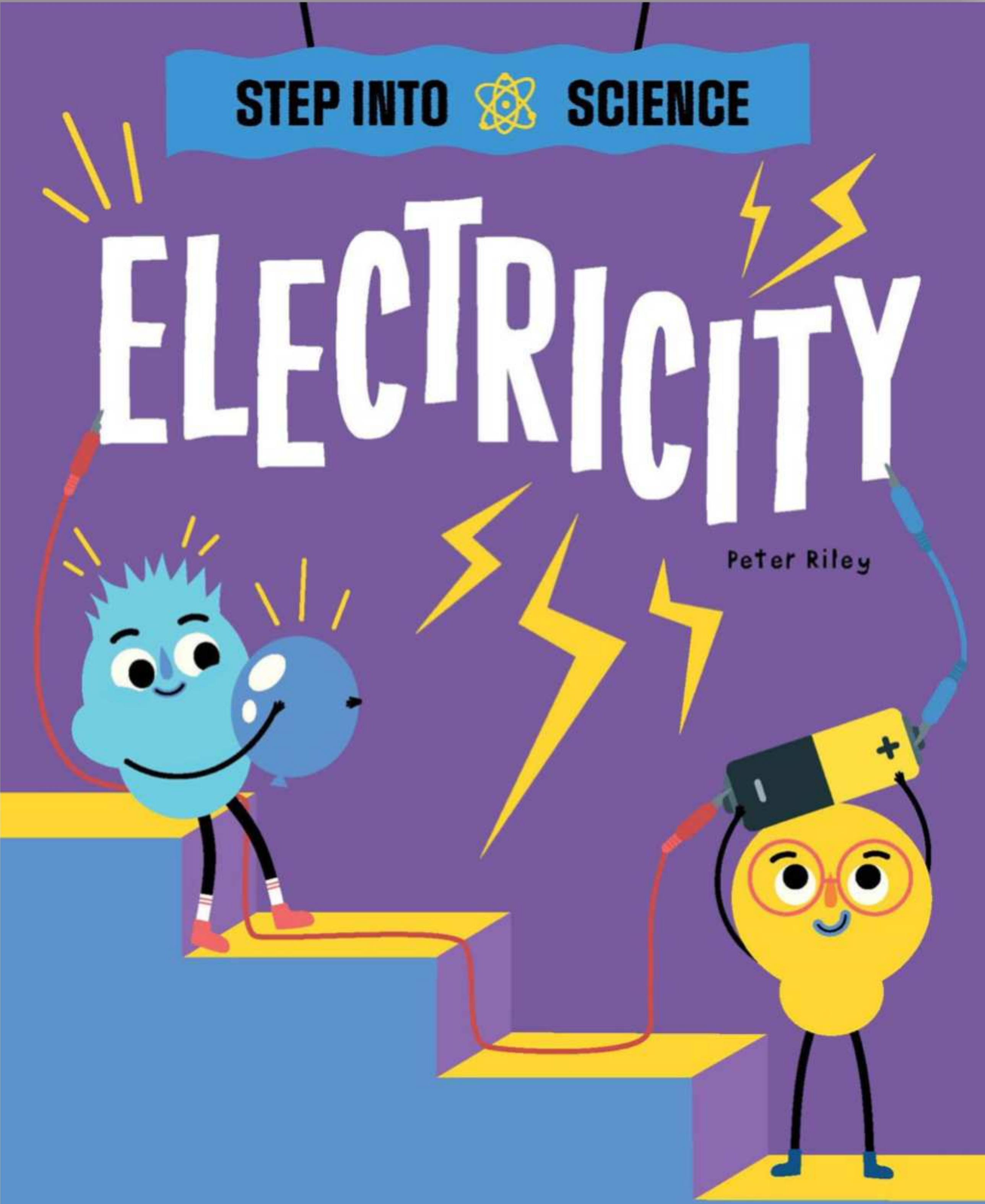
STEP INTO SCIENCE

ELECTRICITY

Peter Riley



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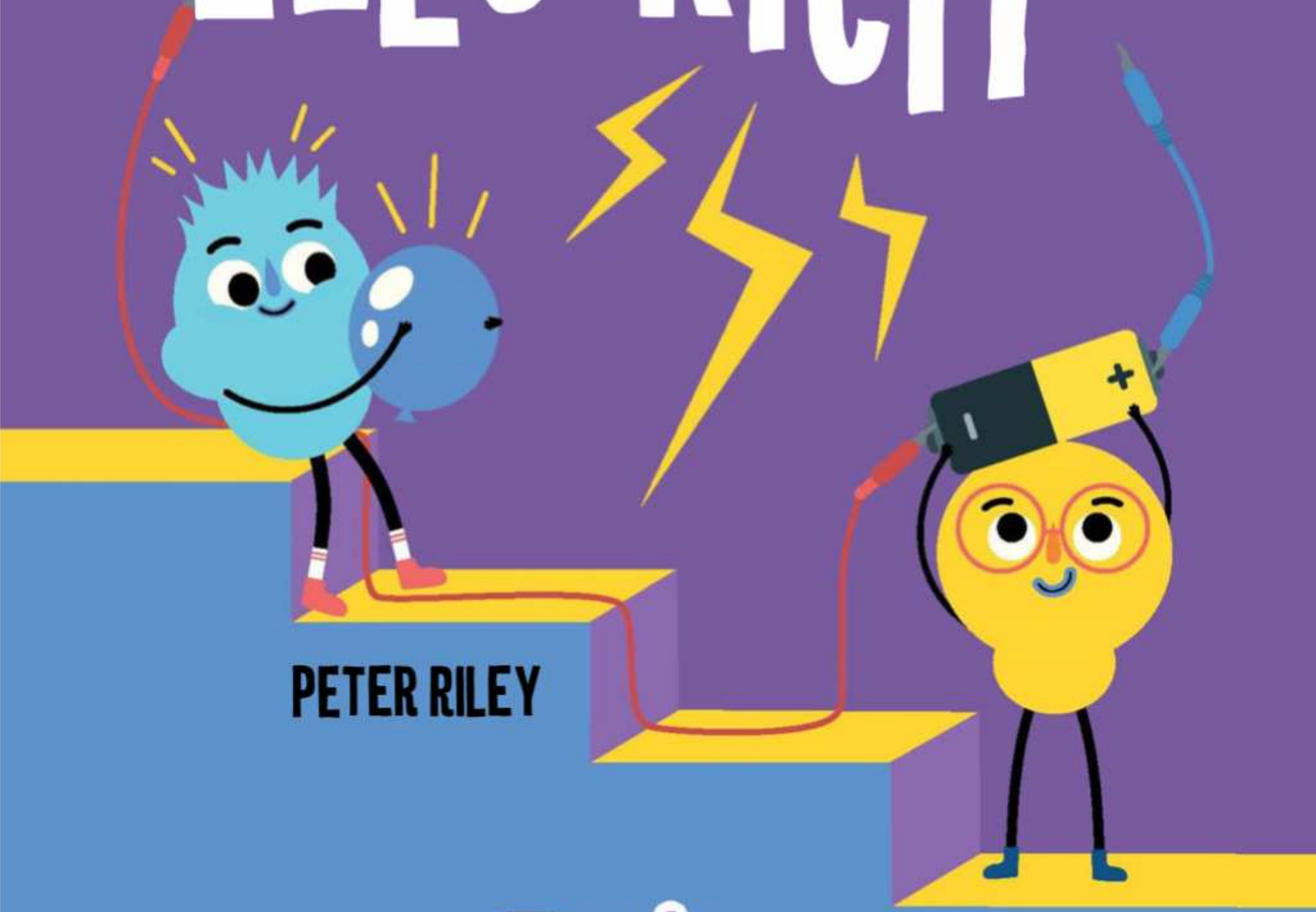

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To my granddaughter, Holly Jane.

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Find us on

We recommend adult supervision at all times while doing the activities in this book. Always be aware that craft materials may contain allergens, so check the packaging for allergens if there is a risk of an allergic reaction. Anyone with a known allergy must avoid these.

- Wear an apron and cover surfaces.
- Tie back long hair.
- Ask an adult for help with cutting.
- Check materials for allergens.

CONTENTS

HOW WE USE ELECTRICITY

Every day, we use electricity. When we turn on a light or travel in a car we are using electricity. Some pieces of electrical equipment are called appliances. They are machines powered by electricity, and they help us in many different ways.

ELECTRICITY AT HOME

Electrical appliances give us heat to cook food and warm our homes. They help move things, such as spinning the blades of a fan. They keep things cool in a refrigerator, provide light in a lamp, and make sound come out of a radio.

Look at the items in this kitchen. How many electrical appliances can you see?

what electrical items can you see in this city?

MAKE A LIST OF THE ELECTRICAL APPLIANCES IN YOUR HOME. WHAT IS EACH ITEM USED FOR? ARRANGE THEM INTO GROUPS ACCORDING TO WHAT THEY DO: DO THEY GIVE HEAT OR LIGHT, FOR EXAMPLE?

USING ELECTRICITY OUTSIDE

Electrical appliances also can be found outside. They power streetlights, traffic lights, and automatic doors on buildings. They are part of vehicles' engines and power their lights.

WHAT IS ELECTRICITY?

Electricity was discovered in ancient Greece by a man called Thales. He rubbed a piece of amber, then put it near some straw and feathers. They jumped up to the amber and stuck to it. The Greek name for amber is "electron" and its strange power became known as electricity.

Amber is a hard yellowish solid that comes from trees that lived millions of years ago.

STATIC ELECTRICITY

The electricity made by rubbing amber is called **static electricity**. It is a pulling force between two surfaces.

Rub a balloon against a dry wool sweater and hold it above some pieces of tissue paper. Static electricity pulls the tissue paper up towards the balloon.

STORM CLOUDS

The most powerful static electricity is **generated** in storm clouds. Inside the cloud, water **droplets** freeze and form ice crystals and hailstones. These rub together and generate static electricity.

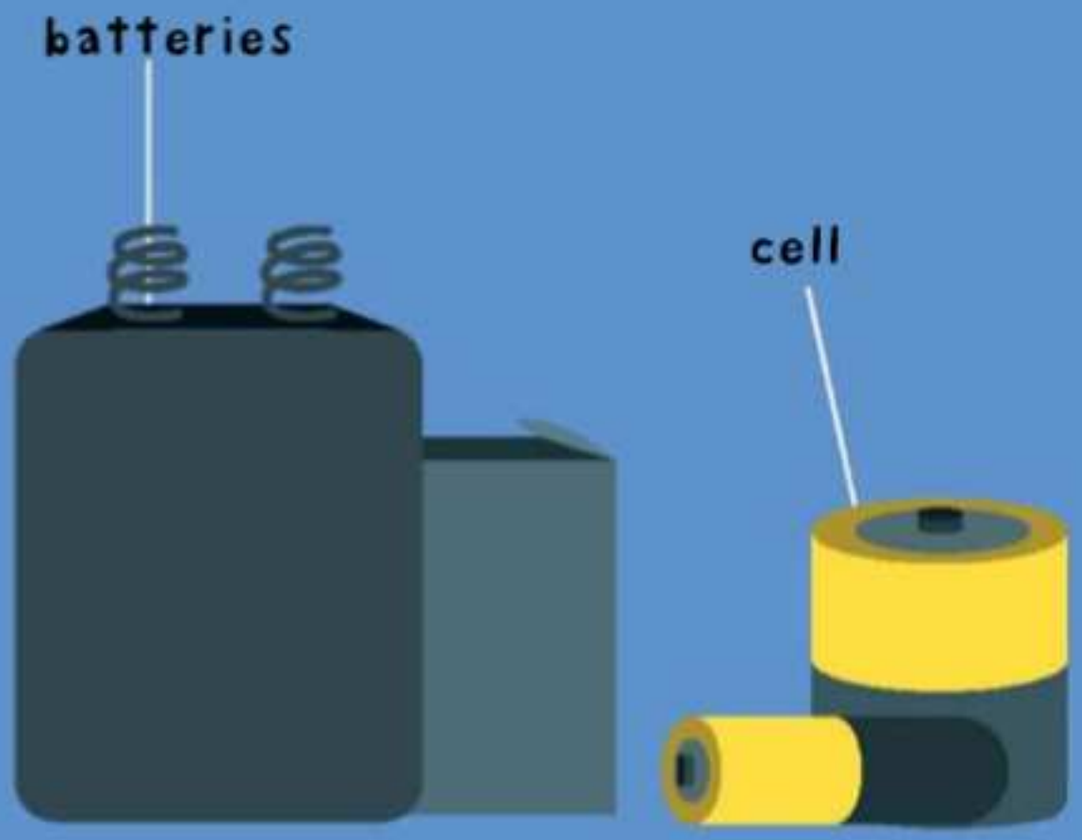
ELECTRIC CURRENT

In a storm, huge amounts of static electricity are released as a **current** of electricity, which flashes through the air as lightning.

Lightning can flash from cloud to cloud or, as seen here, from a cloud to the ground.

CELLS AND BATTERIES

A cell is a store of electricity. A battery is a group of cells joined together. Both are used to make a current of electricity. Batteries can be used to power all sorts of things, such as flashlights, laptop computers, mobile phones, and some toys.

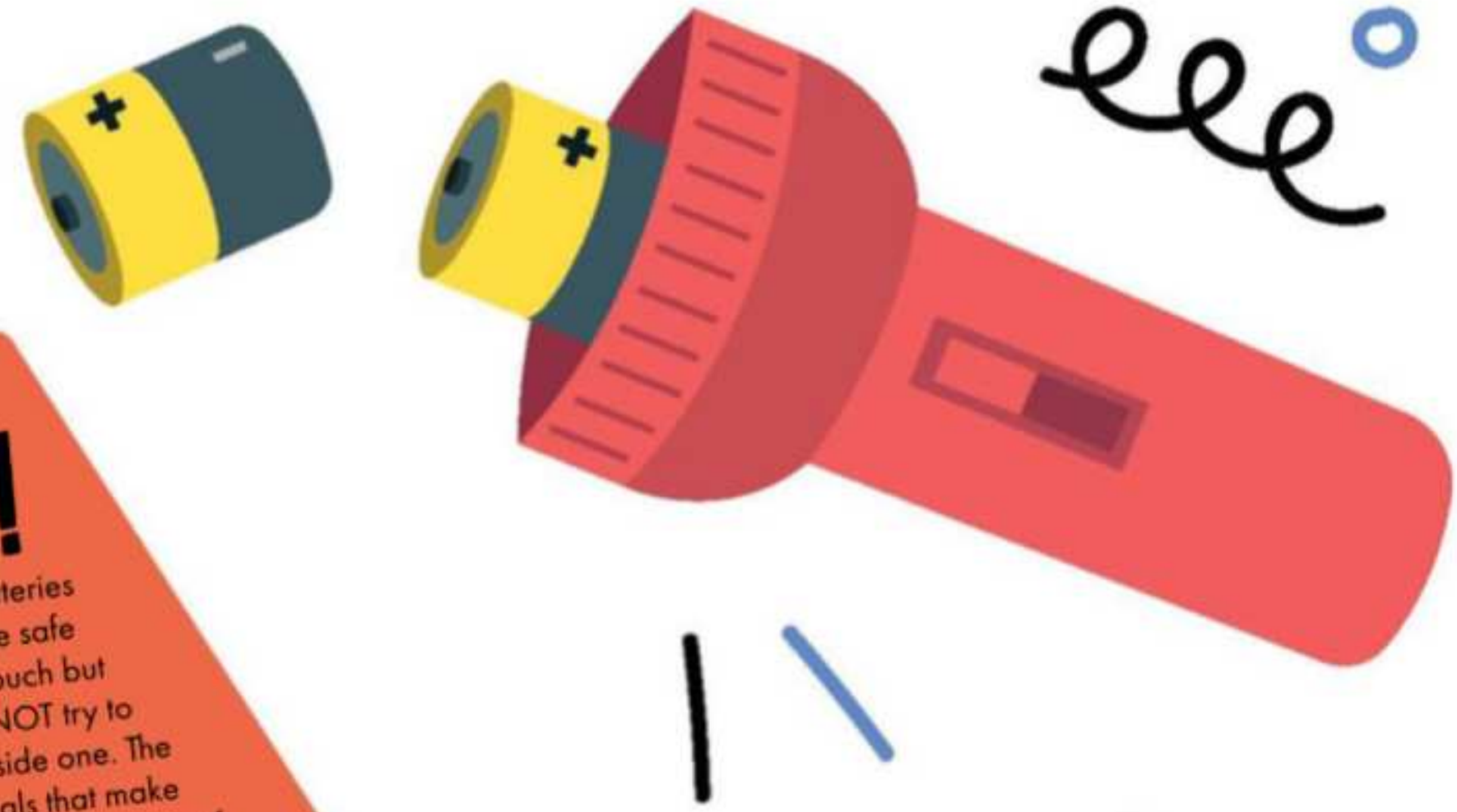


A cell is often shaped like a cylinder. Sometimes the word "battery" is used to refer to cells too. In this book, the word battery has to do with a box in which cells are joined together.

This car battery is made up of six cells joined together. It powers the car's engine, lights, and electrical and electronic equipment, such as the radio.

TERMINALS OF A CELL

If you look closely at a cell, it has a plus sign (+) at one end and a minus sign (-) at the other end. Each end is called a **terminal**. There is a positive terminal (+) and a negative terminal (-). To make electricity flow out of the cell, a **wire** must be in contact with each terminal.



Batteries are safe to touch but DO NOT try to look inside one. The chemicals that make them work can burn you if they get on your skin or clothes.

TWO CELLS

To make more electricity flow, cells are joined together. They have to be joined up with the positive terminal of one cell next to the negative terminal of the other cell. If two of the same terminals are joined together, the electricity will not flow.

FIND A TOY THAT USES CELLS. ASK AN ADULT TO TAKE THEM OUT. LOOK FOR THE PLUS AND MINUS SIGNS ON THE CELLS AND ON THE INSIDE OF THE TOY. CAN YOU PUT THE CELLS BACK IN CORRECTLY AND MAKE THE TOY WORK?

A BULB

Bulbs are used to provide light in the area surrounding them. Let's see how they work.

Bulbs used in experiments are very small and are screwed into plastic holders.

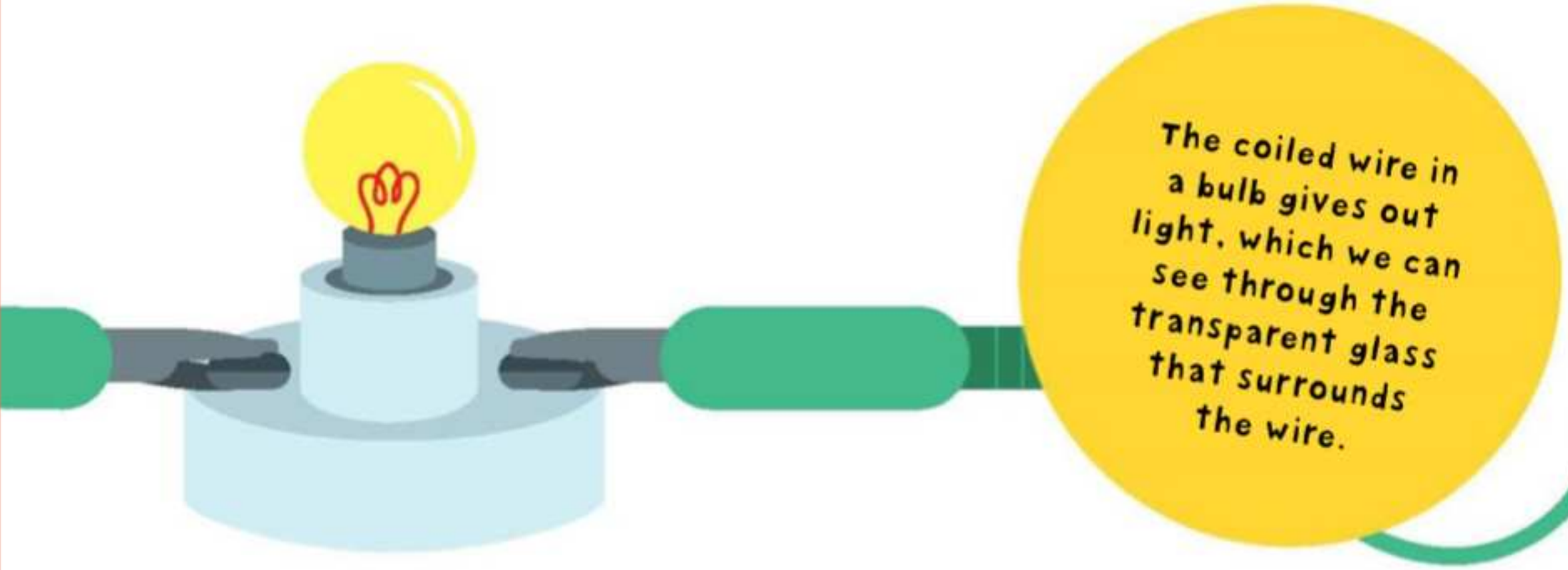
BULBS USED IN SCIENCE

A bulb has two places where wires are attached. They are called **contacts**. The contacts are connected to wires inside the bulb. One of the wires inside the bulb is in the shape of a **coil**.

The light from inside these bulbs passes through the glass and lights up the street.

THE FLOW OF ELECTRICITY

Electricity flows from the cell along a wire to the bulb. When it flows through the coil of wire in the bulb, the coil gets hot and glows. The electricity continues to flow out of the bulb, along the other wire, and back to the cell.



The coiled wire in a bulb gives out light, which we can see through the transparent glass that surrounds the wire.

LIGHTING A BULB

With the help of an adult, you can make a bulb light up in the following way.

1 Attach one end of a wire to one terminal of the cell.

2 Attach the other end of the wire to a contact of the bulb.

3 Attach the other terminal of the cell to the other contact of the bulb with a second wire.

EQUIPMENT:

- two wires with a crocodile clip on each end
- bulb
- cell
- cell holder
- an adult to help you

CONDUCTORS AND INSULATORS

A wire is made of metal. Electricity can flow through it. A material that lets electricity flow through it is called an electrical conductor. Materials that do not let electricity flow through them are called insulators.

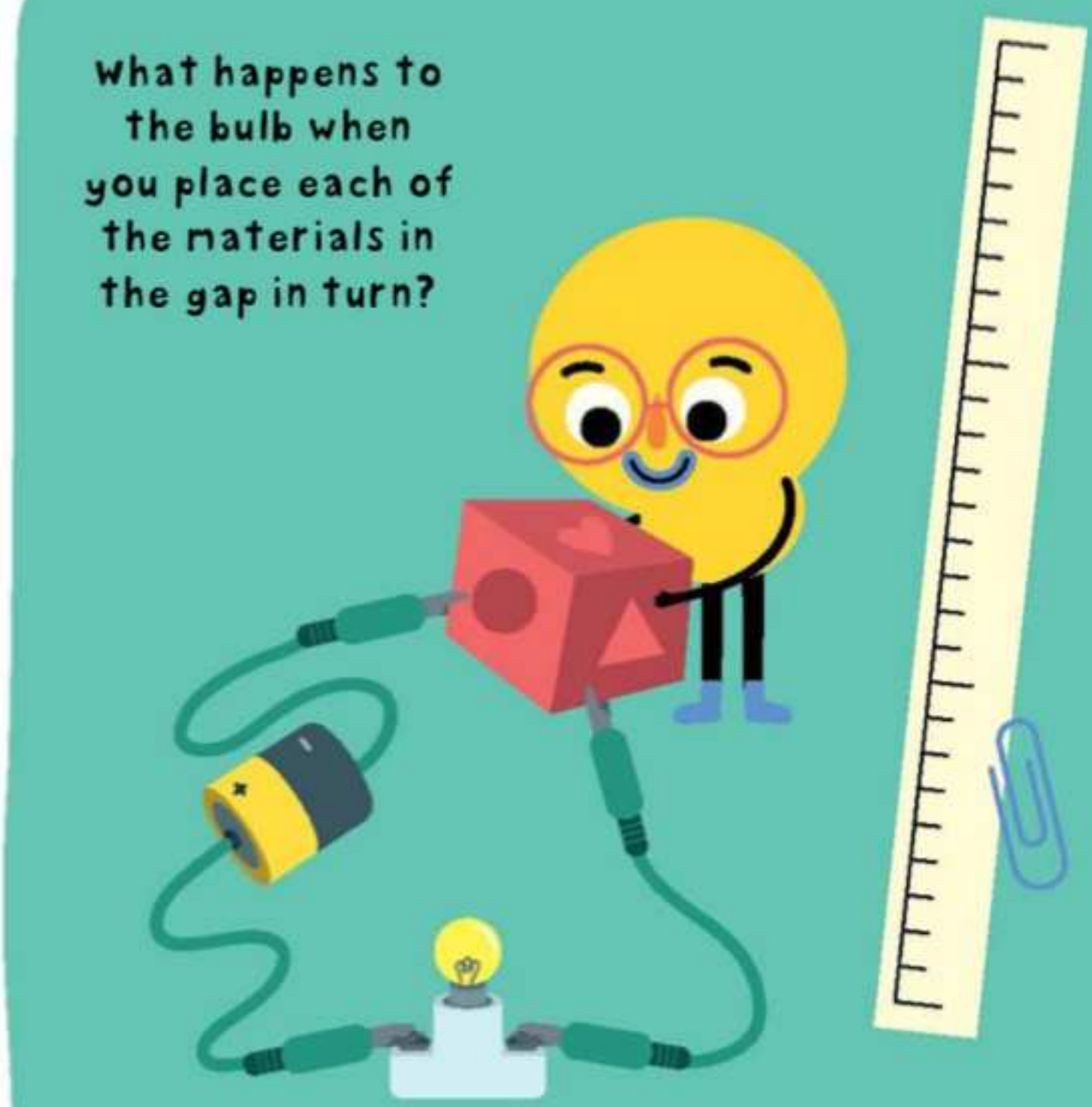
EQUIPMENT:

- two wires with a crocodile clip on each end
- bulb
- cell
- glass
- plastic ruler
- piece of paper
- piece of metal foil
- wooden block
- paper clip
- plastic toy
- an adult to help you

TESTING CONDUCTORS AND INSULATORS

Test materials to find out if they are conductors or insulators by setting up a cell, a bulb, and a gap between two wires. Place each material to be tested across the gap.

What happens to the bulb when you place each of the materials in the gap in turn?



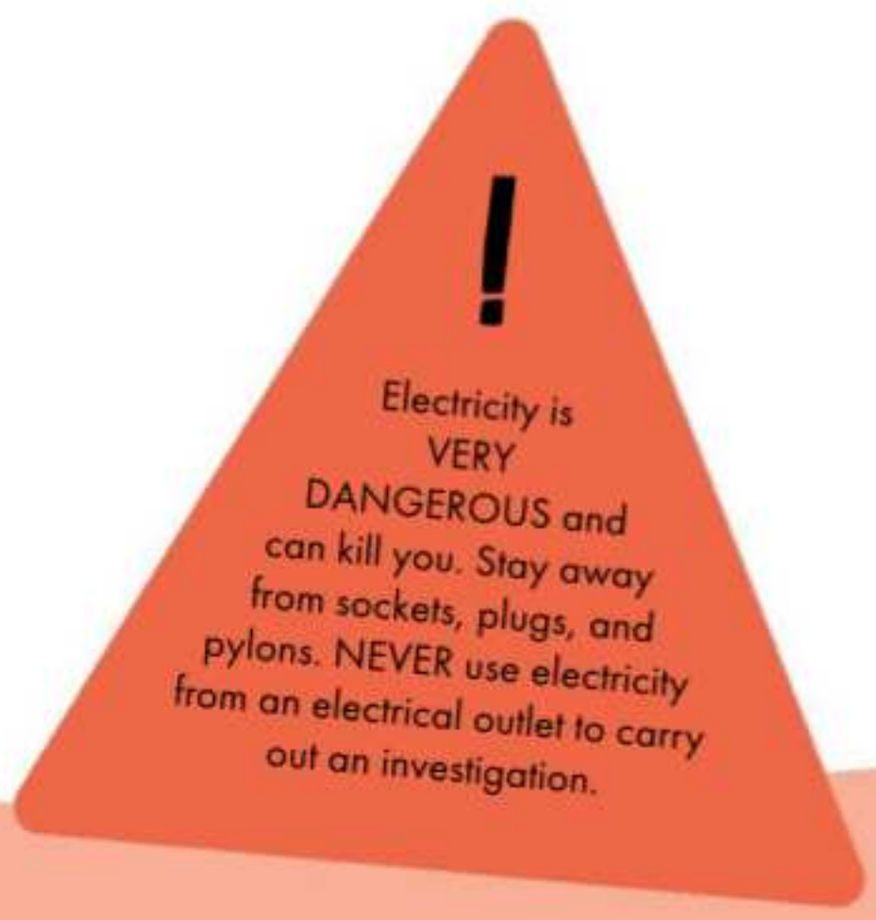
CONDUCTORS

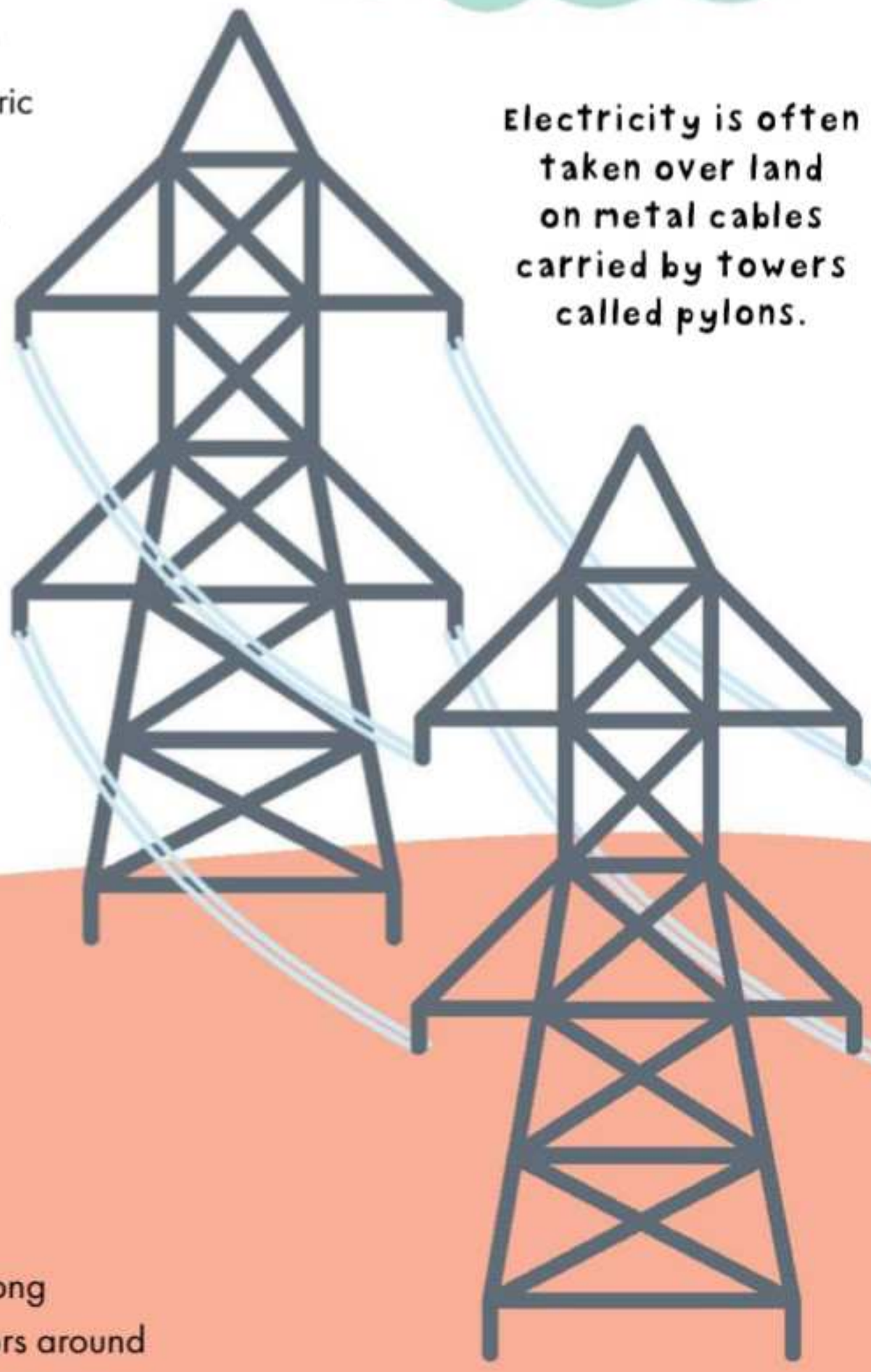
If the material is a conductor, electricity will flow through the material in the gap. When this happens the bulb lights up, showing that the electric current is flowing. All metals conduct electricity.

WHY DOES A CABLE CONNECTING A COMPUTER TO AN ELECTRICAL OUTLET HAVE METAL WIRE INSIDE AND PLASTIC ON THE OUTSIDE?

INSULATORS

If the material is an insulator, electricity cannot flow through it. It stops the electric current and the bulb does not light up. Materials such as plastic, glass, paper, and wood are insulators.





POWER STATIONS

Electricity from power stations flows along conductors to a home's outlets. Insulators around conductors stop the current from harming you.

A CIRCUIT

A circuit is the path that is set up for an electric current to flow. The parts of the circuit are called components.

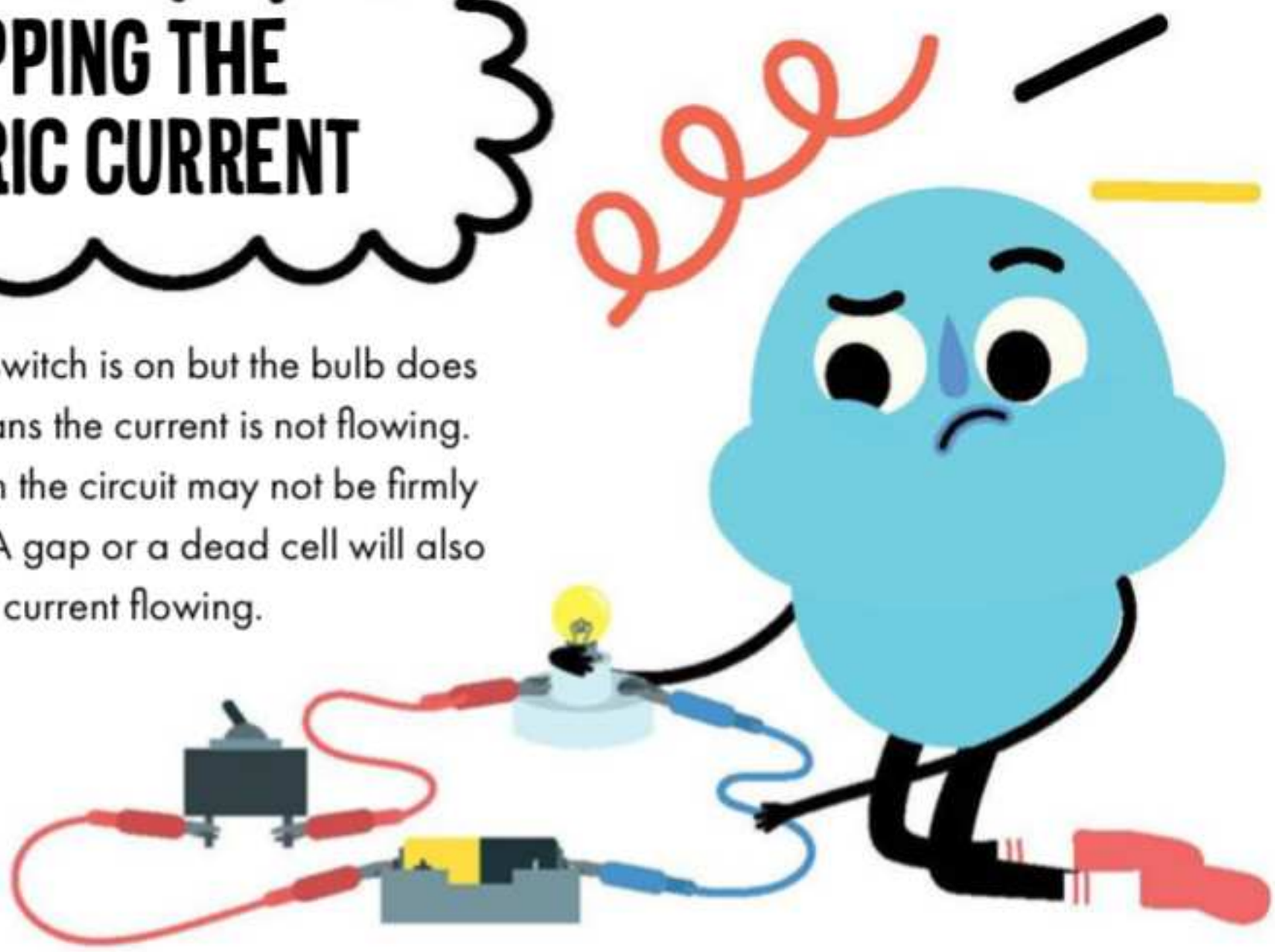
COMPONENTS OF A CIRCUIT

The components of this circuit are a cell, a **switch** (see pages 18–19), a bulb, and the wires that connect them. All the components in the circuit form a loop through which the current flows.

A switch controls the flow of the current in a circuit. If the switch is on, the current flows and the bulb lights up. If the switch is off, the current does not flow.

STOPPING THE ELECTRIC CURRENT

In some circuits, the switch is on but the bulb does not light up. This means the current is not flowing. All the components in the circuit may not be firmly connected together. A gap or a dead cell will also stop the current flowing.



USING CELLS, BULBS, WIRES, AND A SWITCH, MAKE YOUR OWN CIRCUIT. WHEN YOU HAVE MADE A CIRCUIT THAT WORKS, MAKE A RECORD OF YOUR EXPERIMENT. DO THIS BY DRAWING THE COMPONENTS AND THE WAY THEY ARE CONNECTED TOGETHER. USE THE DRAWING OF THE CIRCUIT ON PAGE 14 TO HELP YOU.

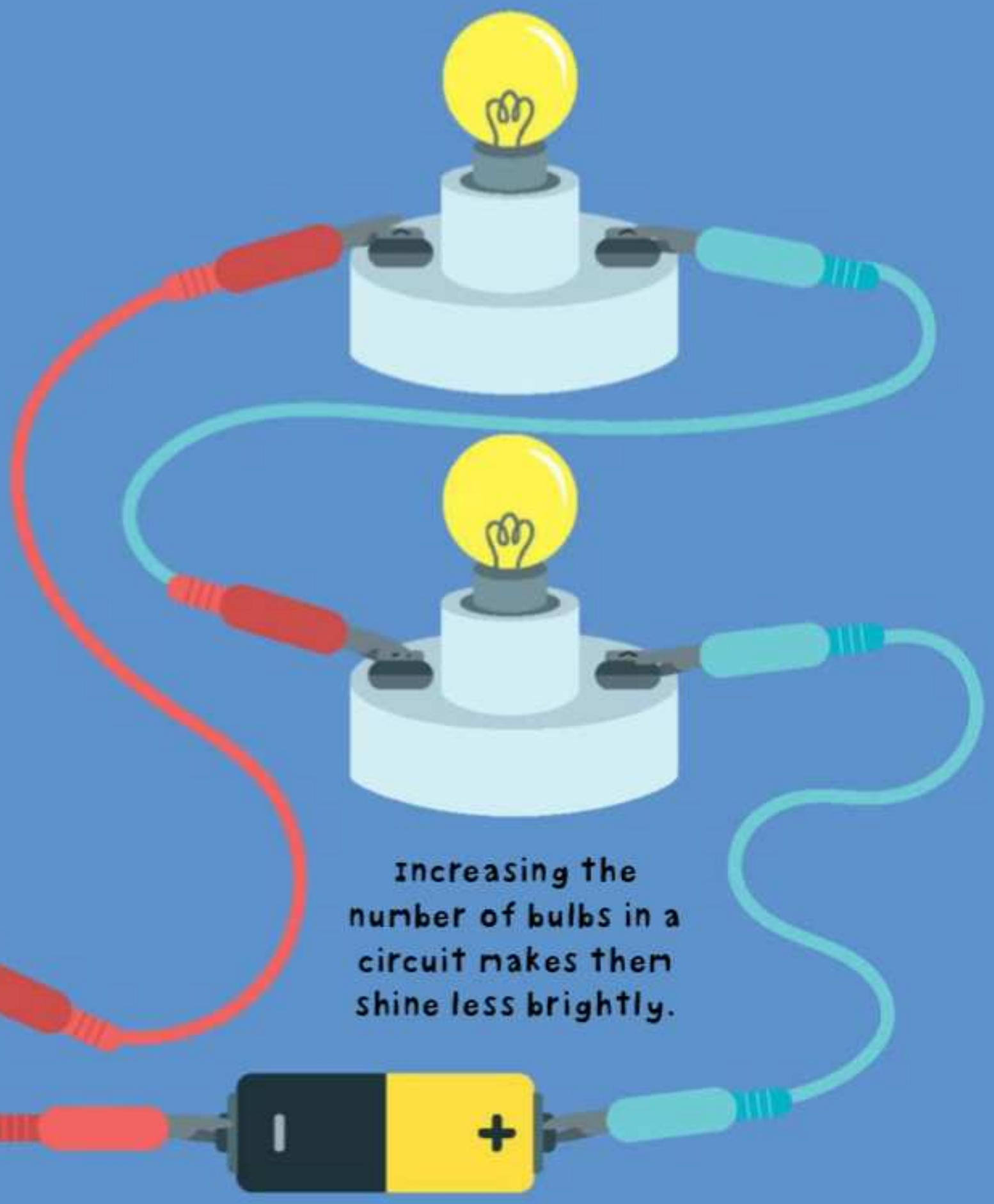
Trained electricians check and repair electric circuits in our homes.

A SERIES CIRCUIT

The correct way to make a circuit is to place all the components in a line and join them together to make a loop. This type of circuit is called a series circuit.

TWO BULBS IN A SERIES CIRCUIT

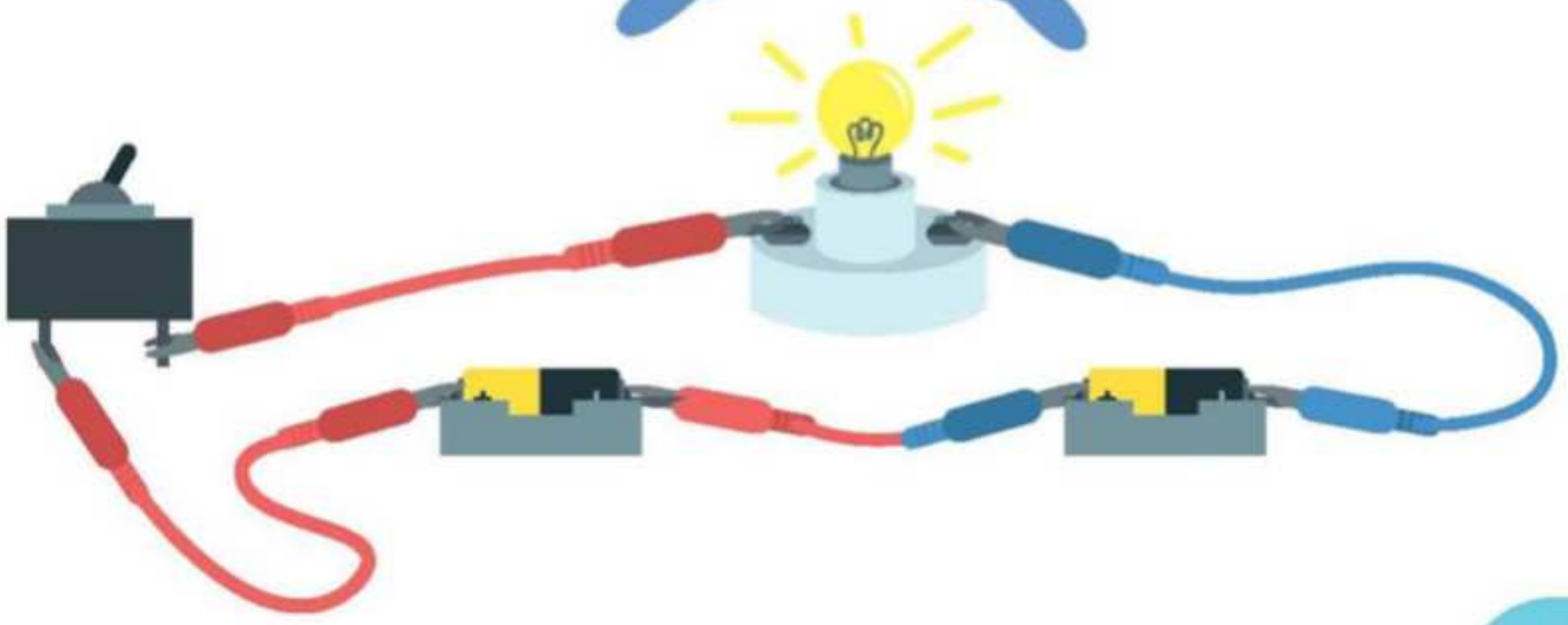
In this circuit there are two bulbs arranged in series. When two bulbs are arranged in series they do not shine as brightly as just one bulb in a circuit, because they are sharing the same amount of electric current.



Increasing the number of bulbs in a circuit makes them shine less brightly.

TWO CELLS IN A SERIES CIRCUIT

In this circuit, two cells are arranged in series. The negative terminal of one cell is connected by a wire to the positive terminal of the other cell. The two cells give more power to the current and the single bulb shines brighter.



WHAT WOULD HAPPEN TO A BULB IN A CIRCUIT IF YOU ADDED ANOTHER CELL IN SERIES? WHAT WOULD HAPPEN IF YOU THEN ADDED ANOTHER BULB IN SERIES?

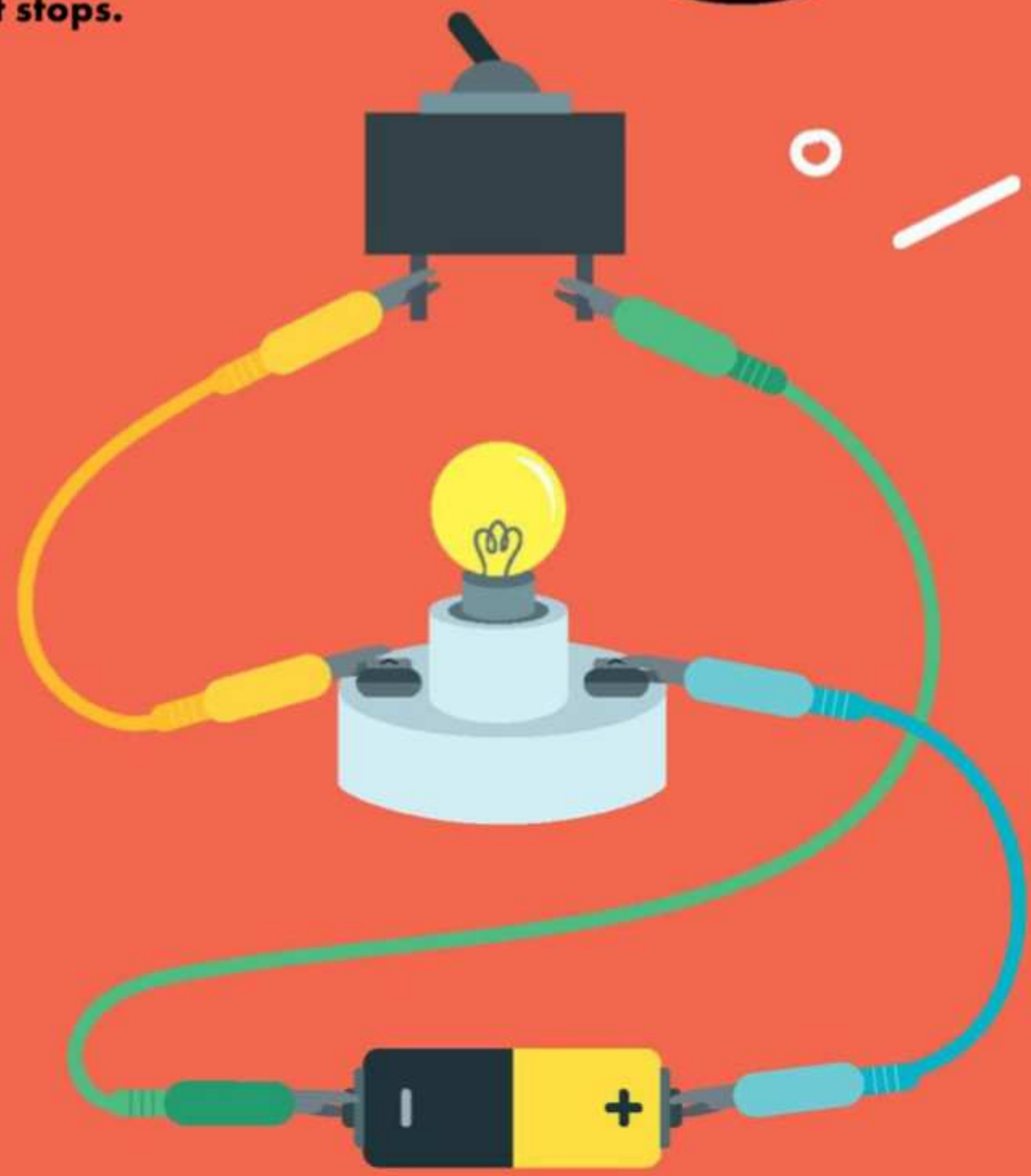
SWITCHES

Switches are used to control the flow of electricity. To use an electrical appliance, such as a hair dryer, you press a switch and the electricity flows through it. When you're done, you press it again and the current stops.

The switch is off so the bulb does not light up.

TESTING A SWITCH

You can test a switch by putting it in the gap between two wires connected to a cell and a bulb. When the switch is on, the electric current flows and the bulb lights up. When the switch is off, the electric current doesn't flow and the bulb doesn't light up.



EQUIPMENT:

- small piece of wood
- two thumbtacks
- paper clip
- two wires with a crocodile clip at each end
- an adult to help you

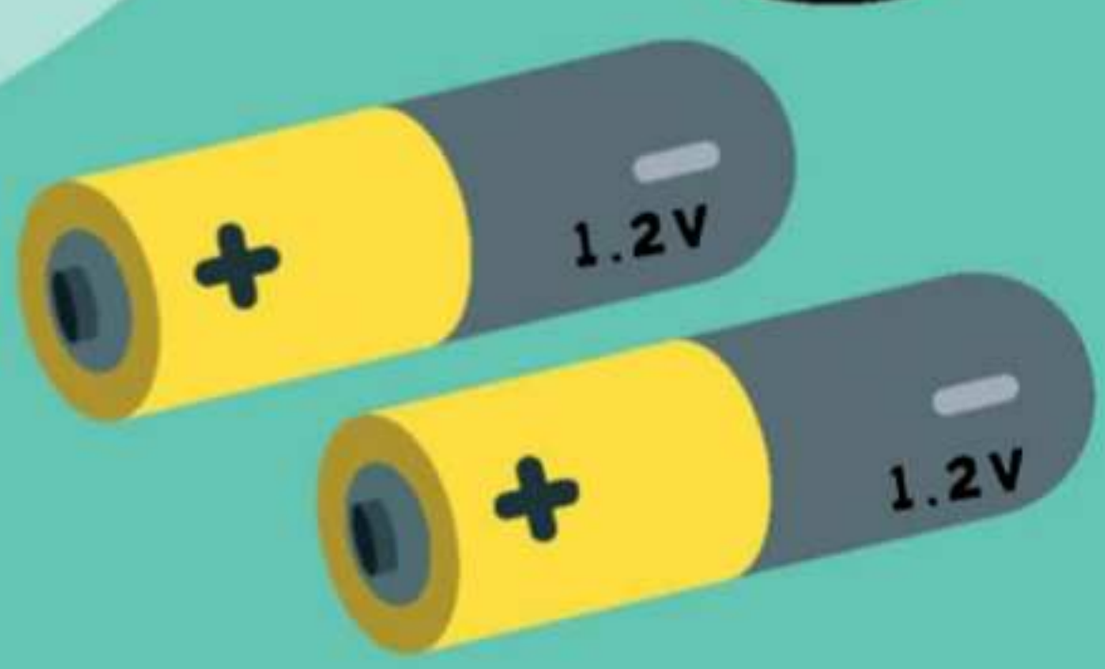
MAKE YOUR OWN SIMPLE SWITCH

Loop your paper clip under one thumbtack. With the help of an adult, push the thumbtacks into the wood so that the paper clip can touch both tacks. Connect the wires to the tacks using the crocodile clips. The paper clip now acts as a switch and is ready to use.

VOLTAGE

The power of a cell is called its voltage and is measured in units called volts. The symbol for this unit is V. You can see the voltage written on the side of the cell.

These cells each have a voltage of 1.2V.



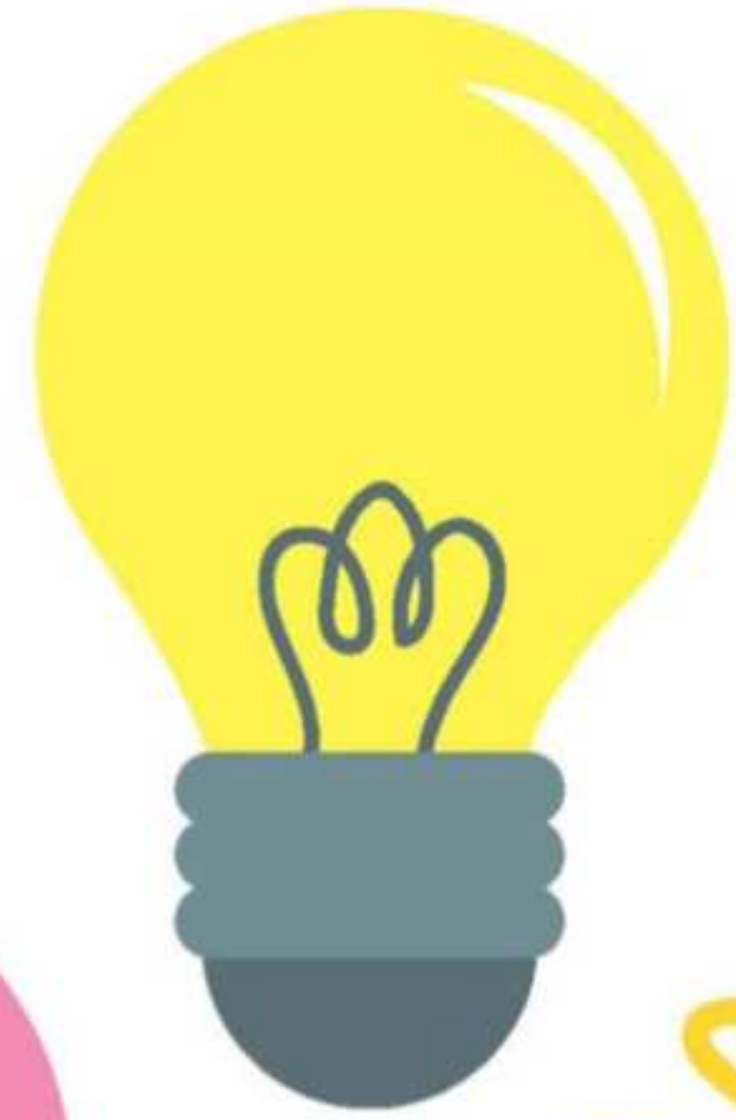
This 6V battery is used in large flashlights to provide a wide beam of light, or in a lantern where the bulb shines in all directions.

INCREASING THE VOLTAGE

When two cells are joined together, the power of one cell is added to the power of the other. If two 1.5V cells are joined together correctly in a circuit, they give a power of 3V (1.5 + 1.5 = 3V). A battery with a number of cells joined together inside it is more powerful than a single cell. Some batteries have a voltage of 4.5V, 6V, or even 9V.

VOLTAGE OF A BULB

Bulbs are made to work at certain voltages, such as up to 1.5V, up to 4.5V, and up to 6V. If a bulb is put in a circuit where the cells supply a higher voltage, the coil of wire in the bulb gets so hot it melts and breaks, and the current stops flowing.



If one twinkle light is damaged and stops the flow of electricity, all the lights will go out if connected in series.

HOW MANY 1.5V CELLS ARE IN A 4.5V BATTERY?

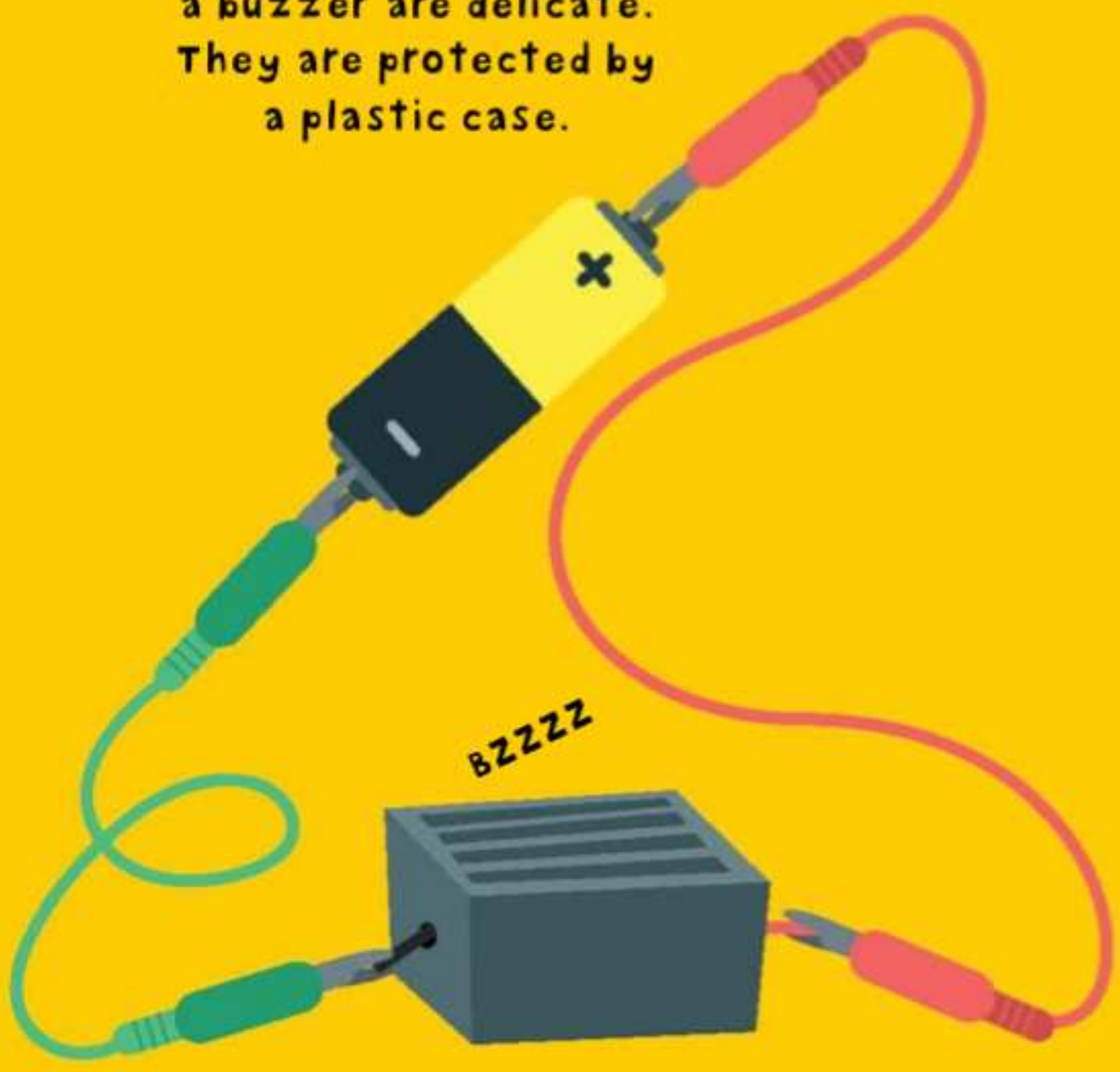
WILL A 1.5V BULB WORK WITH A 1.5V CELL IN THE CIRCUIT?

WILL A 3.5V BULB WORK WITH TWO 1.5V CELLS IN THE CIRCUIT?

BUZZERS AND MOTORS

Buzzers and motors can be found in many electrical appliances. Buzzers can be used in burglar alarms. A buzzer makes a sound when electricity passes through it. Motors can be used in fans. An electric motor has a shaft. Electricity passes through the electric motor, which spins the shaft.

The parts that produce the buzzing sound in a buzzer are delicate. They are protected by a plastic case.

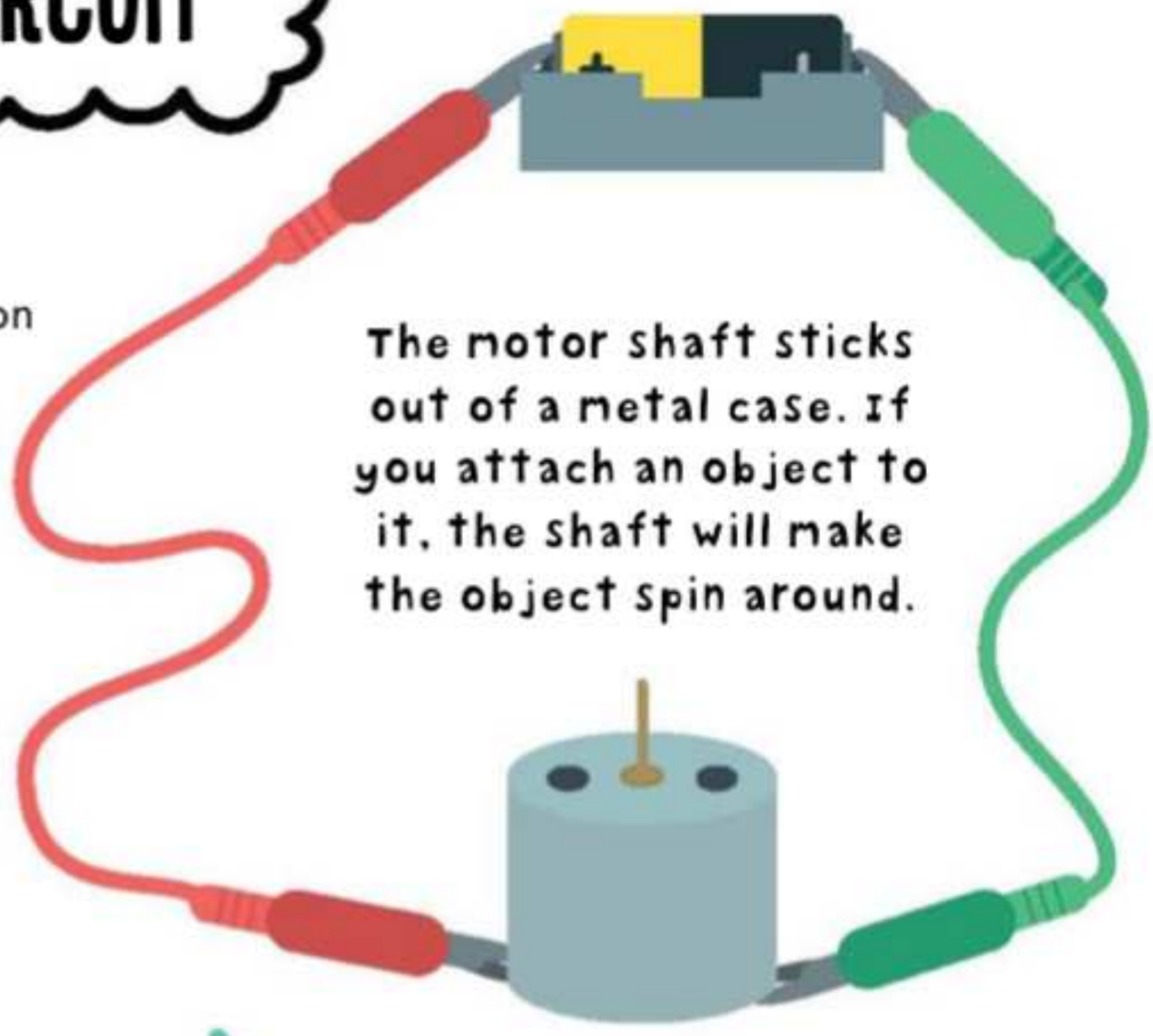


A BUZZER IN A SERIES CIRCUIT

A buzzer is designed to work up to a certain voltage, which is indicated on a label. It has a red wire and a black wire. It must be placed in the circuit carefully. The red wire must be attached to a wire coming from the positive terminal of the cell. The black wire must be attached to the wire coming from the negative terminal of the cell. If the wires are the wrong way around, the buzzer will not work.

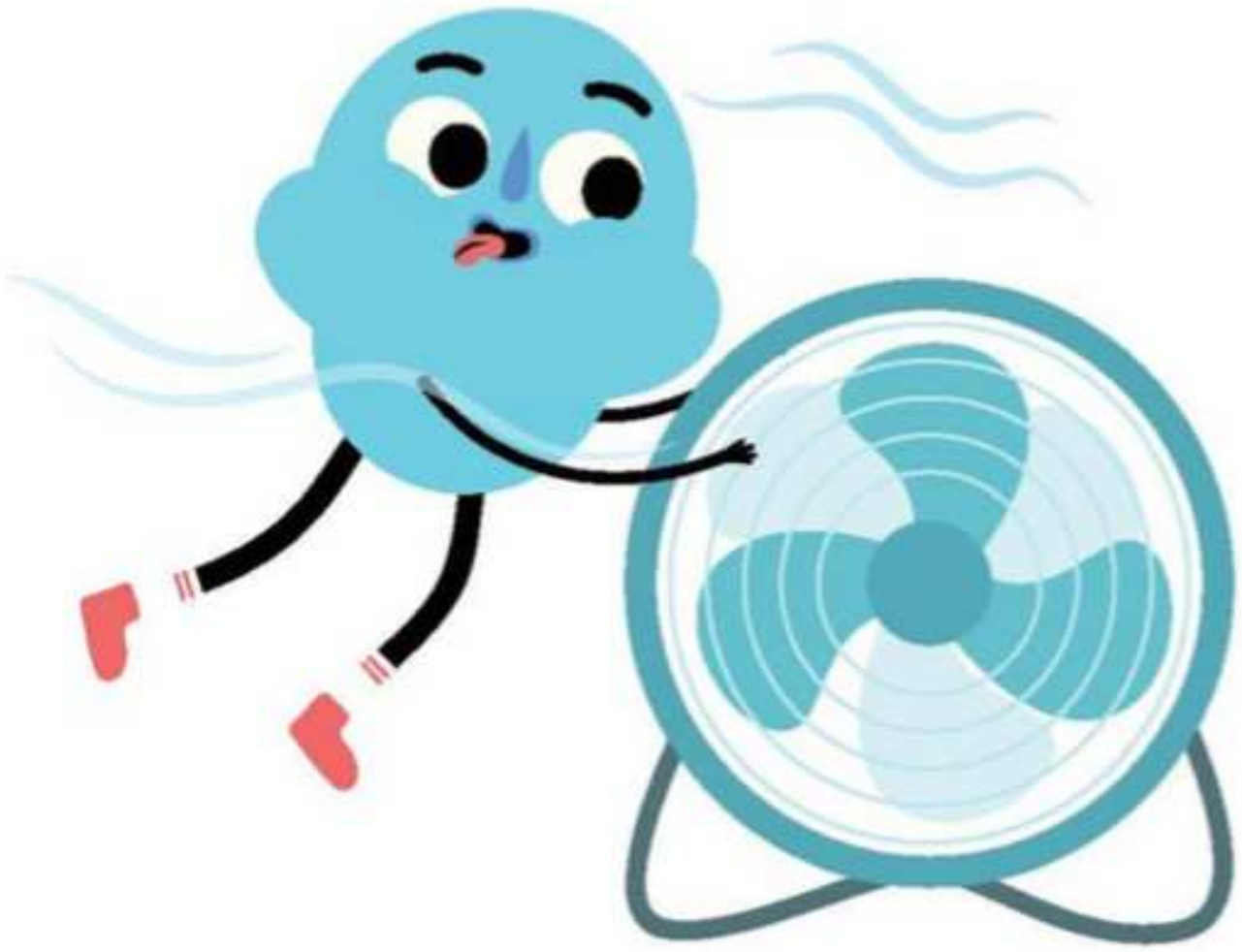
A MOTOR IN A SERIES CIRCUIT

A motor is designed to work up to a certain voltage. There are two contacts on the motor where wires can be attached. The wires do not have to be attached in a special way, unlike the wires of the buzzer.



The motor shaft sticks out of a metal case. If you attach an object to it, the shaft will make the object spin around.

A motor spins this fan, which moves the surrounding air to produce a cooling breeze.



LOOK AROUND YOUR HOME FOR ELECTRICAL APPLIANCES THAT TURN THINGS (BUT DO NOT SWITCH THEM ON). EACH ONE WILL HAVE AN ELECTRIC MOTOR. HOW MANY CAN YOU FIND? WHAT DOES EACH APPLIANCE DO?

A LIGHTHOUSE

Electric circuits can be used to make models. You can make a model lighthouse, for example, using a simple circuit.

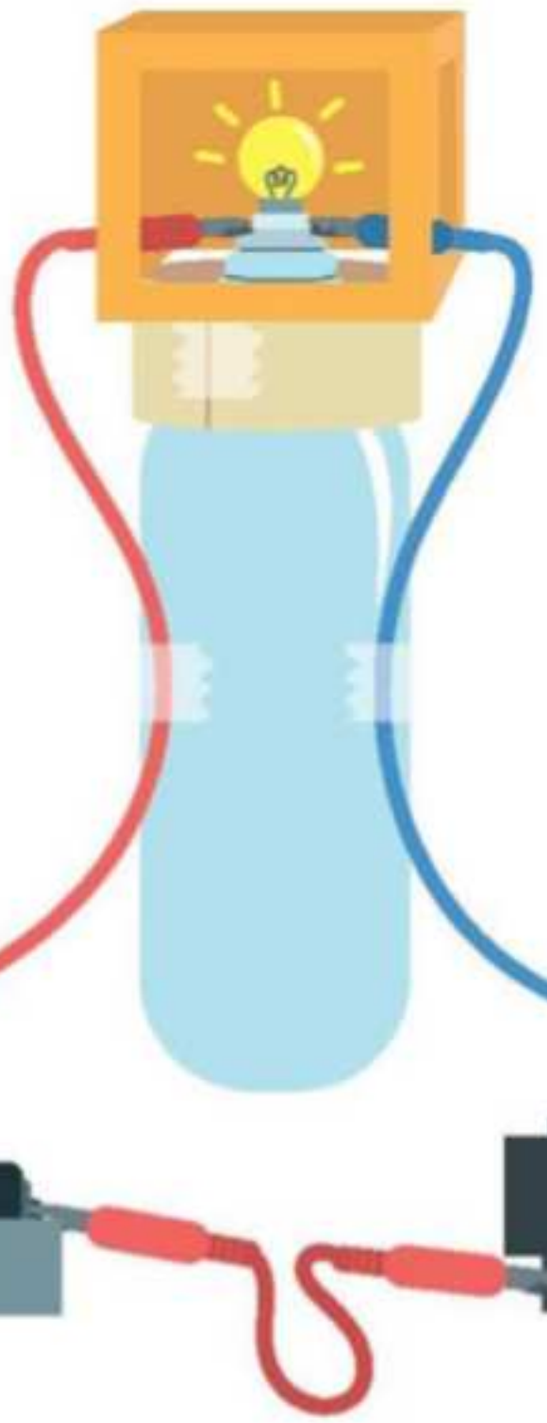
EQUIPMENT:

- plastic bottle
- bulb
- three wires with a crocodile clip on each end
- cell
- switch
- small cardboard box
- **adhesive tack**
- scissors
- clear tape
- thick cardstock that's 1 x 14 inches (2.5 x 35 cm)
- stopwatch
- an adult to help you

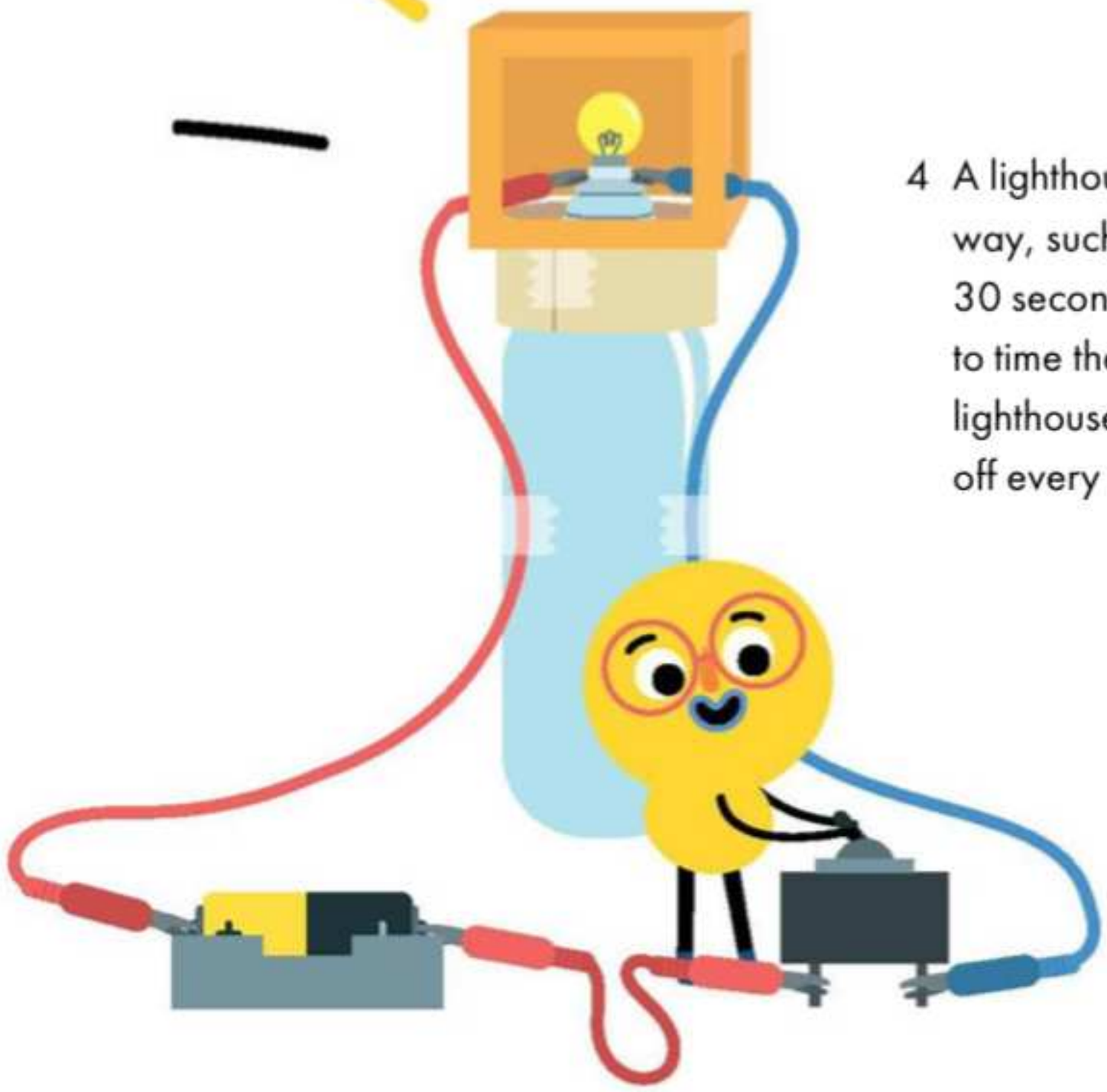
1 The main part of the lighthouse is made from a plastic bottle. Attach the bulb to the top of the bottle with some adhesive tack.

2 Take the strip of thick cardstock and bring the two ends together to make a circle. Stick the ends together with clear tape and place this over the top of the bottle so that it rests on top. With an adult's help, cut windows in each side of the small box and stick this to the circle of cardstock to make your lantern room.

3 Connect the wires to the bulb and stick these to the sides of the bottle with tape. Add the cell and switch to complete the series circuit. The wires could be covered with paper to hide them.



4 A lighthouse flashes light in a certain way, such as three flashes every 30 seconds. You could use a stopwatch to time the flashes on your model lighthouse by switching the light on and off every few seconds.



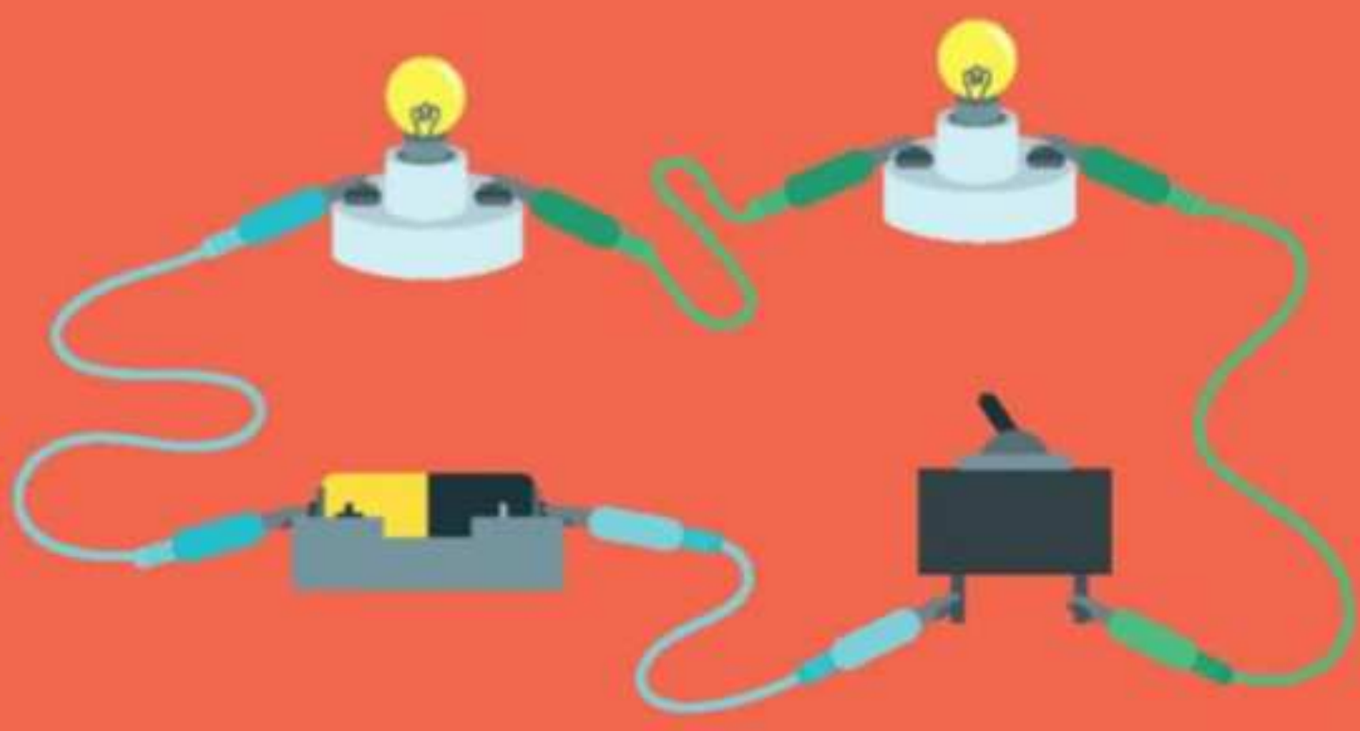
ROBOT HEAD

Make a robot head with two simple circuits. Your robot's eyes will light up – it can buzz too!

EQUIPMENT:

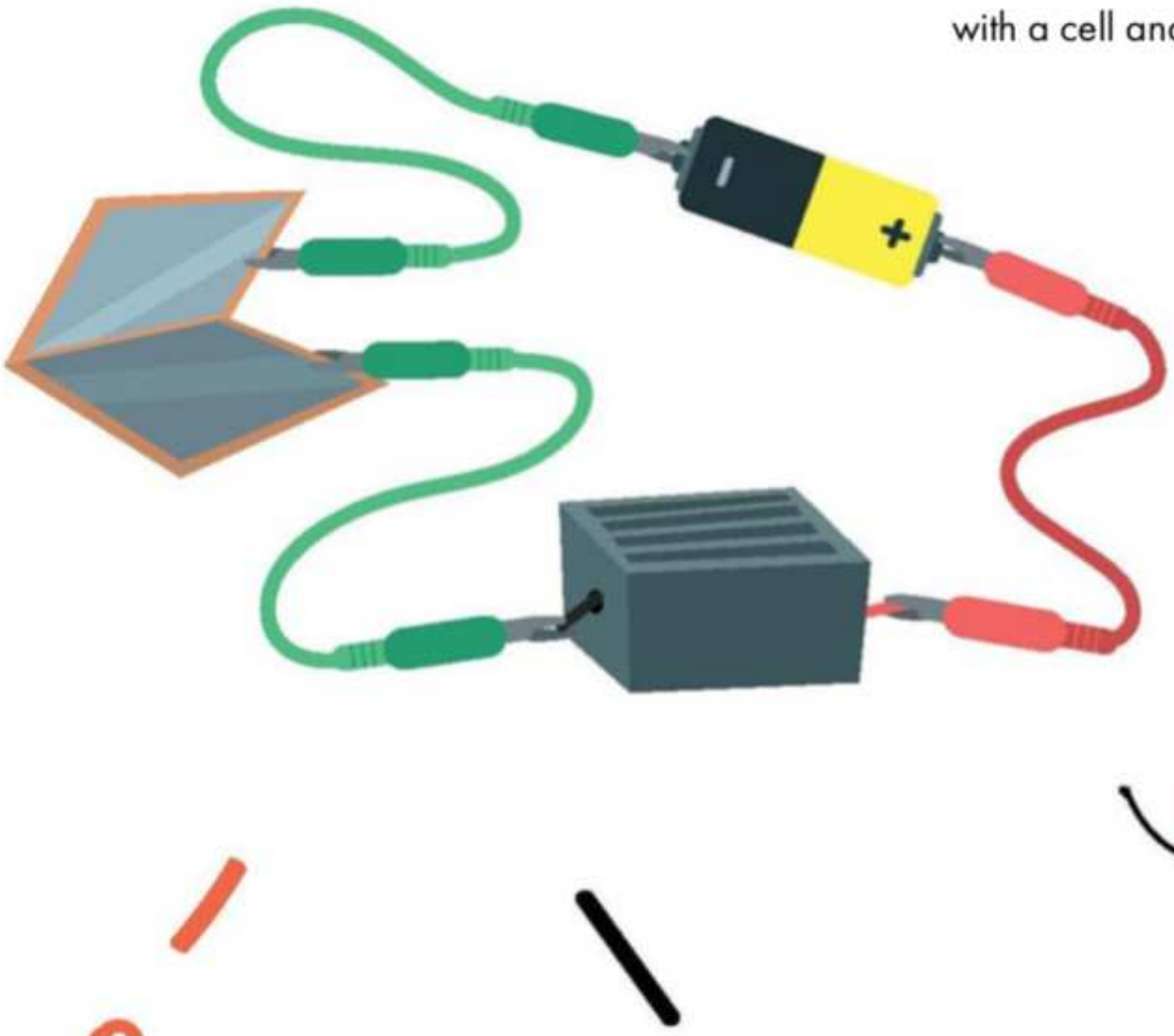
- large cardboard box
- scissors
- clear tape
- two bulbs
- switch
- two cells
- small piece of cardboard
- aluminium foil
- wires with a crocodile clip on each end
- buzzer
- an adult to help

1 Create a circuit with the two bulbs, a switch, and a cell. With an adult's help, cut two eyeholes in the cardboard box and stick the bulbs inside them using tape. Cut a nose hole and stick the switch inside it. Cut a mouth hole and stick the cell inside it.



2 When you tweak the robot's nose, you switch on the circuit and its eyes light up.

3 To make your robot buzz when you pat its head, you will need another circuit and a homemade switch. Make the switch by folding a piece of cardboard and sticking two pieces of aluminium foil inside. Attach a wire to each piece of foil. Complete the circuit with a cell and a buzzer.



4 Attach the switch to the top of the robot's head with tape. When you pat the robot's head, it buzzes!

GLOSSARY

Adhesive tack a sticky substance used to join items together

Amber a honey-colored solid formed from the hardened liquid made by trees that lived millions of years ago

Appliance a machine powered by electricity that helps us; for example, a washing machine or dryer

Battery two or more cells joined together in a line. The positive terminal of one cell is connected to the negative terminal of the next

Bulb a component in a circuit that gives out light when a current of electricity passes through it

Cell a store of electricity. It contains substances that make a current flow around a circuit when the circuit is switched on.

Circuit an arrangement of electrical components looped together so that when they are all connected together electricity flows

Coil a length of wire that has been curled around into a row of circular loops

Components the pieces of equipment that make up parts of a circuit, such as wires, bulbs, and cells

Conductor a material that allows a current of electricity to pass through it

Contact a place on an electrical component where a wire is attached to make part of a circuit

Current the flow of electricity

Droplet a very tiny drop

Generate to make electricity. Substances in a cell generate electricity when a circuit is switched on.

Insulator a material that does not allow a current of electricity to pass through it. Plastic is an insulator.

Material anything that contains matter in one of its three states – solid, liquid, or gas

Series circuit a circuit in which all the components form a line

Shaft the section or part driven around by a motor

Static electricity a form of electricity made by rubbing. Static electricity does not flow or move like an electric current.

Switch a component that controls the flow of electric current by letting it flow or stopping it flowing in a circuit

Terminal the part of a cell that is attached to a wire in a circuit. Electricity flows from the negative terminal to the positive terminal.

Volt a unit that measures the power of electricity

Voltage a measure of the power of a cell in volts

Wire a long thin strand of metal that conducts electricity

ANSWERS TO THE ACTIVITIES AND QUESTIONS

Page 5: How do we use electricity?

Answer: This will vary with each home. Examples are an electric kettle, iron, or hair dryer to provide heat; lamps to provide light; a motor in a food processor to mash up food.

Page 9: Cells and batteries

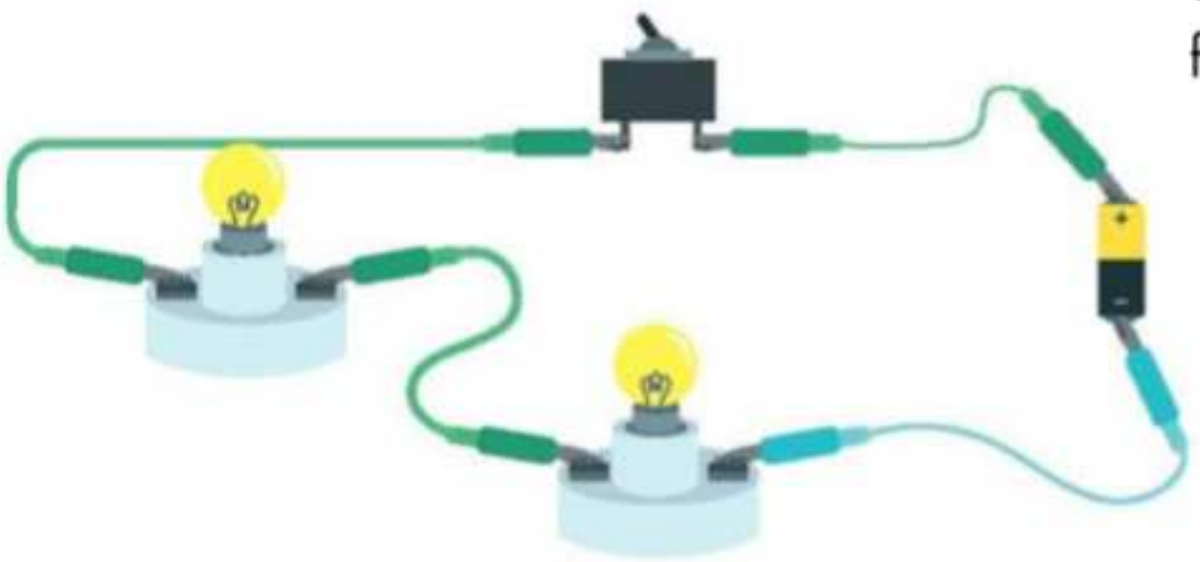
Answer: The toy should work when it is switched on. This shows that the cells are arranged correctly and have a store of electricity. As they are removed, the + and - signs on the cells and inside the toy should be looked for so they can be matched when the cells are returned. The cells are usually held in with springs to make sure they make firm contact with the wires in the circuit.

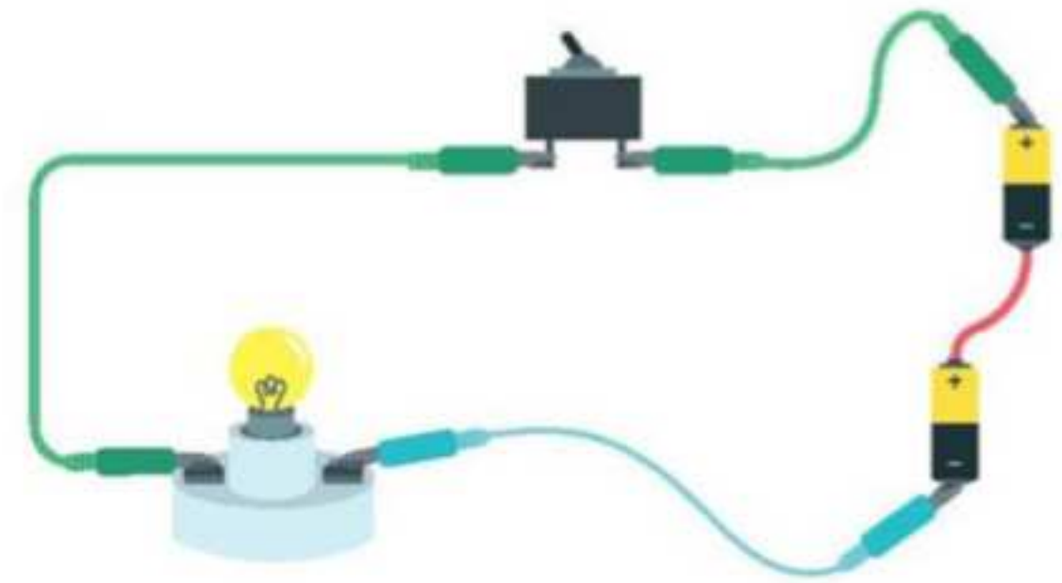
Page 13: Conductors and insulators

Answer: The metal wire is a conductor of electricity and lets the electric current flow to the computer. The plastic in the coating is an insulator and stops the current of electricity from leaving the sides of the wire.

Page 15: A circuit

Here are some examples of circuits you could draw:





Page 17: A series circuit

Answer: It would get brighter. The bulbs would get dimmer.

Page 21: Voltage

Answers: 1. Three 2. Yes 3. Yes

Page 23: Buzzer and motor

Answer: Motors can be found in microwaves to make the turntable spin or in Blu-ray players to make a Blu-ray spin, for example.

FURTHER INFORMATION

BOOKS TO READ

Building the World: Power Stations and Electricity by Paul Mason (PowerKids Press, 2024)

Discover and Do!: Electricity by Jane Lacey (Enslow, 2023)

Be a Scientist: Electricity by Jacqui Bailey (Wayland, 2019)

A Question of Science: Where does lightning come from? And other questions about electricity by Anna Claybourne (Crabtree, 2020)

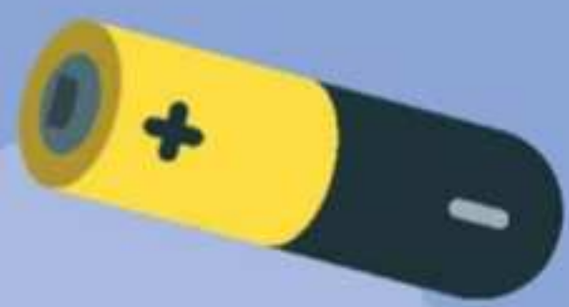
WEBSITES

Learn more about electricity, circuits, conductors, and insulators:

www.bbc.com/bitesize/topics/zj44jxs

Find lots of helpful information on batteries, circuits, and even electrical animals! It also includes an electricity quiz:

www.dkfindout.com/uk/science/electricity/



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