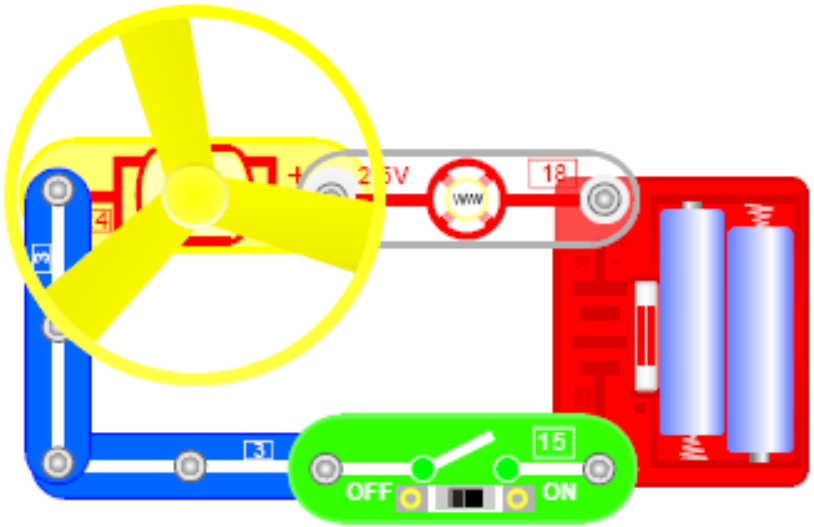
7. Flying Fan
When you make up the circuit, be careful to put the motor in the correct way round with the + sign on the left. The yellow fan should be placed on the motor spigot and not pushed down. **Do not lean over the fan as it will fly off with some force!** Switch on, the fan will rotate and fly up into the air. If the fan does not fly after a few seconds, let go of the switch.
If the spigot gets pushed down on the motor shaft, gently prize it up again using a screwdriver or a key.

8. What happens if the motor is reversed?
Turn the motor round so that the + sign is on the right. Put the fan on the motor and switch on. This time the fan will not fly but will give a powerful current of air in an upwards direction.



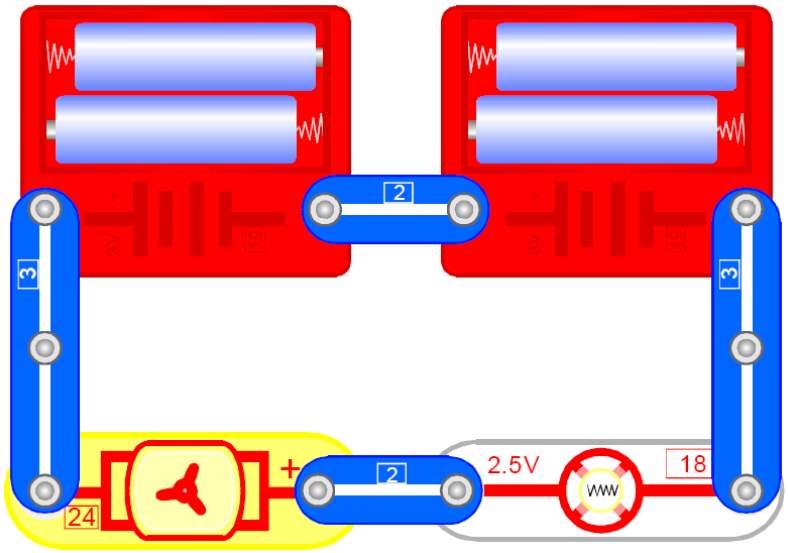
9. A bulb and a motor connected in parallel.
Slide the switch 15 to the on position, the bulb 18 will light brightly and the motor will turn much faster. Switch off, the bulb will go out and the motor stop rotating.

In a parallel circuit, the electricity flows directly to the motor and to the bulb. The battery voltage is 3 volts so they both get the full 3 volts. If you unscrew the bulb, the motor will continue to rotate.



10. A bulb and a motor connected in series.
Slide the switch 15 to the on position, the bulb will light dimly and flicker and the motor will turn slowly. Switch off, the bulb will go out and the motor stop rotating.
In a series circuit, the electricity has to flow through the bulb and then through the motor so they both share the voltage.

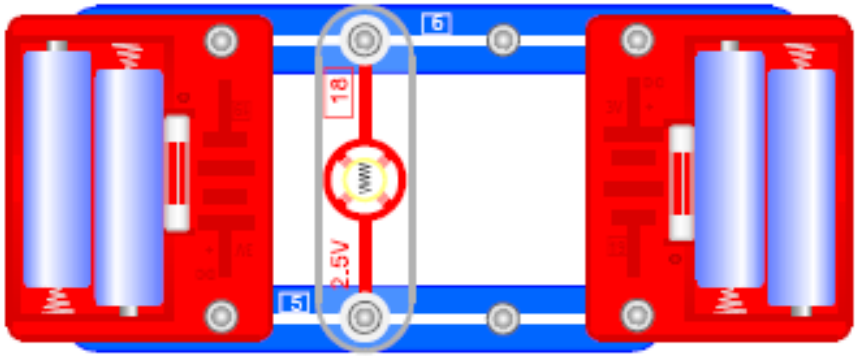
If you remove the bulb, the motor will stop as the electricity can no longer flow. Volts are a measure of electrical pressure rather like the water coming out of a hose pipe. If you put your finger over the end of the pipe the jet of water will travel further but not so much water will flow.

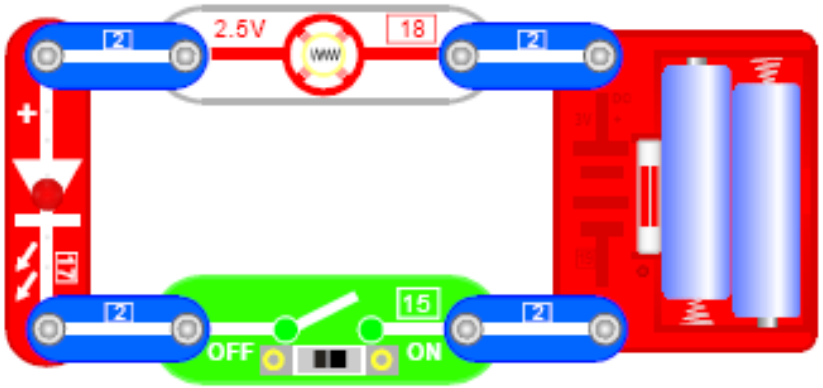


11. Batteries connected in series.
The circuit on the left shows the batteries connected in series. It is a folded out version of circuit 7. When batteries are arranged in this way, the total voltage is the combined voltage of both batteries added together. In this case as both batteries are 3volts, the output to the bulb and the LED is 6volts.

12. Batteries connected in parallel.
The circuit on the right shows how batteries can be connected in parallel.

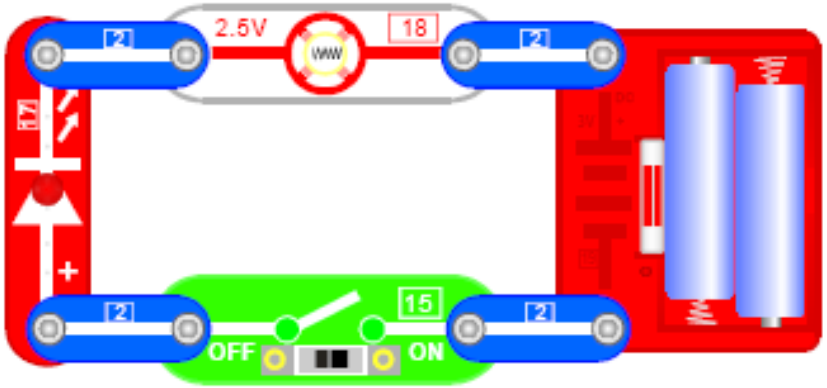
The + terminal of one battery is connected to the + terminal of the other battery and the two – terminals are also connected together. The voltage remains the same at 3 Volts but the capacity of the batteries is doubled so they will last twice as long. This arrangement is not used much these days and it is a throwback to the days when batteries were less powerful.





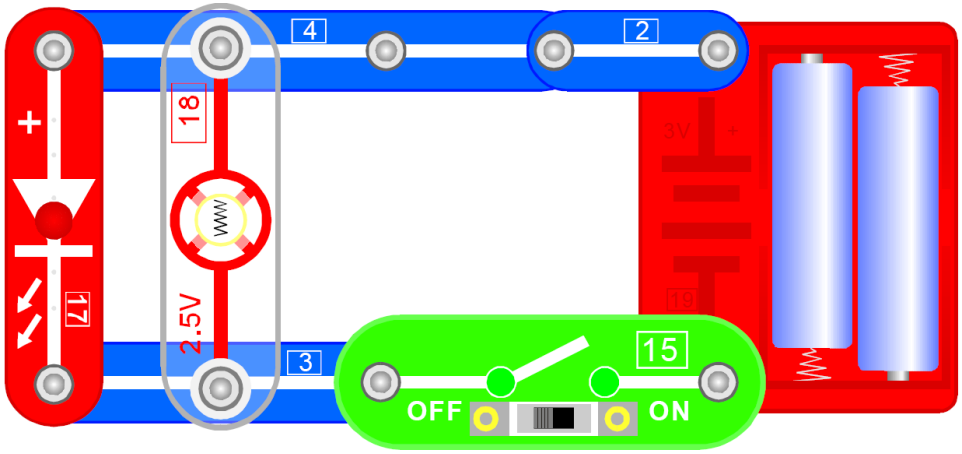
13. A light emitting diode. (LED).
LED's require a resistor wired in series to prevent too much electricity going through the LED and burning it out. You can see this resistor if you look on the underside of the LED.
In this circuit, the LED 17 and the bulb are connected in series. When you switch on, the LED will light but the bulb does not light. This is because the current required to light the LED is much less than is required to light the bulb. Electricity will still flow through the bulb but not enough to make it light.

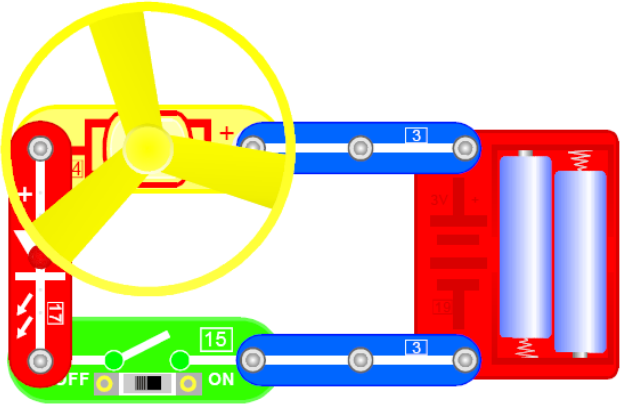
If you unscrew the bulb, the LED will go out.
Current is measured in Amps and it is a measure of the amount of electricity flowing. In the hose pipe idea, it is the amount of water flowing through the pipe. If you are filling a watering can, it will fill much more quickly if you do not put you finger over the end to increase the pressure.



14. LED controlled by a magnet.
Replace the switch 15 with the dry reed switch 13. Bring the magnet close to the dry reed switch and the LED will light. Remove the magnet and the LED will go out.

15. One way conductivity of an LED.
This circuit is the same as number 13 but notice that the LED has been reversed.
When this circuit is switched on, neither the bulb or the LED will light, this is because electricity will only flow through an LED from positive to negative. It is said to be a polarized device.

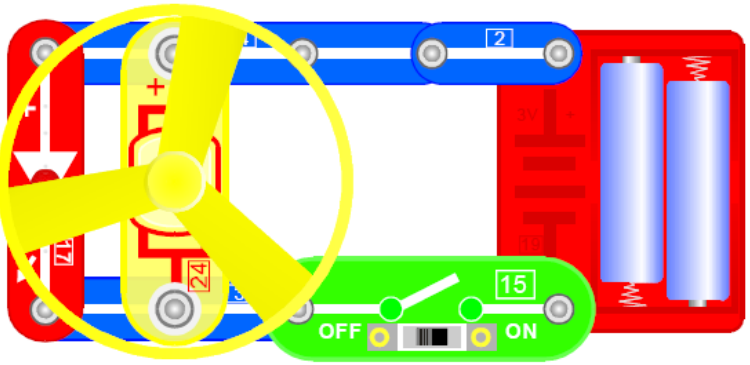




17. An LED and an electric motor connected in series.
Switch on and the LED will light but the motor will not rotate. This is because the motor requires a large current to make it rotate and this is prevented by the LED.

16. An LED and a lamp connected in parallel.
Close the switch, the LED and lamp will light up at the same time.

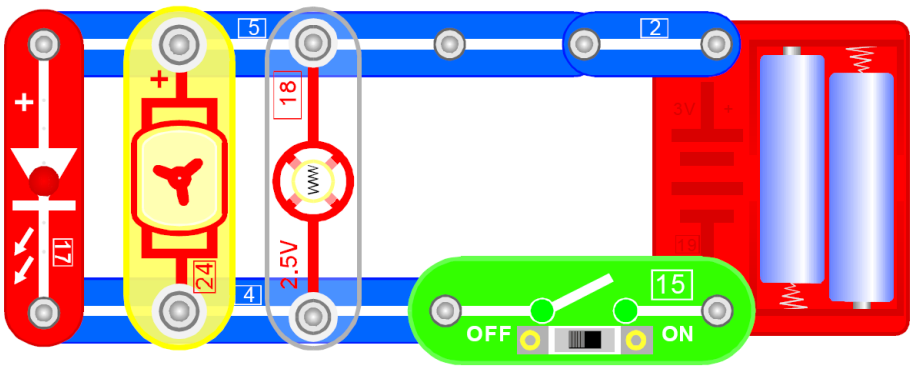
As a general rule, if you wish to have all the components working at the same time, then wire them in parallel and not in series.



18. An LED and an electric motor connected in parallel.
Switch on and the LED will light and the motor will rotate. This is because the motor and the LED are connected in parallel.

If the LED was faulty, would the motor still rotate?

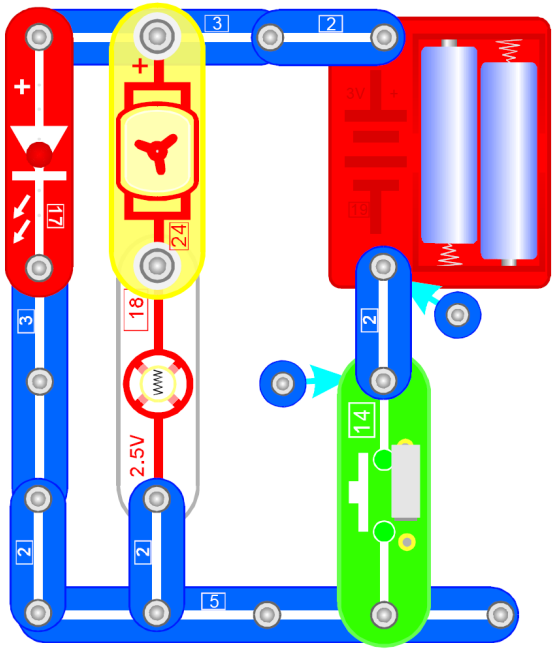
If you are unsure of the answer, just remove the LED and see.



19. An LED, lamp and electric motor connected in parallel.
Close the switch and the LED and the lamp will light up and at the same time, the motor will rotate.

LED's are often used as visual indicators to show that a circuit is switched on.

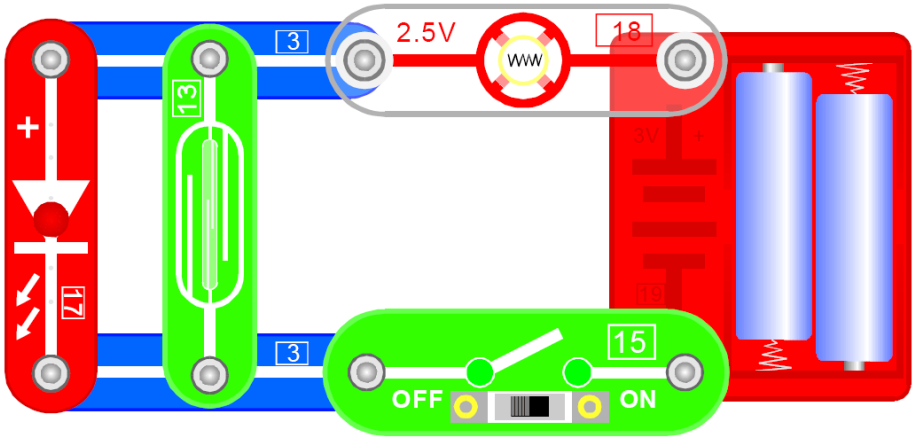
20. Series-parallel connection of LED, lamp and electric motor.
Press the switch and the LED and lamp will light up, the motor will also begin to rotate. Remove the LED and notice that the Motor and Lamp still work.



21. Parallel connection of an LED and a switched lamp.
Replace the press switch with the slide switch and replace the motor with the press switch. Switch the slide switch to the on position and the LED will light up. Press the press switch and the lamp will light as well.

22. Magnetically operated warning light.
Replace the motor with the dry reed switch and replace the press switch with the slide switch. Switch on at the slide switch and the LED will light showing that the circuit is live. Now bring a magnet close to the dry reed switch and the lamp will light.

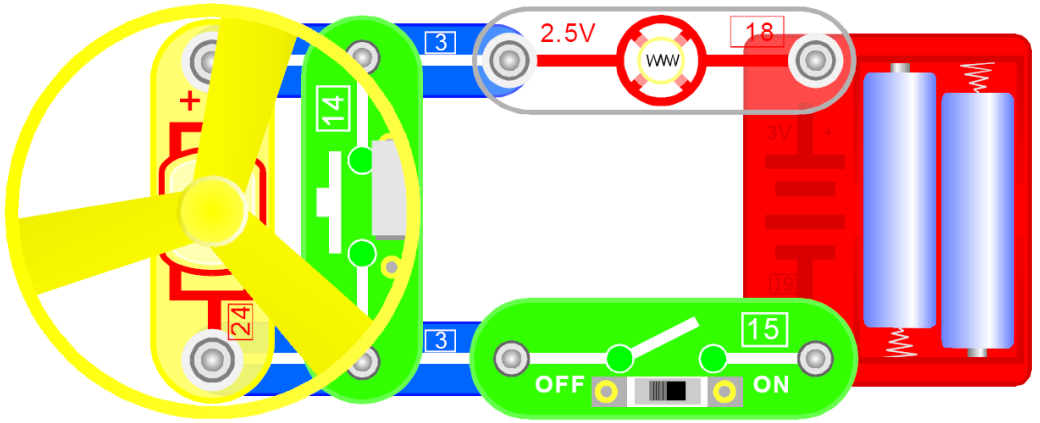
This circuit could be used to show if a door was open or shut. Fix the dry reed switch on the frame of a door and connected it to the circuit with long wires. Fix the magnet to the door so that when the door is shut, the magnet nearly touches the dry reed switch. In this position, the lamp will light showing that the door is closed. If the door is opened, the lamp will go out and alert security to the fact .

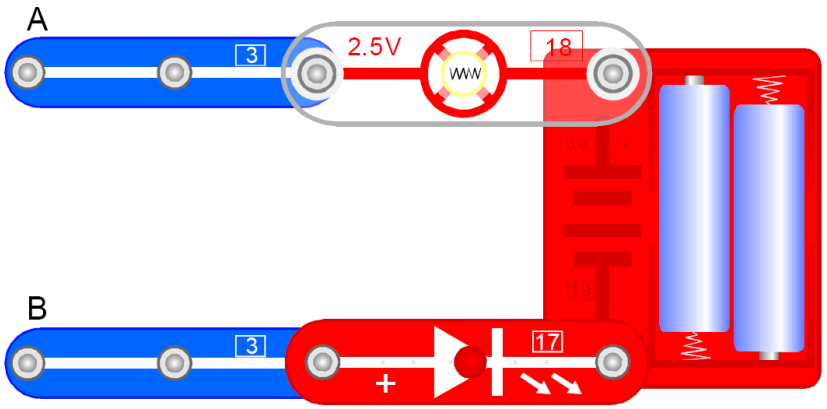


23. Switch lamp and LED.
Close the switch, only the LED will light up, put a magnet near to dry reed switch, the LED will go out and the lamp will light up.

24. Switched lamp and motor.
Close the switch, the lamp will light up and the motor will slowly rotate. Press the press switch, the motor will stop and the lamp will get brighter.

Note, if the motor fails to restart when the switch is released, switch off at the slide switch.





25. Conductor tester.
Put a piece of tin foil across terminals A and B, if the LED lights up then the material conducts electricity.

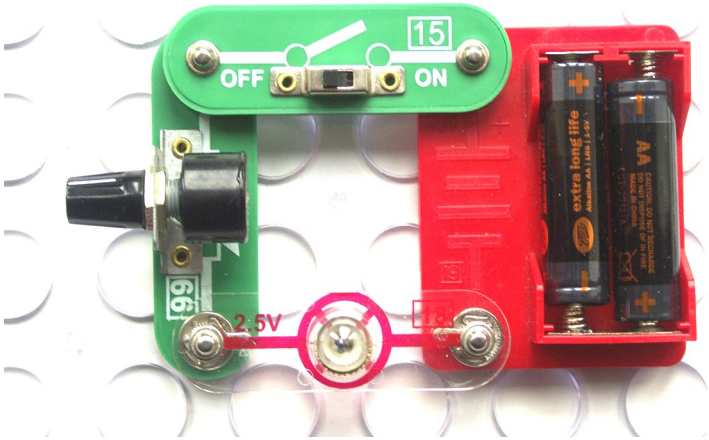
Try other things like wood, plastic, paper, wire and things made of metal. You could make a list of materials that conduct electricity and another list of things that do not conduct electricity.

Things that conduct electricity are called ‘Conductors’ and things that do not are called ‘Insulators’.

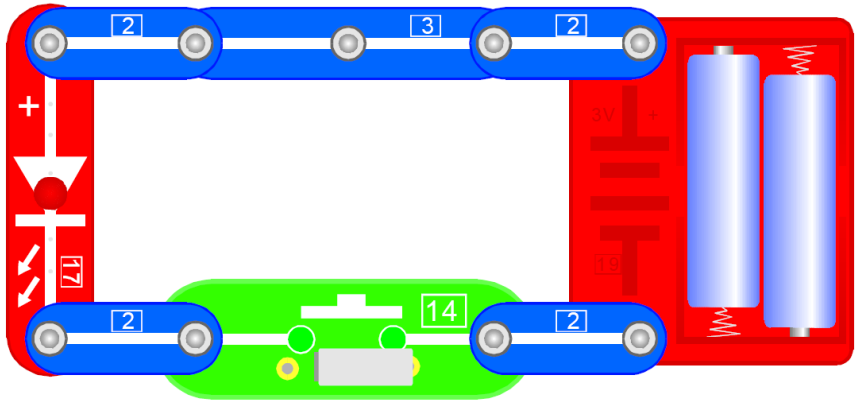
26. Using the variable resistor.
In experiment 13, a resistor was used to prevent too much electricity flowing through an LED. This was a fixed resistor and the resistance could not be changed.

The resistance of the variable resistor can be changed by turning the shaft. Inside the resistor case is a long length of wire coiled up to make it fit inside the case. One end of the wire is connected to one of the press studs. The shaft is connected to a slider which touches the coil of wire. When the shaft is turned, the slider adds more wire to the circuit and so increases the resistance. The slider is connected to the other press stud.

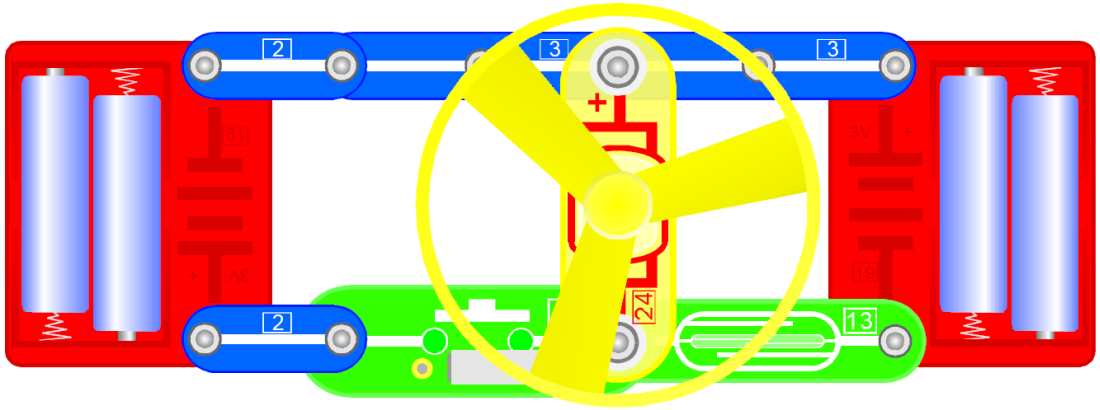
Switch on an change the brightness of the bulb by rotating the shaft of the variable resistor,



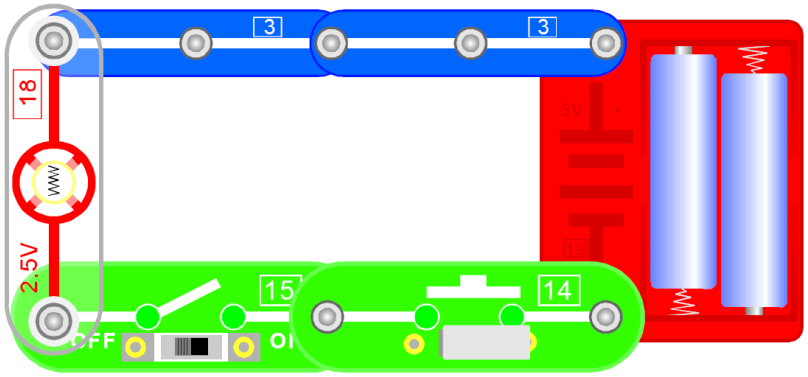
27. Controlling the speed of a motor.
Replace the bulb with the motor and rotate the variable resistor to control the speed of the motor. If you put the yellow fan on the motor, remember to keep your head out of the way as the fan may fly off!



28. Simple and easy signalling practice.
Press the switch in a series of short bursts; the LED will flash, so it can be used for sending messages in Morse code or perhaps make up your own code!



29. Changing the direction of rotation of an electric motor.
Press the switch, the fan will be rotated anticlockwise. Release the switch, put a magnet near to the dry reed switch, the fan will rotate in clockwise direction.
(Safety Note: Do not have both switches on at the same time, or you will blow both the fuses or damage the batteries.)

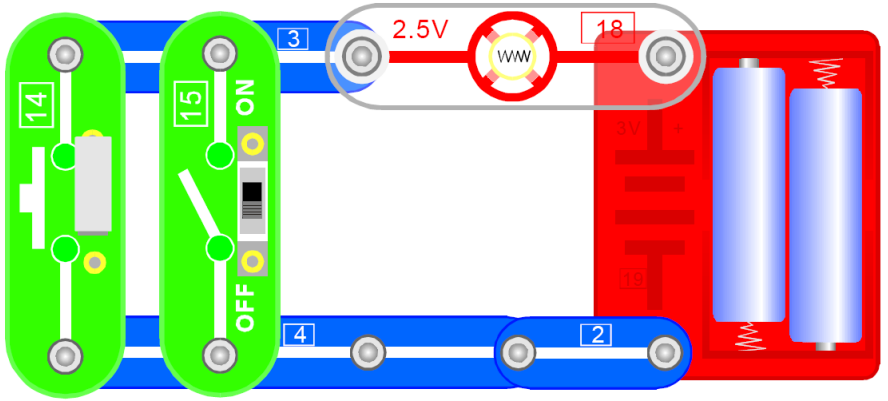


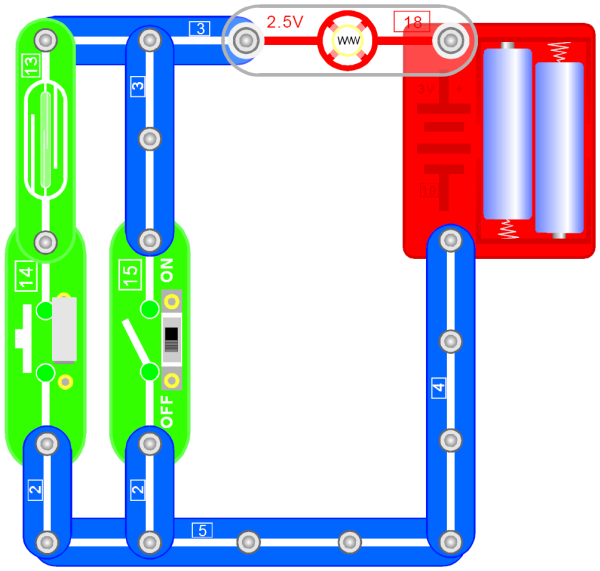
30. The AND gate.
Two switches are connected in series to control a lamp. To make the lamp light, both switches must be used at the same time.

It is called an AND gate because both switch 1 AND switch 2 must be on.
This circuit could be used to fire a missile. Two people have to make the decision to fire the missile, one person alone can not do it. The switches would be operated by keys and each person would only have their own key.

31. The OR gate.
Two switches in parallel are used to control a lamp. The lamp can be switched on by either of the switches.
It is called an OR gate because the lamp can be switched on by switch 1 OR switch 2.

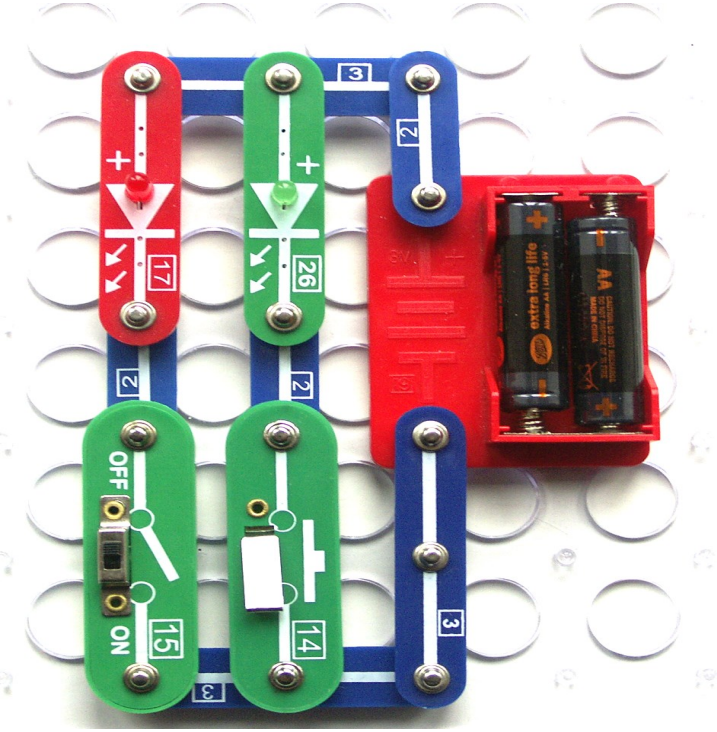
This arrangement could be used to switch a bulb on from two different places.





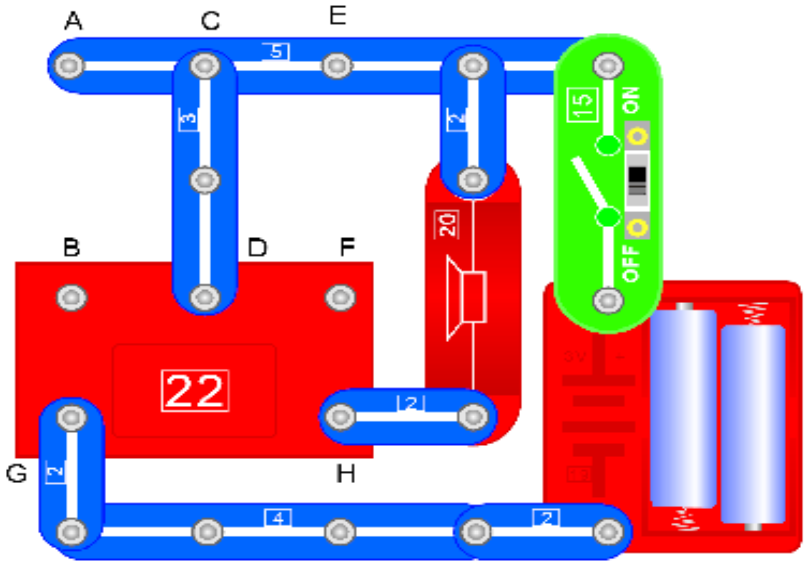
32. This circuit uses two switches in series with one switch in parallel to control a lamp or other device.
The lamp can be switched on by closing switch 15, or by closing both the other switches and at the same time.

The circuit might be used in a missile site. The commander could fire the missile by closing switch 15. If he was away, the missile could be fired if two other officers closed their switches at the same time.



33. Stop-Go traffic light.
Slide switch 15 to the on position, the Red LED will light. Switch off and press switch 14, the Red LED will go out and the Green LED will light.

This could be used to control traffic at road works or entering a car park.



Using the sound module 22.
Sound is caused when anything vibrates. Try holding a ruler over the edge of a table. Flip the free end and the ruler will vibrate. Vary the amount of the ruler over the table and the pitch of the sound will change. The vibrations reach our ears by moving the air and when the air hits our eardrums it causes them to vibrate and produce sounds.
Electricity can also produce vibrations and produce sounds. In module 22 there is a integrated circuit which causes the electricity to vibrate and these vibrations are passed to the speaker which moves the air and so lets us hear the sounds.

34. Sound of police car.
Close the switch, the speaker will make the sound of a police car.

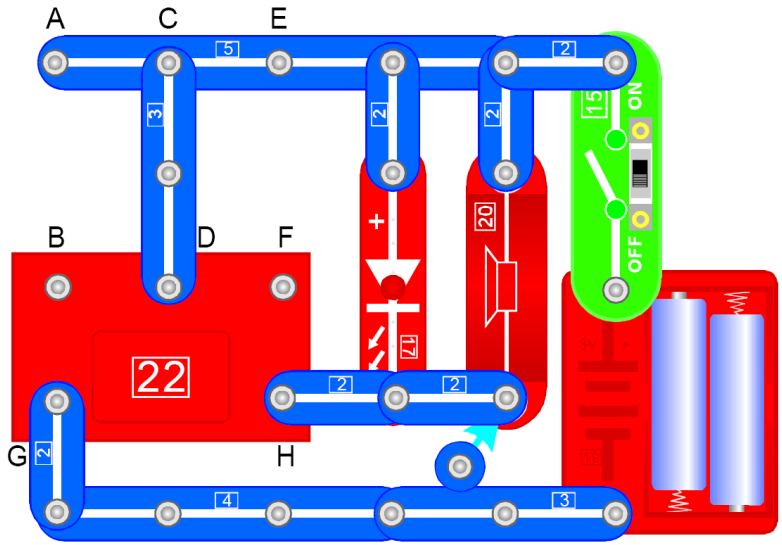
35. Sound of machine gun 1.
Connect terminals CD and EF, close the switch, the speaker will make the sound of a machine gun.

36. Sound of machine gun 2.
Replace the speaker with the motor and the yellow fan. Close the switch, the motor will make the sound of a machine gun and the fan will rotate.

37.Sound of a fire engine
Connect terminals AB and CD, close the switch, the speaker will make the sound of a fire engine.

38.Sound of an ambulance
Connect terminals CD and BG, close the switch, the speaker will make the sound of an ambulance.

39. Sound of gaming machine.
Connect terminals AB, close the switch, the speaker will make the sound of a gaming machine.



More about sound.
All musical instruments produce their sound by vibration. A violin has strings which vibrate, as does a piano. A flute vibrates a column of air. A drum has a skin which vibrates when struck with a drumstick. The greater the vibration, the louder the sound. The pitch of sound is measured in vibrations per second. The sound of middle C is 256 vibrations per second so anything that vibrates at that speed will play middle C.
We humans have a limited range of sounds that we can hear, our range is about 20vps to 22,000vps. As we get older the range gets less and less. A dog whistle vibrates at 26,000vps, we are unable to hear it but a dog can. Bats use sound out of our hearing range as a navigation aid..

40. Sound of police car with red light.
Close the switch, the speaker will make the sound of a police car. The LED will give out a red light at the same time.

41. Sound of a machine gun with red warning light.
Connect terminals CD and EF. Close the switch, the speaker will make the sound of a machine gun. The LED will give out a red light at the same time.

42. Sound of fire engine with red light.
Connect terminals AB and CD. Close the switch, the speaker will make the sound of a fire engine. The LED will give out red light at the same time.

43. Sound of ambulance with red warning light.
Connect terminals CD and BG, close the switch, the speaker will make the sound of an ambulance, the LED will give out red light at the same time.

44. Sound of a gaming machine with red light.
Connect terminals AB. Close the switch, the speaker will make the sound of a gaming machine. The LED will give out red light at the same time.