Science@School | Book 4F

Simple electricity

Teacher's Guide

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The pupil book explained unit by unit

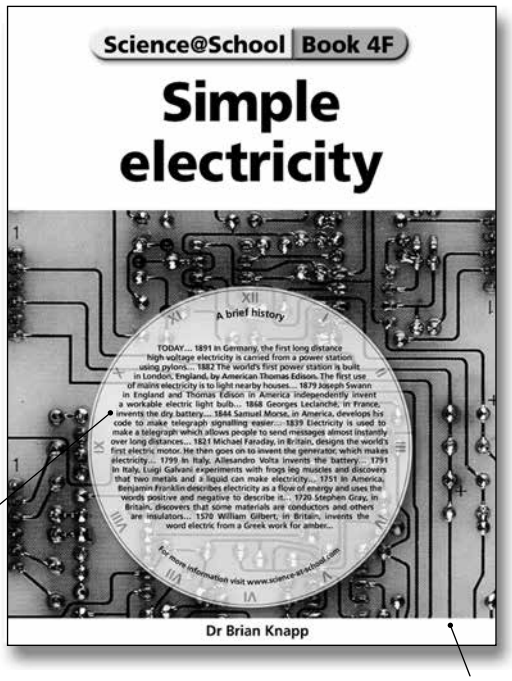
Although the pupil book – *Simple electricity* – is clear and simple, a great deal of care and thought has been given to the structure and the content of each double page spread or unit. The worksheets and activities in this *Teacher's Guide* link directly to the pages in the *Simple electricity* pupil book.

It is possible to use *Simple electricity,* and the worksheets and activities in this *Teacher's Guide*, without reading this section, but we would strongly recommend that you take a short time to familiarise yourself with the construction of the pupil book.

The units are arranged in sequence, to help you with your lesson planning. In this section, a brief description of the content of each unit is given, together with hints on how to start or support it. List 1 (Starting a unit with a demonstration) sets out the resources that you could use to do the demonstrations where suggested. The activity associated with each unit is also briefly described to help you see how the unit and activity work together.

Title page

The book begins on the title page (page 1). Here you will find information about science and technology in the form of a clock. You may want to use this to set the scene for the study of the book's contents. You may choose to focus on an event which ties in with your work in history, before moving onto the rest of the book. Alternatively, you may wish to skip over this page and return to it later. It is not a core part of the book, but helps the children see how the work they are doing now fits in with the work of scientists and engineers in the past. It may also be used to stimulate more able pupils to research the people and events that are described here.



A time clock giving additional historical information about the topic.

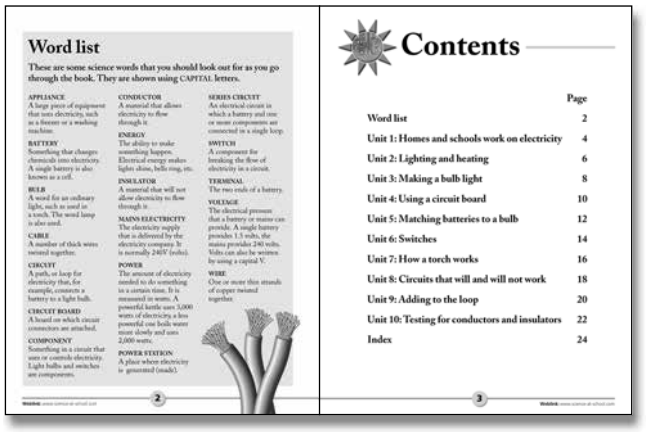
The picture shows part of the circuit board from a radio.

Word list and contents

The core content of the book begins with a word list on page 2. This is a glossary, brought to the front for the pupils' attention. Pupils could be encouraged to look at the list and see how many of the words they already recognise.

One of the important things about science is the precision with which words are used. However, many scientific words are also common words, often used in a slightly different way from how they would be used in science. The word list presents the opportunity for pupils to consider the words they already know, and the meanings they are familiar with.

When your teaching unit has been completed, you may want to invite pupils to revisit this list and see if their understanding of the words has been enhanced or changed in any way.



The entire contents are given on page 3. The book is organised into double page spreads, each double page spread covering one unit.

The units

Heading and introduction

Each unit has a heading, below which is an introductory sentence that sets the scene and draws out the most important theme of the unit.

Body

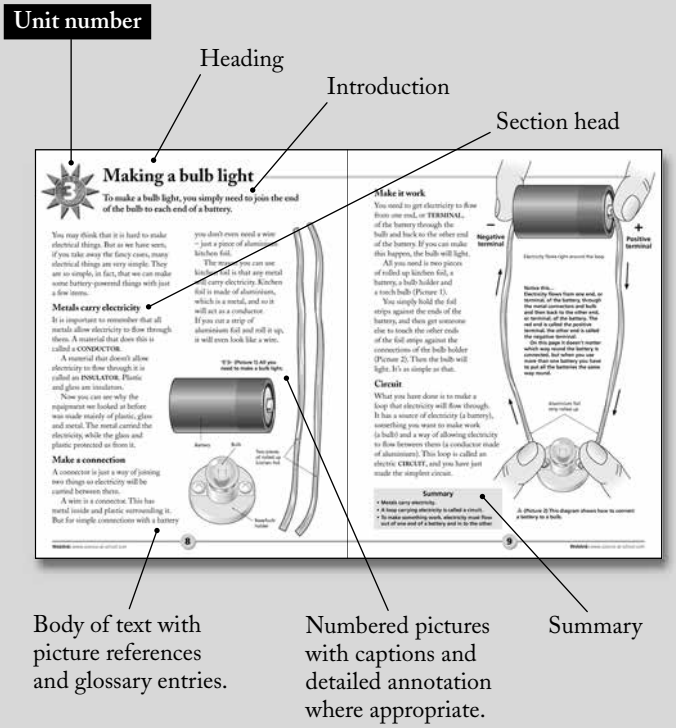
The main text of the page then follows in a straightforward, easy-to-follow, double column format.

Words highlighted in bold capitals in the pupil book are defined in the word list on page 2. A visual dictionary is also given on the CD.

The glossary words are highlighted on the first page on which they occur. They may be highlighted again on subsequent pages if they are regarded as particularly important to that unit.

Summary

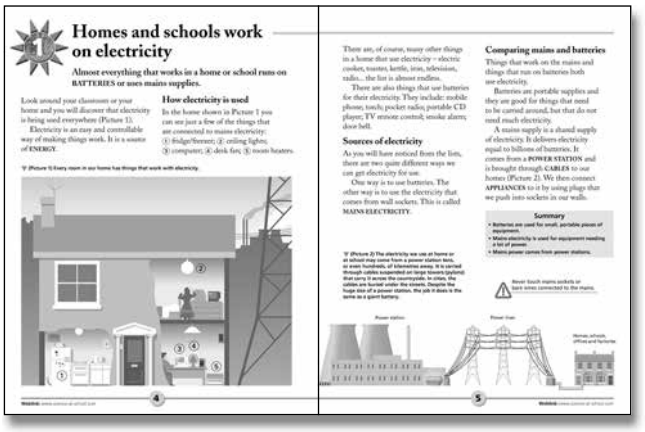
Each unit concludes with a summary, highlighting and reinforcing the main teaching objectives of the unit.



1 Homes and schools work on electricity

The purpose of the unit is to allow you to assess some of the children's previous work on electricity. In the past, they will have identified items which use electricity. You can build on this now by considering energy and looking at its definition in the word list. You may like to say that electricity is a form of energy which can be changed into other forms such as light, heat, movement and sound. Electrical items can then be defined as objects which change energy to other forms. For example, a lamp changes electrical energy into light energy. However, this change may also occur in many steps. For example, the electrical energy used by a fridge provides movement energy for a pump, which passes a cooling liquid round the food cabinet. A computer provides a means of storing or using information whilst also giving out light and sound.

The two sources of electricity – batteries and the mains – are also compared here. This provides



an opportunity for discussing safety and perhaps showing a suitable safety video.

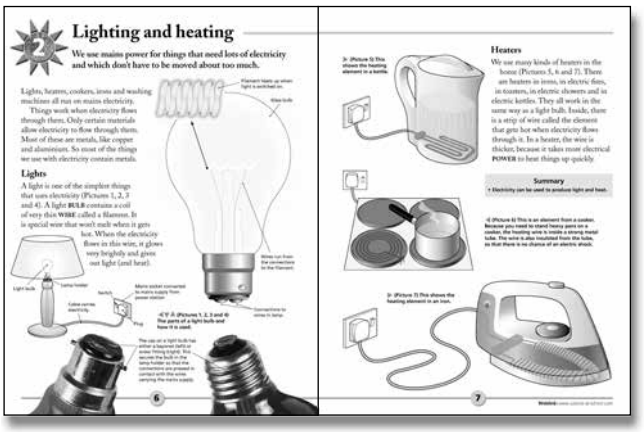
The supporting activity challenges the children to think about how batteries are used in a wide range of items including toys, household appliances and portable music systems.

2 Lighting and heating

Lighting and heating are two of the primary ways in which pupils can begin to understand the way that mains electricity is used, and how simple many pieces of electrical equipment are.

The easiest piece of equipment to investigate is a light bulb, because the bulb is transparent. Look for the filament and the way this is connected to the connections. (The way this differs from a strip light is described in the teacher's notes.) The positions of the elements in some common devices which provide heat have to be inferred, but the diagrams clearly show what is happening.

You may ask the children how they would light and heat their homes if they did not have electricity, and look at how homes were lit in the early nineteenth century. You may also like to look at how homes are lit and kept warm in various parts of the world today where people do not have electricity. This should help children realise what a convenient form of energy it is and how we often take it for granted.



In the activity, the children discover that electricity is used to provide heat for a wide range of purposes and that at certain times of day the demand for electricity is greater than at other times. In one of the complementary activities, they investigate the effect on the environment of using large amounts of electricity and the need for energy conservation.

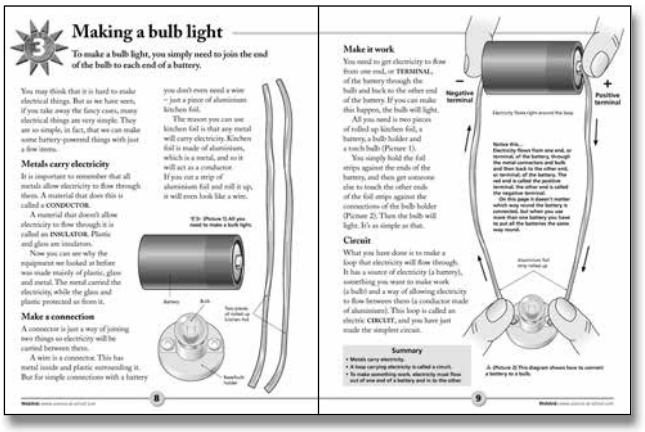
3 Making a bulb light

This is the first unit which addresses practical work with simple electrical equipment. When the children discover this they will probably be excited, so it is important for them first to grasp the basics of a circuit thoroughly.

The unit deals with setting up a very simple circuit. Notice that the circuit does not use wires, but folded up kitchen foil. This makes for ease of construction and also prevents the misconception that electricity only flows through wires.

The unit deals with the concept of conductors and insulators at the outset, and follows this by illustrating how connections are made. A very simple circuit is shown, which you may want the children to make. When they have made their circuit, it will be worthwhile going back through the unit again to relate the text to the circuit they have made.

You may like to set each group a task of explaining how to make a circuit and why the bulb will light. This could be in the form of an instruction sheet, a poster or a presentation.



The unit is supported by an activity where the children investigate common arrangements for circuits that people make when they first start studying electricity. This further builds on the concept of a simple circuit.

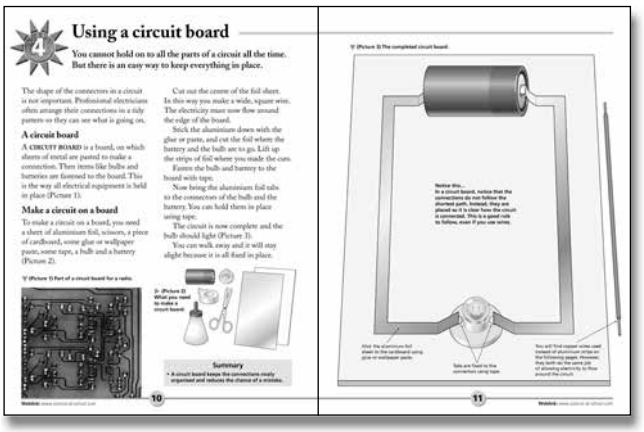
4 Using a circuit board

In the first unit, pupils will have experienced the difficulty of making up a circuit in which none of the components is fixed in place. This is an essential first step in demonstrating why it is important to place the components on a board. This unit continues the progress by making a simple circuit board. The aluminium foil is still used, but in this case it is stuck to the base board. This will show that the size and shape of the connectors do not matter.

Pupils may want to keep this circuit on their boards for some time, instead of having to break up their circuits as usual after their work on electricity. The unit also reinforces the essentials of a circuit, which were established on the previous unit.

Almost all modern electrical equipment contains circuit boards on which the various components are secured. The complicated wiring is reduced to orderly lines, which allows an electrician to find faults quickly.

A photograph on the spread, showing part of a circuit board for a radio, illustrates the complicated way the components are connected together.



The supporting activity challenges the children to make a circuit board of their own design and to cover it to simulate the arrangement of a circuit board in a piece of electrical equipment.

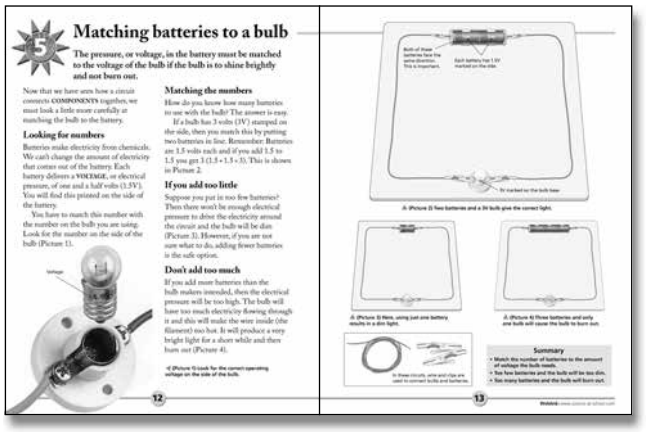
5 Matching batteries to a bulb

This unit uses wires instead of aluminium foil. Explain to pupils that nothing has changed, except that they are using plastic covered wire. It is simply an alternative, and, for class use, it is faster to set up equipment using wires than foil.

Children naturally experiment with bulbs, batteries and wires but are unaware of the ways in which various components have to be matched up if they are to work properly. The key to this is voltage (electrical pressure).

The unit addresses this issue in easy stages, so that those children who tend to be put off by numbers can follow the logic and see how matching the voltages will give them the best results. The scenarios of too little and too much voltage are clearly described.

A complementary activity relates the battery (cell) type to the voltage used and invites the children to calculate the voltages required for different battery-driven toys.



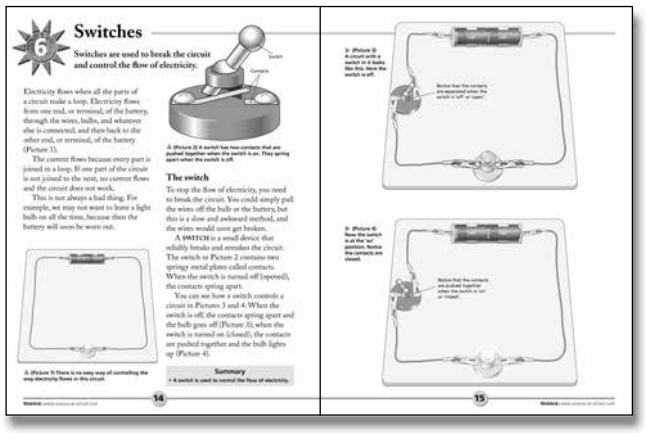
The supporting activity lets the children assess the use of bulbs, motors and buzzers in circuits of different voltages. Notice that this unit, and its associated activity, allow the children to develop skills in calculating how to prolong the lifetime of components and release part of the budget for use in other areas of the science curriculum!

6 Switches

As the children have worked through the three previous units they have built up knowledge and skills relating to making and using circuits. This unit completes the basic components of a circuit by introducing the switch.

As the unit presents the essentials of the switch and its simple application, you may like to begin straight away by going through it with the children. The switch illustrated is a toggle switch and it may help if you have one available for the children to see and perhaps use. Point out to them how the metal contacts are spring-loaded (and made of springy material – relate this to the *3C Properties of materials* unit).

You may like to use the unit to help the children revise what they have learned and let them construct the illustrated circuit and use the switch.



In the supporting activity, the children learn how to use ordinary classroom materials to make a switch. They can also return to the circuit board they made in Unit 4, and design and make a switch for it, too.

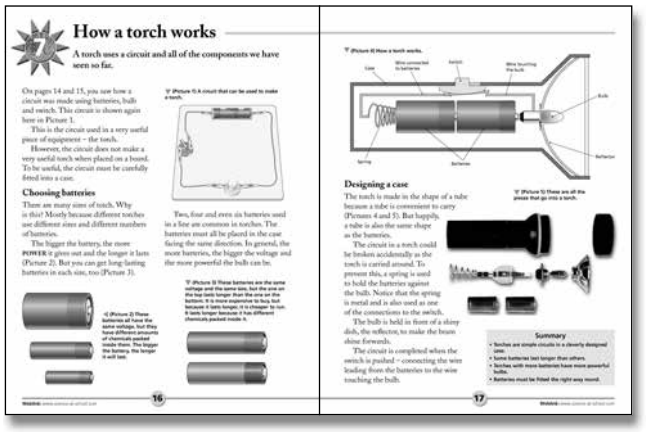
How a torch works

In this unit the children can see how a simple circuit is put to use to solve a practical problem – an example of technology.

Before the lesson, you may ask the children if they have a torch at home and, if so, to bring it to school. You could then begin by displaying the torches and comparing them, then showing the children how they all have the same basic design. You may also like to remind the children that the battery is a portable source of electrical energy, and that there are different kinds of batteries with different levels of power and different combinations of chemicals.

One complementary activity gives ideas for how the children can make their own torches from materials in the classroom.

The supporting activity investigates communicating with light, and challenges the children to devise their own codes and communicate with them.

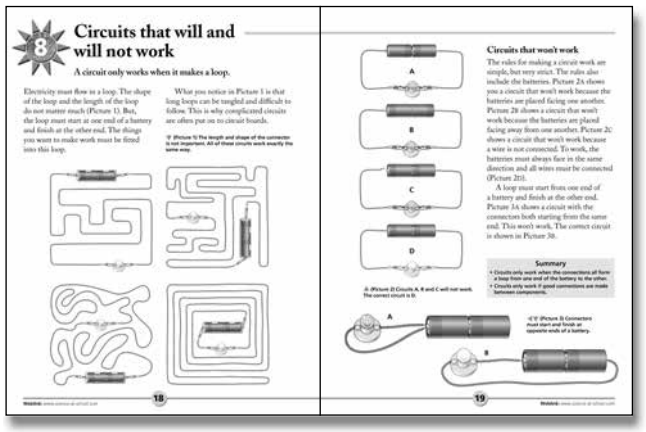


Circuits that will and will not work

Having studied in the previous unit one application for a circuit, this unit helps to further remind children of the rules for making a circuit work. This is particularly relevant at this stage because by now the children's confidence should be growing and they will be more comfortable adding extra components to their circuits.

One common reason for the failure of circuits is due to the arrangement of the batteries, and this unit firmly addresses the problem. It also points out how wires should be connected to a group of batteries, and reminds the children that good connections should be made between all the components in the circuit. The children should use this unit for reference as they build their first circuits with two or more batteries.

The unit also shows that the shape of the circuit does not affect its ability to transport electricity. The complementary work builds on this by suggesting that the children use a 'steady hand' device to see how far they can move a contact along a wavy, loopy wire. In the supporting activity, the children learn to distinguish between series and parallel circuits, if you wish to take this more advanced route.



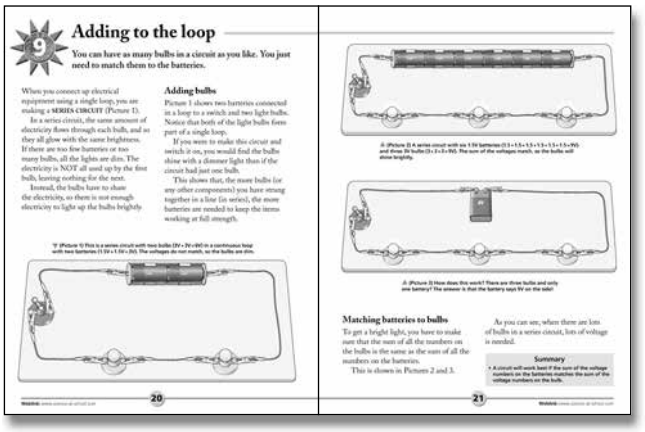
Adding to the loop

This unit moves further, with the idea of matching components by using a number of batteries and bulbs.

You may like to introduce this unit by making a simple circuit with a switch, one bulb and one battery. Leave the circuit switched off. Make a second circuit, but this time add an extra battery and leave it switched off. Make a third circuit and add a second bulb.

Ask the children to predict what will happen when you switch on all three circuits. Ask them for reasons for their predictions, then invite three children to switch on the circuits simultaneously to test their predictions.

The class can now look at the unit, which reminds the children about matching the voltages of bulbs and batteries and defines a series circuit. The unit also explores some possible combinations of batteries and bulbs. You may move from this to the complementary activity, which compares the effect of the number of batteries on motors and buzzers.



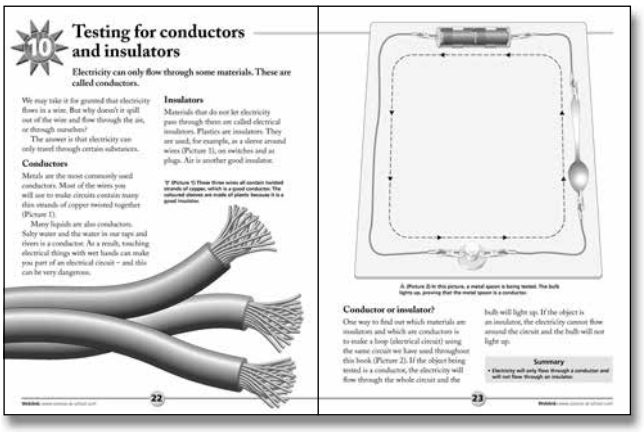
In the supporting activity, the children investigate the relationship between the numbers of batteries and bulbs in a circuit and the amount of electricity that flows through it.

Testing for conductors and insulators

You will remember that the first circuit unit began with the use of kitchen foil rather than a wire, just to make sure the children began by understanding that there were conductors other than wires. In this final unit, you can review what the children have learned, as they progressed through the book and activities, by getting them to use their simple circuit as a continuity tester.

This is an extremely important unit because it has taken children from making a circuit under instruction to using a circuit for some other purpose – and thus lays an important foundation for the whole approach to technology.

The investigation of solids and liquids is important because it can be used as a way of helping pupils understand the danger of touching electrical equipment with wet hands.



When you have considered all aspects of making a simple circuit, you can then move to the supporting activity in which the children plan and carry out an investigation using simple electrical apparatus.

Index

There is an index on page 24.

Using the pupil book and photocopiable worksheets

Introduction

There is a wealth of material to support the topic of electricity in the pupil book and in the *Teacher's Guide*. On this and the following pages, suggestions are made on how to use the worksheets and their associated teacher's sheets, and how to integrate them for lesson planning. On the page opposite you will find the resource lists for introductory demonstrations, the complementary work and the activity worksheets. Learning objectives are provided.

Starting a unit

Each unit in the pupil book forms the basis for a lesson. You may like to start by reading it with the class, or begin with a demonstration Always begin the unit by reading the introductory sentences in bold type. This helps focus the class on the content of the unit and to prepare them for the work.

The first part of the main text introduces the content, which is then developed in the headed sections. The illustrations are closely keyed to the main text, and the captions of the illustrations develop the main text content.

With less skilled readers, you may prefer to keep to the main text and discuss the illustrations when they are mentioned. With more skilled readers, you may want to let them read the captions for themselves. Each unit ends with a summary. The children can use this for revision work. They can also use it to test their understanding by trying to explain the points made in the summary.

The style and content of the unit also make it suitable for use in literacy work, where the needs of both English and science are met. You may wish to use the unit as a topic study in literacy work, or you may want to perform an activity in science time and follow it up with a study of the unit during literacy work.

Using the comprehension worksheets

Each unit in the pupil book has one photocopiable comprehension worksheet in this *Teacher's Guide* to provide a test. The learning objectives are for these comprehension worksheets and relate directly to the knowledge and understanding component of the science curriculum.

The comprehension worksheets begin with simple questions and have harder questions towards the end.

The worksheets may be used singly, after each unit has been studied, or they may be used along with other worksheets to extend the study.

The teacher's sheet, which is opposite the comprehension worksheet, shows the answers and background information to the unit. This teacher's sheet also carries a section on work complementary to the study topic. This work may feature research using other sources. It may also have value in literacy work.

Using the activity worksheets

The activities are designed to develop skills in scientific enquiry. The learning objectives for practical skills associated with each unit are provided. The activities may be small experiments, may focus on data handling or comprise a whole investigation.

Each activity section is a double page spread in this *Teacher's Guide*. On the left hand page is a photocopiable activity worksheet to help the children in practical work, or it may contain data for the children to use or interpret. The page opposite the worksheet is a teacher's sheet providing a step-by-step activity plan to help you organise your work. Each plan has a set of notes which provide hints on teaching or on the use of resources. The activity plan ends with a conclusion, which you may like to read first, to help you focus on the activity in your lesson planning.

Planning to use a unit

The materials in this pack are very flexible and can be used in a variety of ways. First, look at the unit and activity objectives. Next, read the unit in the pupil book, and the associated worksheet and activity units in this *Teacher's Guide*. Finally, plan how you will integrate the material to make one or more lessons. You may wish to add more objectives, or replace some of the activity objectives with some of your own.

Safety

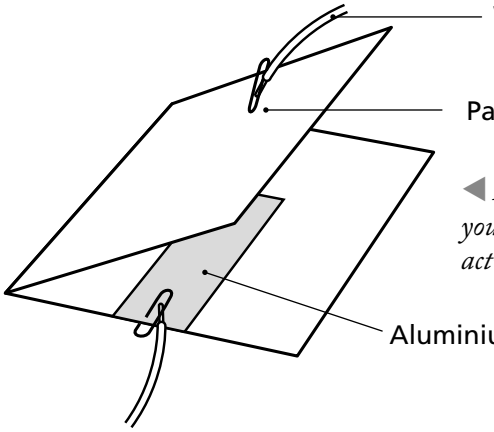
The practical activities feature equipment made from everyday materials or available from

educational suppliers. However, make sure you carry out a risk assessment, following the guidelines of your employer, before you do any of the practical activities in either the pupil's book or the *Teacher's Guide*.

Resources

The three lists below show the resources needed to support the photocopiable worksheets.

- List 1 shows resources for demonstrations suggested for starting a unit.
- List 2 gives resources needed for the complementary work featured on the teacher's sheet associated with each comprehension worksheet.
- List 3 details those resources needed for the 10 activity worksheets.

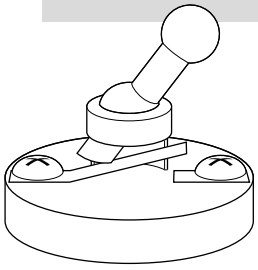


◀ *All you need to make your own switch in the activity in Unit 6.*

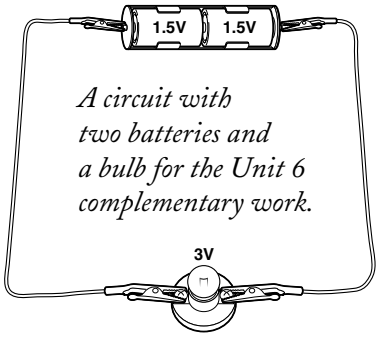
List 1 (Starting a unit with a demonstration)

▼ UNIT

1. –
2. –
3. –
4. –
5. –
6. Toggle switch.
7. Display of children's torches.
8. –
9. Three circuits: 1. one bulb and one battery; 2. one bulb and two batteries; 3. two bulbs and two batteries.
10. –



◀ *A toggle switch for a demonstration in Unit 6.*



A circuit with two batteries and a bulb for the Unit 6 complementary work.

List 2 (Complementary work)

Each group will need the following items:

▼ UNIT

1. Playground, chalk.
2. Secondary sources for how light bulbs are made, energy conservation and global warming.
3. Materials for making model lighthouse or clown's face.
4. Circuit board obtained from an electrician.
5. Cells and batteries, secondary sources to find out what is inside a cell (battery) and for the arrangement of cells in a battery.
6. Range of switches from educational suppliers, circuit with two batteries and a bulb.
7. Materials for making a simple torch, including aluminium foil for the reflector. Secondary sources about how batteries are used by miners and cavers.
8. 'Steady hand' tester, circuit with battery and bulb or buzzer.
9. Three 6V motor circuits with up to four 1.5V batteries, 6V buzzer.
10. Secondary sources about how electricity is carried in overhead power lines and underground cables.

List 3 (Activity worksheets)

Each group will need the following items:

▼ UNIT

1. Objects containing batteries, or pictures of objects containing batteries taken from a mail order catalogue.
2. Pictures of household items that provide heat, taken from a mail order catalogue.
3. Bulb, battery, two short wires, two long wires.
4. Aluminium strip, cardboard base board, paste (non-allergic), battery, bulb, cardboard for cover, scissors, sticky tape.
5. –
6. Card, strips of aluminium foil, two paper clips, three wires, bulb, battery.
7. Battery, two long wires, switch, bulb, photocopy of morse code from page 45 in this book.
8. Battery, two bulbs, four wires, switch.
9. Three batteries, three bulbs, switch, five wires.
10. Two batteries, bulb, three wires, a selection of insulators and conductors.

Learning objectives

Comprehension worksheets

The table below shows the learning objectives for knowledge and understanding associated with each unit in the pupil book, using the comprehension worksheets in this *Teacher's Guide*:

Unit 1

- Electricity can be supplied by batteries or the mains.
- Mains electricity is more powerful than electricity from batteries and can be dangerous.
- Mains electricity comes from power stations.

Unit 2

- In a light bulb, the electricity passes through a filament to make light.
- In a heating device, electricity passes through an element to make heat.

Unit 3

- A simple circuit can be made using a battery, two strips of metal and a bulb.
- Conductors let electricity pass through them and insulators do not.

Unit 4

- Circuits which need to be set up permanently are set up on a circuit board.

Unit 5

- The voltage of a bulb must be matched to the voltage of the batteries for the bulb to work most efficiently.

Unit 6

- Switches are used to open and close the circuit and control the flow of electricity.

Unit 7

- A simple circuit is used to light the bulb in a torch.

Unit 8

- All the batteries in a circuit must face in the same direction.
- A wire must be connected to each end of a battery.
- There must be no gaps between the connections in a circuit.

Unit 9

- In a series circuit, all the components are in a line.
- Adding more bulbs to a series circuit reduces the flow of electricity.
- Adding more batteries to a series circuit increases the flow of electricity.

Unit 10

- Metals, and many liquids, are conductors of electricity.
- Plastic and air are insulators.

Learning objectives

Activity worksheets

The table below shows the learning objectives for practical skills associated with each unit in the pupil book, using the activity worksheets in this *Teacher's Guide*:

Unit 1

- Identify simple patterns in observations.
- Use observations to draw conclusions.

Unit 2

- Use different sources of information to answer a question.
- Use observations to draw conclusions.

Unit 3

- Make a prediction and test it.

Unit 4

- Use simple equipment.

Unit 5

- Make comparisons in observations.
- Use scientific knowledge and understanding to explain the selection of circuits.

Unit 6

- Use simple equipment.
- Make predictions and test them.

Unit 7

- Use simple equipment.
- Use observations to draw conclusions.

Unit 8

- Compare observations.
- Make a prediction and test it.

Unit 9

- Identify simple patterns in the results of an investigation.

Unit 10

- Plan the arrangement of a circuit for a test.
- Make predictions and test them.
- Use observations to draw conclusions.

Name: ..... **Form:** .....

See **pages 4 and 5** of *Simple electricity*

Homes and schools work on electricity

Almost everything that works in a home or school runs on batteries or uses mains electricity.

Q1. Look at the diagram. Name two things in the bedroom that run on electricity.

1 ✎..... 2 ✎.....

Q2. Looking in other rooms in the house, name four electrical things which give out heat.

1 ✎..... 2 ✎.....

3 ✎..... 4 ✎.....

Q3. Name two electrical things in the house which make things cool.

1 ✎..... 2 ✎.....

Q4. Name any three things which need batteries to make them work.

1 ✎..... 2 ✎..... 3 ✎.....

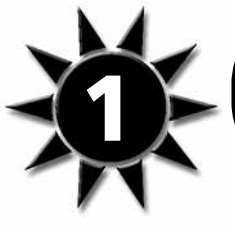
Q5. Where does the electricity in the mains come from?

✎.....

Q6. Describe how mains electricity gets to your home.

✎.....

✎.....



Teacher's sheet: comprehension

See **pages 4 and 5** of *Simple electricity*

Answers

1. **Ceiling light, television.**
2. **Toaster, cooker, kettle, iron, electric fire.**
3. **Fridge, freezer, fan.**
4. **Mobile phone, torch, pocket radio, portable CD player, TV remote control, smoke alarm, door bell.**
5. **Power station.**
6. **It is carried through cables suspended from large towers (pylons) across the countryside, then in cables buried underground in towns and cities.**

Complementary work

(a) If you wish to describe the flow of electrons in a circuit you could mark out a rectangle (battery) in the playground, in which three children could stand in a line; and a narrow path, taking the form of a square, starting at one end of the battery and ending at the other end. The circuit on page 13 of the pupil book shows the plan. Other members of the class could now take their positions on the path, so that you have a loop of children. Say that you are switching on the electricity and ask the children in the 'battery' to move forwards and the other children to shuffle round the path. As the children leave the 'battery' other children should enter from the opposite side. The children are behaving as electrons in a current of electricity.

Teaching notes

The children will have done work on electricity in the infant department and this unit can be used as a revision of looking at electrical appliances. Some children may wonder about the nature of electricity, and you may wish to provide them with some information. In their work on materials, they may have come across the concept of using particles to explain the properties of matter and the differences between solids, liquids and gases. They may know from their general reading about something very small called an atom. If this is the case, then they may be able to accept the idea of even smaller particles in atoms called electrons.

An electric current is a flow of electrons. The mover of the electrons is either a battery or a generator at a power station. These movers simply push the electrons through the material. In a later unit, voltage is used as the term for this push, or pressure, on the electrons. The rate at which electrons flow through a wire is measured in units called amperes or amps. When the current is one amp, six million, million, million electrons are flowing past any given point in the wire.

Name: ..... **Form:** .....

Based on **pages 4 and 5** of *Simple electricity*

Battery power

Try this...

1. Look at some batteries and draw each one in the space below.

2. Look at a selection of objects that use batteries for power. Write the name of each object in the left hand column of the table below.

3. Think about what the batteries are used for in each object and put a tick in the appropriate column or columns.

	Use of power		
Object	light	movement	sound

Looking at the results.

4. What is the power in batteries most often used for?

✎.....

Teacher's sheet: activity

Based on **pages 4 and 5** of *Simple electricity*

Introducing the activity

(a) Ask the children to look at some batteries and describe them (see note (i)).

(b) Ask them to describe how batteries are held in place in the objects which use them (see note (ii)).

(c) Ask the children for examples of objects which have batteries (see note (iii)).

Using the sheet

(d) Give out the sheet, let the children fill in their names and form then go through tasks 1 to 3 (see note (iv)).

(e) Let the children complete tasks 1 to 3.

(f) Check their drawing (see note (v)) and table, then let them complete task 4.

Completing the activity

(g) Let the children compare their answers. They will see that the results depend on the selection of items observed. For example, a selection containing a large number of torches will show light as the main use of power (see note (vi)).

Conclusion

Batteries are used as a portable source of power to provide light, movement and sound.

Teaching notes

(i) The children may describe the shape, the terminal cap at one end and then say what is written on the battery. Encourage them to look for the plus and minus signs as appropriate for the battery type. The number with the letter V can be noted but left until the activity in Unit 5.

(ii) They should describe a plastic holder which has springs and carries the plus and minus signs. You may say that the signs help to distinguish the ends of the battery and the signs on the holder show where the ends of the batteries should be placed.

(iii) This should not be exhaustive, but should prepare the children for the activity.

(iv) Encourage the children to write down any symbols or words on the batteries. You may like to refer to these to support later work. Depending on the ability and attitude of the class, you may like to let them look at real objects containing batteries. These could be a selection of toys, a portable radio, CD player or cassette player. Alternatively, you could give them pictures of the items that you have cut out of an old mail order catalogue.

(v) The ends of the batteries with the plus signs should be in the places marked with a plus on the holder. The ends with the minus signs should be in the places marked with a minus sign on the holder. You may wish to tell the children that batteries need to be arranged in a certain way for the current to flow, and the signs help people with the arrangement.

(vi) A remote control for the television uses infra-red which can be classified as light. Remote controls for cars and aeroplanes use radio waves to control movement.

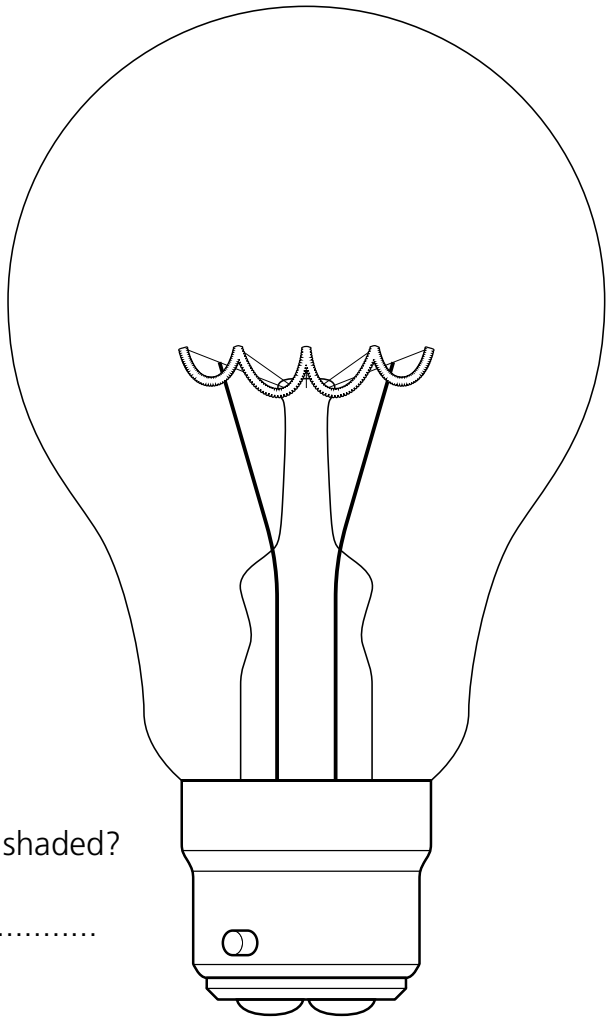
2

Name: ..... Form: .....

See **pages 6 and 7** of *Simple electricity*

Lighting and heating

We use mains power for things that need lots of electricity and which don't have to be moved about too much.



Q1. Shade in the part of the bulb that gives out light when electricity passes through it.

Q2. What is the name of the part you have shaded?

✎.....

Q3. What is the part made of?

✎.....

Q4. There are two kinds of fittings a light bulb can have. What kind of fitting does this light bulb have?

✎.....

Q5. In an iron, what is the wire called that gets hot when electricity flows through it?

✎.....

Q6. How do you stop electricity flowing through a lamp or heater?

✎.....

Teacher's sheet: comprehension

See **pages 6 and 7** of *Simple electricity*

Answers

1. **The filament should be shaded.**
2. **Filament.**
3. **A strip of very thin (coiled) wire which does not melt when it gets hot.**
4. **Bayonet.**
5. **Element.**
6. **Switch it off (or pull out the plug).**

Complementary work

(a) Use secondary sources to find out how light bulbs are made.

(b) Perform an investigation, using secondary sources, to find out why turning off lights that are not being used may save coal and oil supplies and help stop global warming.

Teaching notes

If you have introduced the children to the idea of electrons, you may like to tell them that some materials let electrons flow easily through them and other materials make it hard for electrons to flow. In these latter materials, the electrons give out energy as heat and light as they move. We have harnessed these materials for use in light bulbs and heating elements.

In the filament, the wire is coiled, then coiled again, to make a very long length fit in a short space, so that a large amount of light can be given out. Whenever energy changes from one form to another some of it is lost as heat. This explains why, although the lamp is designed to give out light, it must also give out heat. Strip lights work by a flow of electrons passing through a gas inside the tube. Some of the electrons hit mercury atoms which give out ultraviolet light. This hits the special fluorescent coating on the inside of the tube, which then lights up. This energy change produces less heat than filament lamps. If a metal filament was to heat up in air, it would soon burn out, so it is enclosed in a bulb with a gas that does not let it burn. This gas is called argon. It is normally present in the air in only tiny amounts.

Heating elements are made of thicker wire, to let a large amount of electricity flow through them. As the huge number of electrons flow, they produce a large amount of heat energy and some light energy, which may be seen as a glow in a toaster. In a kettle the element is enclosed in a watertight tube for safety.

2

Name: ..... **Form:** .....

Based on **pages 6 and 7** of *Simple electricity*

Heaters in the home

Try this...

1. Look at the pictures of items in the home that provide heat. Sort them by the rooms where they are normally found.

2. Set out the items in the table below in this order – items found in the kitchen, living room, bedroom, bathroom, airing cupboard.

Item	Use

3. For each item write down its purpose.

4. Find out when the different heaters in your home are used by trying this survey: On a separate piece of paper, divide up the day into morning, daytime, evening and night. Note down when each item was used.

5. Look at your record for the day and work out when the most electricity was used for heating and when the least electricity was used for heating. Write down your findings here.

✎.....

✎.....

6. How could this information be useful to people who run a power station?

✎.....

✎.....

Teacher's sheet: activity

Based on **pages 6 and 7** of *Simple electricity*

Introducing the activity

(a) You may begin by asking the children which items they used at home this morning to provide heat. The children may mention kettles, toasters and showers. Ask the children how they could have had a wash and cooked their breakfasts this morning without electricity (see note (i)).

(b) You could then say that we use electricity to provide heat for a wide range of purposes without really thinking about it; and in this activity we are going to take some time to look at heaters in the home and when we use them.

Using the sheet

(c) Give out the sheet, let the children fill in their names and form then go through tasks 1 and 2 (see note (ii)).

(d) Let the children complete tasks 1 and 2 then check their work.

(e) Let the children try task 3.

(f) Go through task 4 and set as homework (see note (iii)).

(g) Let the children try tasks 5 and 6 in class.

Completing the activity

(h) The children may identify times of day when all households use large amounts of electricity, such as in the morning or evening (see note (iv)).

Conclusion

Electricity is a clean and convenient way of providing heat for a wide range of purposes in the home.

Teaching notes

(i) We often take electricity for granted, and this question will help the children realise what a clean and convenient source of energy it is compared to coal or wood.

(ii) For each group, you will need pictures cut from old mail order catalogues which show items such as kettles, toasters, sandwich makers, deep fat fryers, slow cookers, electric cookers, showers, electric blankets, electric fires, washing machines and tumble driers. You will also need a picture of an immersion heater.

(iii) You may wish to tell the children that they are not to use any items that they do not normally use, but can note down when other items are used by other members of the family, such as the washing machine or iron.

(iv) Depending on your class, this may need some care and sensitivity, such as considering people on shift work or who are unemployed. As an alternative, you may like to say that the electricity boards do recognise certain times of day when they need to provide large amounts of electricity.

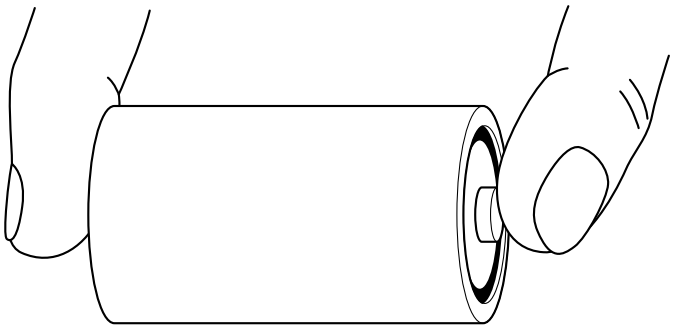
3

Name: ..... **Form:** .....

See **pages 8 and 9** of *Simple electricity*

Making a bulb light

To make a bulb light, you simply need to join the end of the bulb to each end of a battery.



Q1. (i) Draw on this diagram the things you would use to make the bulb light.
(ii) Label the things you have drawn.

Q2. What is the name for materials that let electricity pass through them?

✎.....

Q3. Give an example of a material that lets electricity pass through it.

✎.....

Q4. What is the name for materials that do not let electricity pass through them?

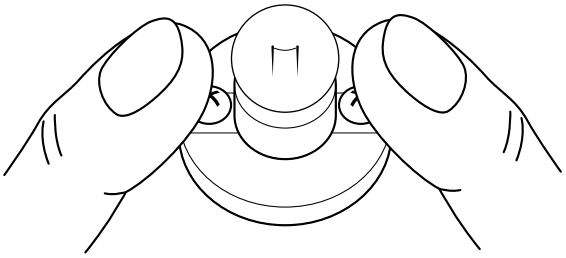
✎.....

Q5. Give an example of a material that does not let electricity pass through it.

✎.....

Q6. What is the name for the loop that lets electricity flow through it?

✎.....



Teacher's sheet: comprehension

See **pages 8 and 9** of *Simple electricity*

Answers

1. **(i) Two strips of aluminium foil or two wires. (ii) Strip of aluminium foil or wire.**
2. **Conductors.**
3. **Metal, copper, aluminium and graphite (the lead in pencils).**
4. **Insulators.**
5. **Plastic, glass (and most other non-metallic substances except graphite (the lead in pencils).**
6. **A circuit.**

Complementary work

(a) You may want to make a model to demonstrate the circuit. A lighthouse is traditionally made, but a clown's face with a light-up nose is one alternative. This model can also be used later, when a circuit with a switch is discussed.

Teaching notes

All materials are made of atoms. Each atom contains a nucleus and electrons. The movement of electrons produces an electric current.

In most materials, the electrons in the atoms are held firmly in place. They do not let a current of electricity pass through them – these are insulators. In metals, some of the electrons leave the atoms and are free to move around inside the material. When a battery or the mains put pressure on them, they flow and form an electric current.

The circuit shown here is very simple. The purpose of the bulb is to show that electricity is passing through it. An even simpler circuit could be made with just one wire connecting the ends of the battery, but this should not be done as it releases the electricity too quickly and can make the wire very hot.

The main points here are to make sure that the children know that one wire should touch the base of the battery, and the other touch the cap, and that there are no gaps in the circuit. They should always remember these points when they are making any circuits in the future.

3

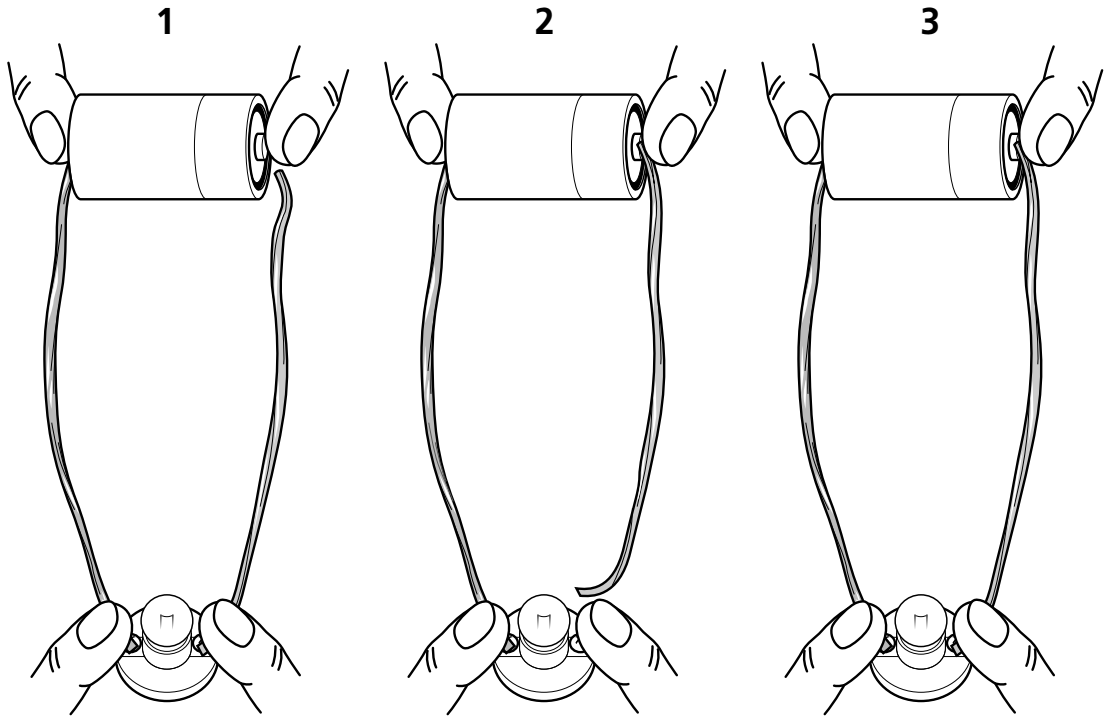
Name: ..... **Form:** .....

Based on **pages 8 and 9** of *Simple electricity*

Will it light?

Try this...

1. Look at these four circuits using bulbs, batteries and wires.



2. In the table below put a tick in the prediction column if you think the bulb will light and cross if you think that it will not.

Circuit	Prediction	Test result
1		
2		
3		

3. Test each circuit, and fill in the last column of the table. Put a tick if the bulb lit and a cross if it did not.

Looking at the results.

4. How good were your predictions?

✎.....

Teacher's sheet: activity

Based on **pages 8 and 9** of *Simple electricity*

Introducing the activity

(a) Begin by saying it is always exciting using batteries, bulbs and wires, and so it is natural to experiment with the equipment to make it work without really thinking about what is happening.

In this activity, pupils will experiment with different circuits in order to test which ones will work to make the bulb light.

Using the sheet

(b) Give out the sheet, let the children fill in their names and form then go through tasks 1 and 2.

(c) Let the children try tasks 1 and 2.

(d) Let the children collect their equipment and try task 3 (see note (i)).

(e) When the children have put away the equipment tidily let them try task 4 (see note (ii)).

Completing the activity

(f) Let the children compare their results.

Conclusion

Electricity will flow through circuits where there are no gaps between the components. Pupils will find that configuration 3 works.

Teaching notes

(i) Each group will need a battery, a bulb and two wires.

(ii) Electrical equipment soon gets mixed up after practical work. You may want to challenge the children to devise an orderly way of storing the equipment so that they may spend more time on the practical work and less on sorting out the equipment.

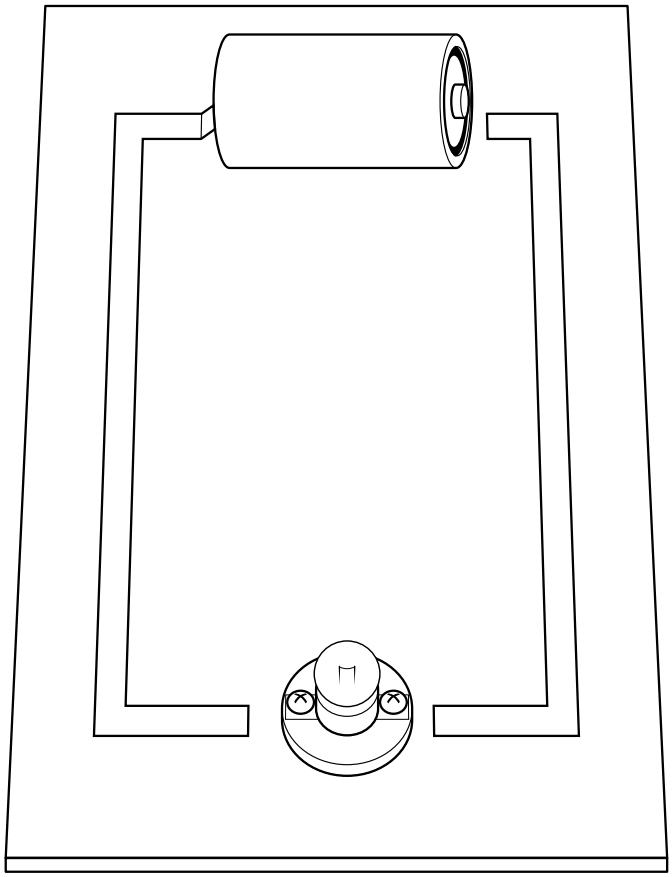
4

Name: ..... **Form:** .....

See **pages 10 and 11** of *Simple electricity*

Using a circuit board

You cannot hold on to all the parts of a circuit all the time. But there is an easy way to keep everything in place.



Q1. The diagram shows a circuit board with only one metal tab in place. Draw in the positions of the missing metal tabs.

Q2. What metal is used to make the strips in the circuit?

✎.....

Q3. What metal is used in wires?

✎.....

Q4. How are the metal strips connected to the board?

✎.....

Q5. Name something which has a circuit board.

✎.....

Q6. Why are circuit boards used?

✎.....

✎.....

4 Teacher's sheet: comprehension

See **pages 10 and 11** of *Simple electricity*

Answers

1. **There should be one at the top right connecting the metal strip to the central terminal of the battery. There should be one on either side of the bulb connecting the metal strips to the connectors.**
2. **Aluminium.**
3. **Copper.**
4. **With wallpaper paste or glue.**
5. **Radio, computer, Game Boy, Nintendo, etc.**
6. **Because they make the connectors into a tidy pattern so electricians can see what is going on.**

Complementary work

(a) You may like to show a circuit board that you have obtained from an electrician, just to show the sheer complexity of the links between the components. (Do not remove a circuit board from any equipment yourself or encourage the children to look for circuit boards in equipment – for safety reasons.)

Teaching notes

The children will probably have made simple circuits as infants. In these circuits, they may have used bulbs and buzzers. They should be reminded that the parts of a circuit are called components, and bulbs and buzzers are examples of components.

There are many different kinds of components. Some limit how much electricity can go round one part of a circuit, others control the flow, while yet others store and release electricity at certain times. The components work together to allow a piece of equipment to perform a task. If you made a model earlier, you may like to remind the children that the bulb allowed the model to do a task, and the only components that were needed for that were two wires, a light and a battery. Most items need more components. Children may be familiar with the cycle of a washing machine, where the electricity controls heating, washing and spinning in an orderly sequence.

If you let the children make a circuit board as shown on the spread, make sure that you use non-allergic wallpaper paste or glue.

4

Name: ..... **Form:** .....

Based on **pages 10 and 11** of *Simple electricity*

My circuit board

Try this...

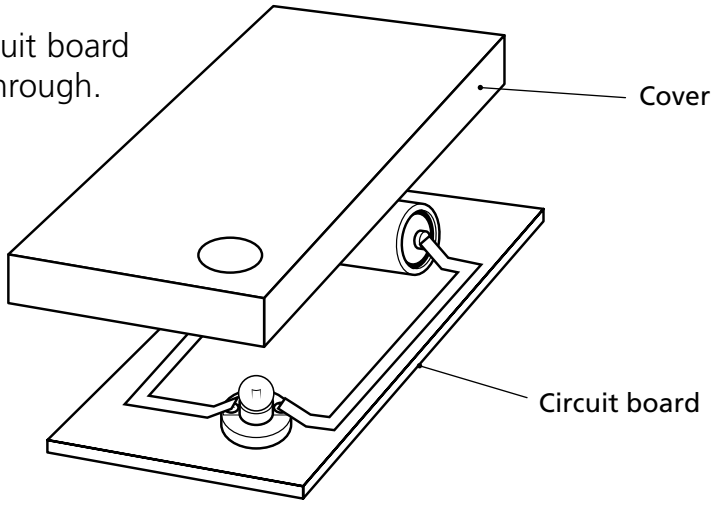
1. Draw an arrangement of aluminium strips that you would like to make into a circuit board.

2. Mark where you would put the battery and the bulb.

3. Make your circuit board.

4. Test your circuit with the battery and the bulb.

5. Make a cardboard cover for your circuit board with a hole in it so the bulb can shine through.



6. When you have finished, disconnect the battery. Keep your circuit board. You will add a switch to it later.

Teacher's sheet: activity

Based on **pages 10 and 11** of *Simple electricity*

Introducing the activity

(a) Begin by saying that a circuit board forms a permanent circuit and in this activity they are making a circuit they can keep, and also testing the idea that the electricity will move around any shape of circuit.

Using the sheet

(b) Give out the sheet, let the children fill in their names and form then go through tasks 1 and 2.

(c) Let the children try tasks 1 and 2 then check their work for gaps in the circuit (see note (i)).

(d) Let the children try tasks 3 and 4.

(e) Go through task 5 with the children, then let them make the cover (see note (ii)).

Completing the activity

(f) The children may display their work to others (see note (iii)).

Conclusion

Electricity will flow through differently shaped circuits.

Teaching notes

(i) Go through this with the children so that they can see that it is important to examine plans before building circuitry. It also helps them to see why they must not leave gaps in the circuit.

(ii) Circuit boards are hidden from view under the casing of the electrical equipment and this activity helps the children realise this.

(iii) When working on switches in the next unit, the children may like to try to devise a switch that can be incorporated into their circuit. This may involve some cutting and pasting of the aluminium and cutting another hole in the cover. The exercise should help them realise how the shape of the cover of a circuit sometimes relates to the components underneath.

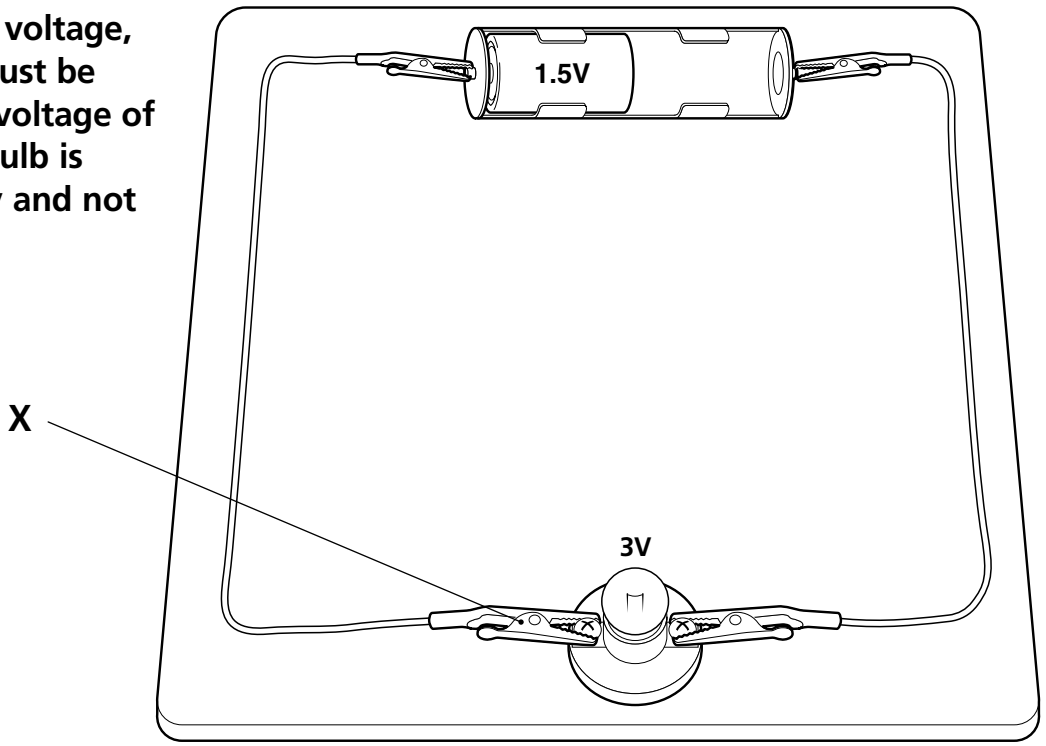
5

Name: ..... **Form:** .....

See **pages 12 and 13** of *Simple electricity*

Matching batteries to a bulb

The pressure, or voltage, in the battery must be matched to the voltage of the bulb if the bulb is to shine brightly and not burn out.



Q1. What does the V on the side of the battery stand for?

✎.....

Q2. Draw in the missing battery.

Q3. What is the item labelled X?

✎.....

Q4. How will the brightness of the bulb change if you use one battery instead of two?

✎.....

Q5. What will happen if you use three 1.5V batteries in the circuit?

✎.....

Q6. Why will this take place?

✎.....

✎.....

Teacher's sheet: comprehension

See **pages 12 and 13** of *Simple electricity*

Answers

1. **Voltage.**
2. **The battery faces the same direction as the one in the diagram and has 1.5V on its side.**
3. **Crocodile clip.**
4. **It will get dimmer.**
5. **The light will be very bright for a short time then go out.**
6. **Because the wire in the filament gets too hot, melts and breaks the circuit.**

Complementary work

(a) The children could look at a selection of cells and batteries and could use secondary sources to find out what is inside a cell and how cells are arranged in a battery.

(b) The children could look in the toy section of a mail order catalogue and see what voltage is required for each toy. For example, '2 AA batteries' produce a voltage of 1.5 x 2 = 3 volts.

Teaching notes

The movement of electrons in a circuit is produced by a chemical reaction inside the battery. The push on the electrons, by the battery, is called the voltage and is measured in volts. It is important that the components in the circuit can cope with the voltage provided by the battery. Each component has a voltage marked on it. This shows the maximum voltage that can be used in the circuit to avoid damage to the component.

If you have been using the term battery, and are thinking of trying to introduce the term cell, then this unit provides an opportunity. In the word list, battery is defined, but a cell is also mentioned and defined as a single battery. Each single cylinder of chemicals for providing electricity is known as a cell. The word battery should really be reserved for a group of cells. So, two or three cells joined together form a battery, or a battery of cells. The best use of the term battery is in the devices where two or more cells are joined together in a box with terminals on the top. If you wish to make the distinction to the children, show them a single cell and a box type battery.

The children may be familiar with looking for different battery types for their toys. For example, types LR03 (AAA), LR6 (AA), LR14 (C) and LR20 (D) are all 1.5 volts. PP3 and PP9 are both 9 volts. The type depends on what chemicals are used in the battery. The distinction between type and voltage should be made clear.

5

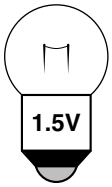
Name: ..... **Form:** .....

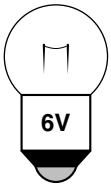
Based on **pages 12 and 13** of *Simple electricity*

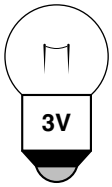
Don’t let them burn out

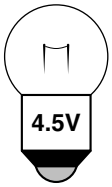
Try this…

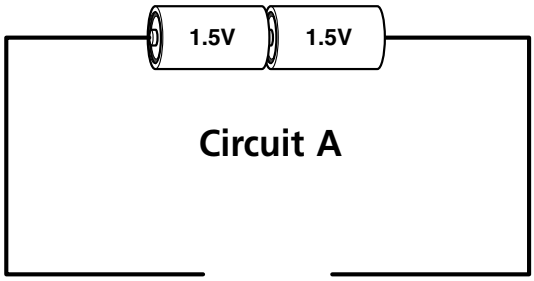
1. Look at the 4 bulbs below. Each bulb shows a different voltage. Draw the correct bulb in the circuits A to D so that each bulb will shine brightly.

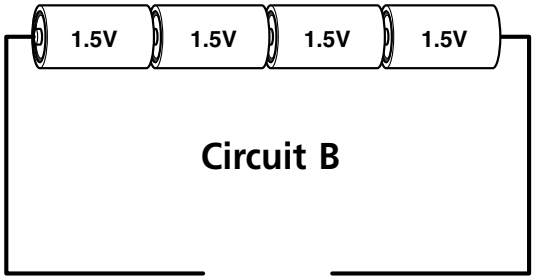


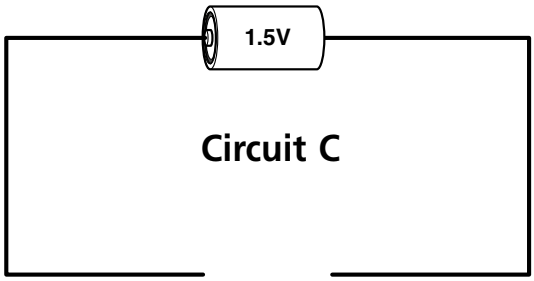


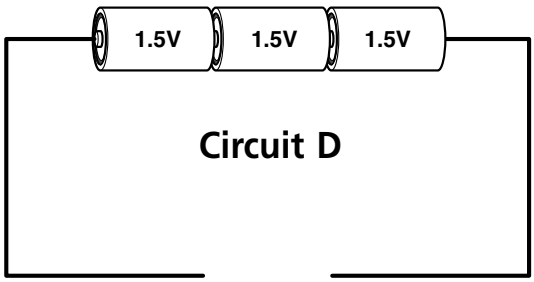












2. Which circuits would NOT match a 3 volt motor?

✎.....

3. Why won’t the circuits B, C and D work with the 3V motor?

✎.....

4. Which circuits would match a 6 volt buzzer?

✎.....

5. Why should the others not be used with a 6V buzzer?

✎.....

✎.....

6. In which circuit would the buzzer be the loudest?

✎.....

7. A large battery has a voltage of 9 volts.

(a) How many type **3** bulbs may shine brightly with it? ✎.....

(b) How many type **1** bulbs may shine brightly with it? ✎.....

Teacher's sheet: activity

Based on **pages 12 and 13** of *Simple electricity*

Introducing the activity

(a) The children need to know that it is extremely important to match the components to the voltage of the batteries in the circuit. If the voltage is too high for the component, it will be damaged and burn out. This spoils investigation work, is costly to the school and is a waste of materials.

(b) You may want to tell the children that this activity is designed to find out who can safely match the components and avoid them burning out.

Using the sheet

(c) Give out the sheet and let the children fill in their names and form. Go through all the tasks briefly, but make sure the children know what they have to do.

(d) Let the children complete their tasks. Give help where needed.

Completing the lesson

(e) Go through the answers with the children and see who would cause the fewest components to burn out (see note (i)).

(f) With those who struggled with the numbers, show them again how to do the work (see note (ii)).

Conclusion

The voltages of the battery in the circuit must match the voltages of other components in the circuit if they are to work efficiently.

Teaching notes

(i) Answers to questions on the worksheet:

1. Circuit A = Bulb 3, Circuit B = Bulb 2, Circuit C = Bulb 1, Circuit D = Bulb 4.
2. Circuits B, C and D.
3. The voltage of the batteries is too high or too low.
4. Circuit B.
5. Three are below 6V and only one is 6V.
6. Circuit B.
7. (a) 3 (b) 6.

(ii) The voltages of the batteries, bulbs and other components are those most frequently supplied to schools, so the children will not have to work with other numbers. This may make it easier for them to remember the relationships between the batteries and other components.

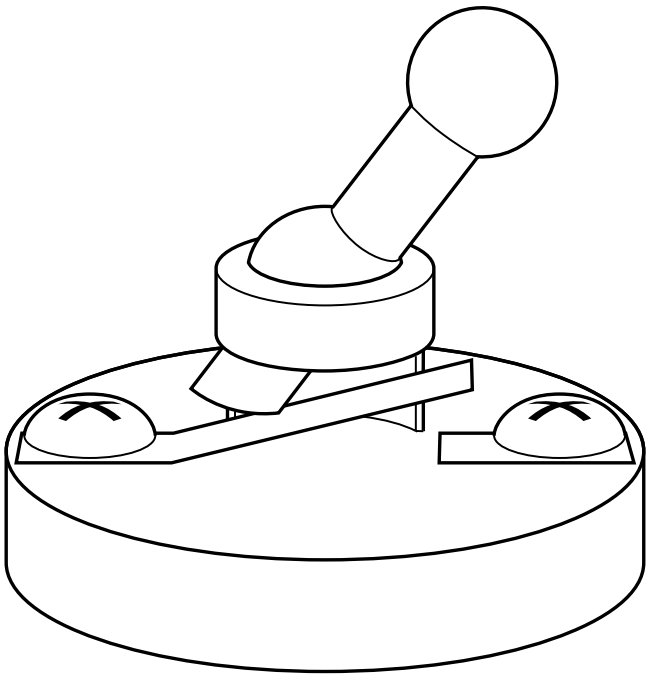
6

Name: ..... **Form:** .....

See **pages 14 and 15** of *Simple electricity*

Switches

Switches are used to break the circuit and control the flow of electricity.



Q1. Is the switch on or off?

✎.....

Q2. Explain your answer to question 1.

✎.....

✎.....

Q3. Will the switch be on or off when the handle is turned the other way?

✎.....

Q4. Explain your answer to question 3.

✎.....

✎.....

Q5. What are the spring metal plates in a switch called?

✎.....

Q6. What are the ends of a battery called?

✎.....

6 Teacher's sheet: comprehension

See **pages 14 and 15** of *Simple electricity*

Answers

1. **Off.**
2. **The pieces of metal are not touching, so electricity cannot pass between them.**
3. **On.**
4. **The pieces of metal will touch, so electricity can flow between them.**
5. **The contacts.**
6. **The terminals.**

Complementary work

(a) Let the children make the circuit shown on page 15 and try a range of switches.

(b) Let the children use secondary sources to find out how a wall light switch works. They must not take apart real switches.

Teaching notes

So far in this course the children have only considered wires and components. They may already have found that if they have been using sticky tape to hold the wire to the battery terminals, after opening and closing the circuit a few times the tape will not stick as well (an open circuit is a broken circuit, a closed circuit is one in which the electricity can flow). Also, if they have been using bulb terminals where the wire has to be screwed in – attaching and unattaching the wire a few times will lead to some of the metal threads breaking.

It is important to present the switch as a way of controlling the flow of electricity without damaging the wires or components. After working without a switch while they learned the basics of the circuit, the children should appreciate its use and the ease with which electricity is turned on and off. There are several types of switch – the push switch, toggle switch and rocker switch are available from suppliers, and the children should be able to try all three at different times in their circuits.

The children should realise that the part of the switch that is handled is made from an insulator.

6

Name: ..... **Form:** .....

Based on **pages 14 and 15** of *Simple electricity*

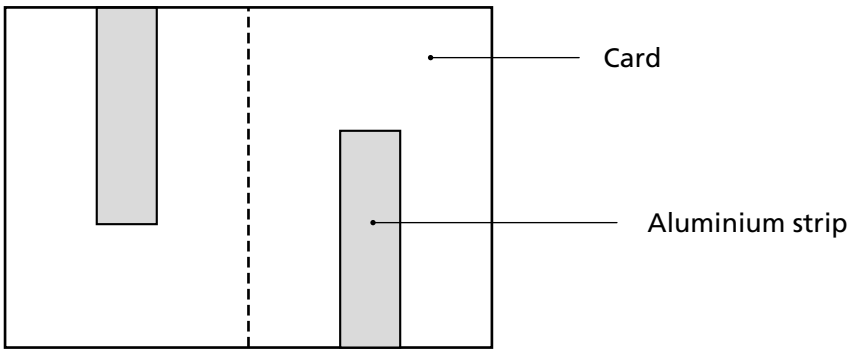
Make your own switch

Try this…

1. Take a piece of card, fold it in half and open it out again.

2. Cut out two strips of aluminium foil and paste them in place as Diagram 1 shows.

Diagram 1

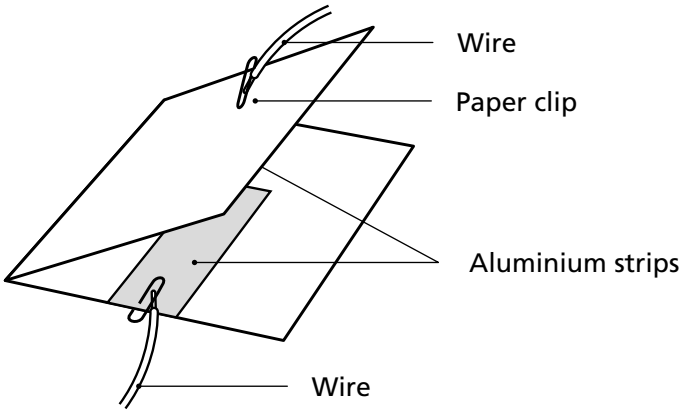


3. Fold the card again to make sure the strips overlap and touch when the card is shut.

4. Connect the ends of two pieces of wire to two paper clips.

5. Fasten the paper clips to each aluminium strip as Diagram 2 shows.

Diagram 2



You have now made a switch.

6. Test your switch in a circuit with a bulb and a battery.

7. This switch is called a pressure pad switch. It could be put under a piece of carpet and used as part of a burglar alarm. A light, or buzzer, could be set up to go off when the carpet is trodden on.

6 Teacher's sheet: activity

Based on **pages 14 and 15** of *Simple electricity*

Introducing the activity

(a) Remind the children of the essential parts of a switch – the two metal pieces which can be brought together or moved apart.

(b) Tell the children that they are going to make a switch of their own from materials in the classroom, and test it, and that there are instructions for building the first one to help them begin.

Using the sheet

(c) Give out the sheet, let the children fill in their names and form then go through tasks 1 to 3.

(d) Let the children try tasks 1 to 3.

(e) Go through tasks 4 and 5.

(f) Let the children try tasks 4 and 5.

(g) Let the children test their switch in a circuit and try to make it work under a piece of lightweight carpet. The children may find that they need to put some elastic material inside the card to separate the contacts when the carpet is put on top.

Completing the activity

(h) Let the children demonstrate their switches.

(i) Challenge the children to make switches of their own design (see teaching note).

Conclusion

A switch can be made from a range of materials, provided that it has two metal contacts which can be moved apart by an insulating material.

Teaching notes

(i) The children could look at the circuit board they made in Unit 4 and see if they could work out a design for a switch and make it work.

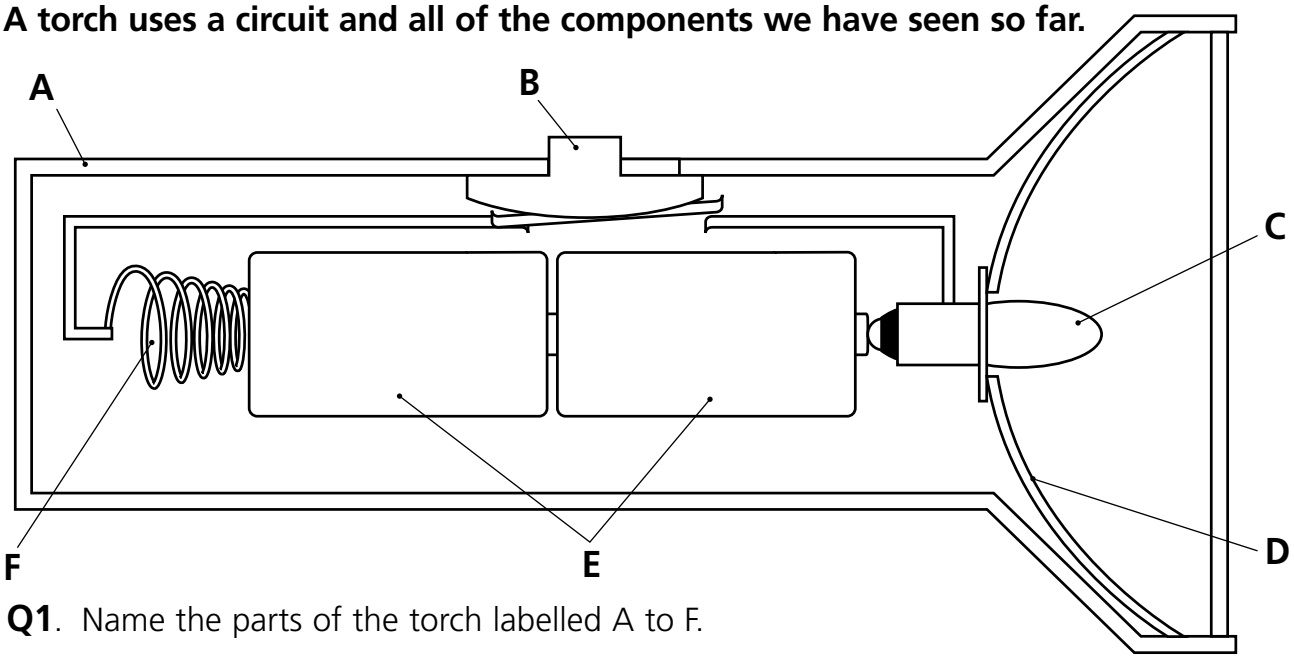
7

Name: ..... **Form:** .....

See **pages 16 and 17** of *Simple electricity*

How a torch works

A torch uses a circuit and all of the components we have seen so far.



Q1. Name the parts of the torch labelled A to F.

A ✎..... B ✎..... C ✎.....

.

D ✎..... E ✎..... F ✎.....

Q2. Which part makes the torch easy to carry?

✎.....

Q3. Which part controls the flow of electricity?

✎.....

Q4. Which part provides the electricity?

✎.....

Q5. Which part makes the light?

✎.....

Q6. Name two things that part F does.

1 ✎.....

.

2 ✎.....

.

7 Teacher's sheet: comprehension

See **pages 16 and 17** of *Simple electricity*

Answers

1. **A = case, B = switch, C = bulb, D = reflector, E = batteries, F = spring.**
2. **A or case.**
3. **B or switch.**
4. **E or batteries.**
5. **C or bulb.**
6. **It lets electricity pass through it. It keeps the batteries close together.**

Complementary work

(a) The children may be able to design and make a torch with the circuit in a box with the bulb sticking out of it, surrounded by a reflector made of aluminium foil. They may also be able to design a switch which works on the outside of the box.

Note: A different torch design – the children may also be able to design and make a torch with the batteries stacked on top of each other and the bulb on top. The batteries could then be covered in card or thick paper to make a case. The reflector could be a sheet of foil, placed between the top battery and the bulb.

(b) The children could use secondary sources to find out about the torches and batteries used by miners and cavers.

Teaching notes

A battery is a portable store of electrical energy. It contains chemicals that react when the battery is in a closed circuit. As a result of the chemical reaction, electrons are pushed around the circuit. The movement energy of the electrons can be changed into other forms of energy, such as light energy in a torch.

There are different types of batteries, and each type has a particular combination of chemicals. When the chemicals have been used up in the reaction, the battery becomes useless.

The torch is a good example of a simple piece of electrical equipment because children usually have had one or used one. It is a simple circuit which can be quite easily worked out, and it shows how a circuit can be adapted to a practical use – an example of technology. When discussing this with the children, it is important to say that often there are ingenious ways of adapting a circuit for a need. In the torch, the use of the spring to hold the two batteries together, so they do not break contact, is coupled with the need for a conductor to carry electricity between the rest of the circuit and the end of one of the batteries. This means that the spring does the job of the wire and the battery holder. If children look in battery holders in toys they may see springs doing this same task.

7

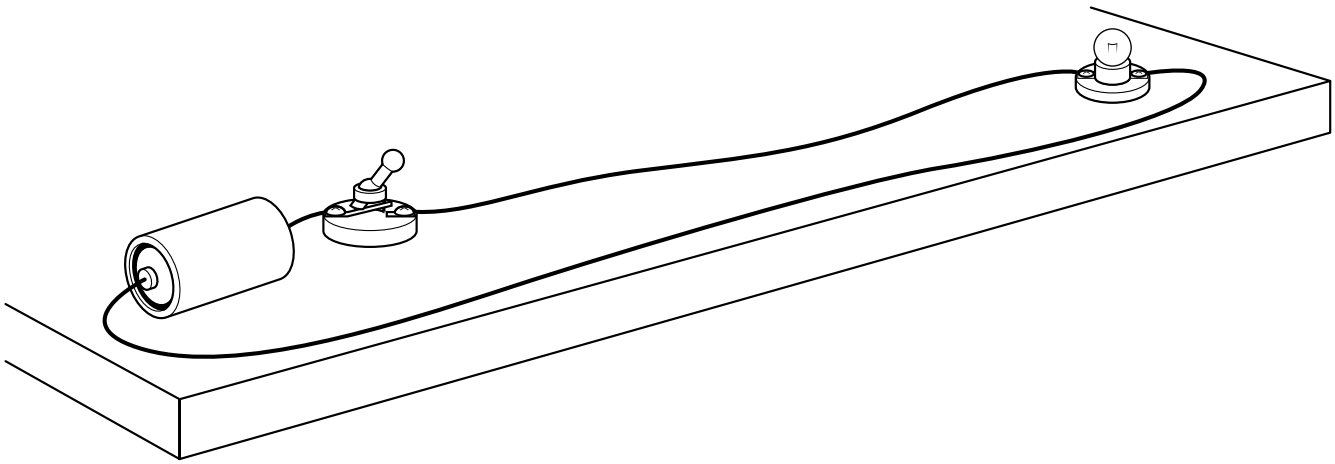
Name: ..... **Form:** .....

Based on **pages 16 and 17** of *Simple electricity*

Sending messages

Try this…

1. Set up a circuit like the one shown. Check that the switch can be turned on and off quickly.



2. Work out a code of flashes between you and your partner. For example, two short flashes may be, "Can I borrow your pencil, please?" Do this for five or six different messages.

3. Each of you write down your code so that both you and your partner have a copy.

4. Work the switch and send a coded message to your partner. Your partner ticks the message on the sheet.

5. Ask your partner to read out the message and compare it with the one you sent.

6. Set up a second circuit for your partner so that you can send coded messages to and fro.

7. Use a buzzer instead of a bulb and decide which you think is better to use for sending messages.

Teacher's sheet: activity

Based on **pages 16 and 17** of *Simple electricity*

Introducing the activity

(a) Ask the children if they have ever seen light used to send messages (see note (i)).

(b) Tell the children that they are going to send messages by flashing light. Write three messages on the board with a simple code (one, two or three flashes) and flash a torch at them to illustrate the idea.

Using the sheet

(c) Give out the sheet, let the children fill in their names and form, then go through task 1 (see note (ii)).

(d) Let the children try task 1.

(e) Go through tasks 2 to 5, then let the children try them.

(f) Go through task 6 then let the children try it (see note (iii)).

(g) Let the children try task 7 (see note (iv)).

Completing the activity

(h) Let the children compare their codes. Introduce the Morse code shown on the bottom right of this page as an example of an international code and let the children work out their names in the code.

(i) The children could send the names of other people in the class to their partners and have the partners work out the name (see note (v)).

Conclusion

Light can be used to send messages if a code is worked out.

Teaching notes

(i) The children may have seen a film where a mirror is used or, less likely, a second world war film where ships communicate by flashing lights. If you have access to such a film it may be worth showing the sequence to the children.

(ii) The children may like to make their own switch to turn off and on quickly, or use the switch from Activity 6.

(iii) The children may like to put a partition between them to make the method of communicating more realistic.

(iv) The ear is more sensitive to rapid on-off signals than the eye, although if several groups are using buzzers at once there may be some confusion.

(v) This is easier than having a person sending their own name, because the person sending their own name would have to be hidden from the person receiving the message, and this may be difficult to arrange in a classroom.

Morse code

The Morse code for the alphabet is given below. The dot represents a short flash or buzz and the dash represents a long flash or buzz.

(a)	• –	(n)	– •
(b)	– • • •	(o)	– – –
(c)	– • – •	(p)	• – – •
(d)	– • •	(q)	– – • –
(e)	•	(r)	• – •
(f)	• • – •	(s)	• • •
(g)	– – •	(t)	–
(h)	• • • •	(u)	• • –
(i)	• •	(v)	• • • –
(j)	• – – –	(w)	• – –
(k)	– • –	(x)	– • • –
(l)	• – • •	(y)	– • – –
(m)	– –	(z)	– – • •

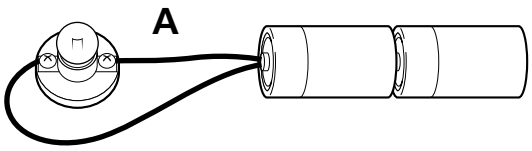
8

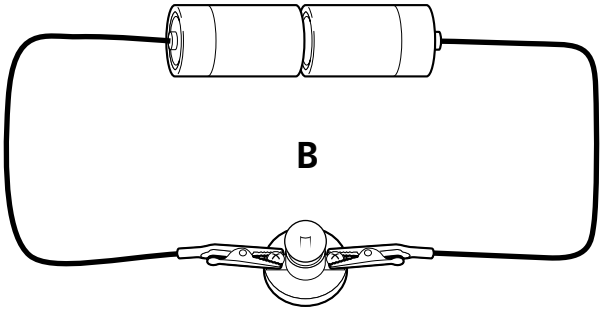
Name: ..... **Form:** .....

See **pages 18 and 19** of *Simple electricity*

Circuits that will and will not work

A circuit only works when it makes a loop.





Q1. What is wrong with circuit A?

✎.....

Q2. What is wrong with circuit B?

✎.....

Q3. Draw the correct circuit.

Q4. Why is it important to screw a bulb into its holder correctly?

✎.....

✎.....

Q5. What happens if a wire separates from a battery?

✎.....

✎.....

Q6. How does the shape the wires make in a circuit affect the brightness of the bulb?

✎.....

Teacher's sheet: comprehension

See **pages 18 and 19** of *Simple electricity*

Answers

1. **Both wires go to one battery terminal.**
2. **The batteries are back to back.**
3. **A circuit with the batteries facing in the same direction, one wire from the bulb attached to the front terminal of one battery and the other wire attached to the back terminal of the other battery.**
4. **It allows the metal part of the bulb to touch the metal part of the holder so electricity can flow between them.**
5. **Electricity no longer flows round the circuit and the bulb goes out.**
6. **It does not affect the brightness.**

Complementary work

(a) The study of the loops in Picture 1 may be extended by making a 'steady hand' tester with a wire that can be bent into waves and loops. One end of the wire is connected into the circuit and the other is connected to a metal loop which has to be successfully moved along the wire without touching it. If the loop touches, the circuit is closed and a light or buzzer sounds. The children could draw the circuit and the length of wire with its waves and loops to the point where they made contact with it.

Teaching notes

When a battery is used in a circuit, electrons leave the negative terminal and flow through the circuit to the positive terminal. Originally, this was thought to be the other way round. This idea of electricity flowing from the positive to the negative was put forward by Benjamin Franklin and became widely accepted before the real direction of the flow was discovered. Franklin's idea is still used today. It is known as the conventional current direction.

In Picture 2A in the pupil book, the two negative terminals are both pumping electrons into the circuit. The action of one opposes the action of the other so the current cannot flow. In Picture 2B both positive terminals are ready to receive electrons, but the negative terminals are together so again the current cannot flow. Only when the batteries are arranged as in Picture 2D can the electrons flow around the circuit.

In Picture 3A the electrons cannot flow through the bulb because both ends of the wire are attached to the same, positive terminal. No electrons are being released. If both ends of the wire were attached to the negative terminal there would not be a flow of current because the negative terminal can only release electrons.

8

Name: ..... Form: .....

Based on **pages 18 and 19** of *Simple electricity*

Series and parallel circuits

Try this…

1. Make the circuit shown in Diagram 1, then change it to the circuit shown in Diagram 2. These are both called series circuits because the bulbs, switch and battery are in a single loop.

Diagram 1

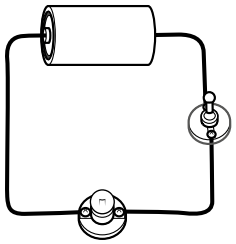
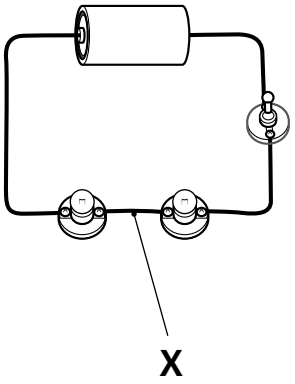


Diagram 2



2. Do the two bulbs glow (a) more brightly; (b) more dimly or; (c) with the same power as the single bulb?

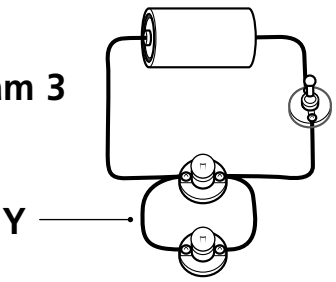
✎.....

3. What happens if you unfasten the wire marked X?

✎.....

4. Make the circuit shown in Diagram 3. The two bulbs are side by side. This circuit is called a parallel circuit.

Diagram 3



5. Do the two bulbs glow (a) more brightly; (b) more dimly or; (c) with the same power as the single bulb?

✎.....

6. What happens if you unfasten the wire marked Y?

✎.....

7. How well do you think the bulbs would shine if you added a third bulb next to the other two? Write down your prediction then try the test.

✎.....

8 Teacher's sheet: activity

Based on **pages 18 and 19** of *Simple electricity*

This activity is for more advanced pupils

Introducing the activity

(a) Begin by discussing that there are two ways in which components can be arranged in a circuit. They can be arranged one after the other in series or they can be arranged side by side in parallel. So far, we have arranged components one after another in series. In this activity, the children can compare the two arrangements (see note (i)).

Using the sheet

(b) Give out the sheet, let the children fill in their names and form, then go through tasks 1 to 3.

(c) Let the children try tasks 1 to 3 (see note (ii)).

(d) Go through task 4.

(e) Let the children try task 4 (see note (iii)).

(f) Let the children try tasks 5 to 6 (see note (iv)).

(g) Let the children try task 7 (see note (v)).

Completing the activity

(h) Let the children compare their task 7 work.

Conclusion

There are two kinds of circuits – series and parallel. In a series circuit, multiple bulbs will glow more dimly than a single bulb, and all the bulbs will go out if the circuit is broken. In a parallel circuit, all the bulbs will glow as brightly as a single bulb, and only one bulb goes out when there is a break in the circuit.

Teaching notes

(i) When the children have access to a number of wires and bulbs, they tend to experiment with different circuit arrangements, and some may have already arranged them in this way.

(ii) The answer to task 2 is (b); the answer to task 3 is 'both bulbs go out'. In a series circuit both bulbs offer resistance to the flow and glow more dimly.

(iii) The children may still need help to make a parallel circuit even though you have been through how to make it.

(iv) The answer to task 5 is (c); the answer to task 6 is 'one lamp goes out and one lamp stays shining'. When the bulbs are in parallel, each is in a separate circuit, so both offer the same resistance to the flow, as if they were on their own, so they shine as brightly as a single lamp. As two circuits are being run from one battery, the battery is used up more quickly. When a wire is unfastened in one circuit, it does not affect the flow of electricity through the other part of the circuit.

(v) The three bulbs will shine as brightly as the single bulb, but the battery will use up its supply of electricity more quickly.

9

Name: ..... Form: .....

See **pages 20 and 21** of *Simple electricity*

Adding to the loop

You can have as many bulbs in a circuit as you like. You just need to match them to the batteries.

Q1. In the space above, draw a circuit with a switch, four wires, two batteries and two bulbs.

Q2. What kind of circuit have you drawn?

✎.....

Q3. When you switch on the circuit does (a) the bulb nearest the switch shine brighter than the other; (b) the bulb nearest the switch shine more dimly than the other; or (c) do both bulbs shine with the same brightness?

✎.....

Q4. If you took one bulb out of the circuit and switched the circuit on again, would the single bulb shine (a) the same as before; (b) brighter than before; or (c) more dimly than before?

✎.....

Q5. If a third bulb was added, how would they shine compared to two bulbs?

✎.....

Q6. What voltage do four 1.5V batteries give?

✎.....

Teacher's sheet: comprehension

See **pages 20 and 21** of *Simple electricity*

Answers

1. **Going around the circuit, the batteries should be facing the same way; the end of one wire should be touching the front terminal of the battery; and the other end of the wire should be connected to a switch. The end of a second wire should be connected to the other contact of the switch. The other end of this wire should be connected to a bulb. The bulbs should be connected together by the third wire; and the fourth wire should connect the second bulb to the back terminal of the second battery.**
2. **A series circuit.**
3. **(c) Both bulbs shine with the same brightness.**
4. **(b) Brighter than before.**
5. **More dimly.**
6. **6 volts.**

Complementary work

Motors and buzzers may work at voltages different to those specified on the case. You can try this as below, but make sure children know that while components may work, when building a circuit every attempt must first be made to get matching components.

(a) Set up a motor which can work at 3 or 6 volts. Begin with a 1.5V battery in the circuit then add a second and compare the speed of the motor. If the motor works best at 6V add a third 1.5V battery, note the motor speed, then add a fourth battery and note the speed again. You could attach the motor to a simple machine. Then the ability of the motor to do work could be compared using different numbers of batteries.

(b) Repeat the exercise with a 6V buzzer.

In both activities, make sure the voltage of the combined batteries does not exceed the power that the motor or buzzer is designed to use.

Teaching notes

Children need to have a thorough knowledge of how to make different series circuits. By this stage the children should be able to arrange batteries and start adding bulbs. In their growing confidence, they may forget about the matching of batteries to bulbs and the dangers of using too much power. This unit reminds the children of relating power supply to power demand.

The series circuit is the one used most often in elementary circuit work. In the previous activity parallel circuits were introduced for comparison only. Most circuits that we use in the home are parallel circuits, and street lights are also arranged in parallel circuits, so if one bulb fails all the other bulbs do not go out. In the home, the most familiar use of a series circuit are Christmas tree lights. Alarms and warning systems have series circuits too, as the children will have seen if they made the folding card switch and used it as a pressure pad alarm under a carpet.

9

Name: ..... **Form:** .....

Based on **pages 20 and 21** of *Simple electricity*

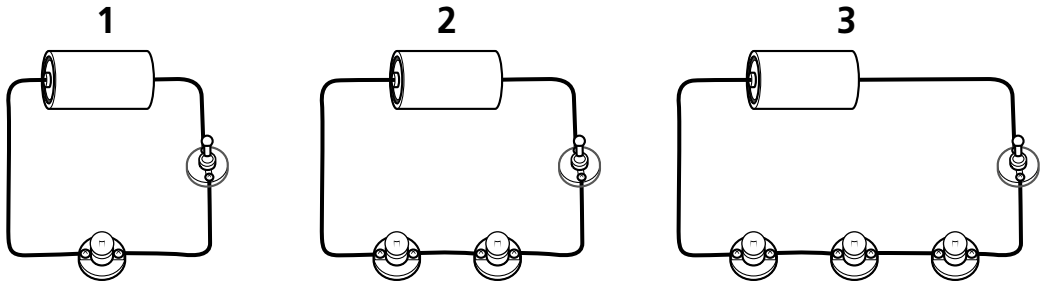
Investigating brightness

Try this…

1. Make circuit 1 and write down whether the bulb is dim, bright or very bright, in the top box of the second column in the table.

2. Make circuit 2 and write down whether the bulbs are dim, bright or very bright, in the second box of the second column.

3. Make circuit 3 and write down whether the bulbs are dim, bright or very bright, in the third box of the second column.



Circuit	One battery	Two batteries	Three batteries
1			
2			
3			

4. Make circuits like the ones in the diagrams, but use two batteries instead of one. Record your results in the third column of the table.

5. Make circuits like the ones in the diagrams, but use three batteries instead of one. Record your results in the fourth column of the table.

Looking at your results.

6. How does increasing the number of batteries affect the brightness of the bulbs in the circuit?

✎.....

7. How does increasing the number of bulbs affect the brightness of the bulbs in the circuit?

✎.....

Teacher's sheet: activity

Based on **pages 20 and 21** of *Simple electricity*

Introducing the activity

(a) Tell the children that they are going to find out how the number of batteries and bulbs in a circuit affects the amount of electricity flowing though the circuit (see note (i)).

Using the sheet

(b) Give out the sheet, let the children fill in their names and form, then go through tasks 1 to 3.

(c) Let the children try tasks 1 to 3 (see note (ii)).

(d) Check that the children have successfully filled in the second column of the table.

(e). Go through tasks 4 and 5 with the children.

(f) Let the children try tasks 4 and 5.

(g) Let the children complete tasks 6 and 7.

Completing the activity

(h) Let the children compare their results.

(i) Ask the children for two ways of increasing the flow of electricity in a circuit with two bulbs and two batteries (see note (iii)).

(j) Ask the children for two ways of decreasing the flow of electricity in a circuit with two bulbs and two batteries (see note (iv)).

Conclusion

The brightness of the bulbs in a circuit (and the flow of current) is increased by increasing the number of batteries. The brightness of the bulbs in a circuit (and the flow of current) is decreased by increasing the number of bulbs.

Teaching notes

(i) The children should be introduced to the concept that the brightness of the bulb can be used to compare the amount of electricity flowing through a circuit. A bright bulb indicates a large flow of electricity; a dim bulb indicates a small flow of electricity.

(ii) Make sure that the bulbs do not exceed the maximum voltage provided by the three batteries.

(iii) Add a battery or take away a bulb.

(iv) Take away a battery or add a bulb.

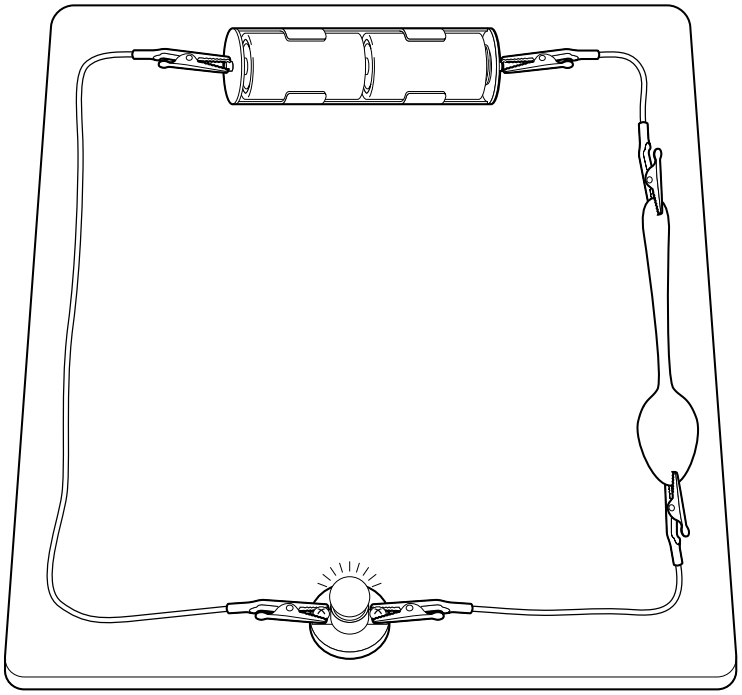
10

Name: ..... **Form:** .....

See **pages 22 and 23** of *Simple electricity*

Testing for conductors and insulators

Electricity can only flow through some materials. These are called conductors.



Q1. Draw arrows to show the direction electricity moves in the circuit.

Q2. How can you tell when electricity is moving through the circuit?

✎.....

Q3. What kind of material is the spoon made from?

✎.....

Q4. How can you tell that the spoon shown in the circuit is made from that material?

✎.....

✎.....

Q5. Name a liquid conductor.

✎.....

Q6. Why should you never touch electrical things with wet hands?

✎.....

✎.....

✎.....

Teacher's sheet: comprehension

See **pages 22 and 23** of *Simple electricity*

Answers

1. **The arrows should go anticlockwise round the circuit.**
2. **The bulb lights up.**
3. **A conductor, or metal.**
4. **It allows electricity to flow through it because the bulb is shown lit up.**
5. **Salty water, river water, tap water.**
6. **The water can make you part of the circuit and a dangerous amount of electricity will flow through you.**

Complementary work

(a) Use secondary sources to find out how the electricity carried by overhead power lines is kept insulated from the surroundings.

(b) Use secondary sources to find out how underground power cables are kept insulated from their surroundings.

Teaching notes

This unit builds on the work in Unit 3, when the focus was on making a current flow to light a bulb. Both conductors and insulators are needed to channel electricity. If insulators did not surround a conductor, the electric current would dissipate through the surrounding materials.

Conduction of electricity is a test to identify metals. The only non-metal that conducts electricity is graphite (a form of carbon), which is used in pencil leads. Some liquids are also conductors. One common type of conductor is a salt solution like sweat. This is the reason why electrical equipment must not be handled with wet hands, as droplets of moisture could form a connection between a conducting metal and the skin.

Most materials are insulators. These include natural materials like wood or stone, and manufactured materials like plastic. Air is an insulator. The air beneath an overhead power cable forms an insulation layer between the cable and the ground below. If very high voltages occur, such as in lightning, the air breaks up into charged particles – including electrons. These flow rapidly through the air and make a bolt of lightning.

Static electricity is the build-up of electrons on an insulator. Rubbing a balloon on wool transfers electrons to the surface of the balloon. The electrons give the surface a negative charge. When the balloon is brought near a wall the negative charge makes the surface of the wall become positively charged. As opposite charges attract, just like opposite poles of a magnet attract, when the balloon is pressed against the wall the strength of the opposite charges keeps it in place.

10

Name: ..... **Form:** .....

Based on **pages 22 and 23** of *Simple electricity*

Conducting electricity

Try this…

1. In the space below, draw the circuit you will make to test if a material conducts electricity.

2. How will you know if a material conducts electricity?

✎.....

3. Fill in the first column of the table with the materials you will test.

4. Predict which materials will conduct electricity and tick them in the second column of the table.

5. Test each material in turn. If it conducts electricity put a tick in the third column of the table. If it does not conduct electricity put a cross.

Material	Prediction	Conductor

Looking at the results.

6. How does the number of conductors compare with the number of insulators?

✎.....

7. How accurate were your predictions?

✎.....

10

Teacher's sheet: activity

Based on **pages 22 and 23** of *Simple electricity*

Introducing the activity

(a) The children can be told that they are going to make an investigation using electrical equipment, and that they have to decide what they need and plan their work.

Using the sheet

(b) Give out the sheet, let the children fill in their names and form, then go through tasks 1 and 2 (see note (i)).

(c) Let the children try tasks 1 and 2 (see note (ii)).

(d) Go through tasks 3 to 5.

(e) Let the children try tasks 3 to 5.

(f) Let the children try tasks 6 and 7.

Completing the lesson

(g) The children should compare their results. If they have all tested different materials they can pool their results on the board.

(h) Sharpen both ends of a pencil and challenge the children to predict whether the pencil lead will conduct electricity, then demonstrate that it does using one of the circuits the children have made (see note (iii)).

Conclusion

In any selection of everyday materials, there are likely to be more insulators that conductors. Metals are conductors and non-metals are insulators. The exception is graphite, which conducts although it is a non-metal.

Teaching notes

(i) The children must be aware that the bulb will light when a conductor is put in the gap, because it closes the circuit and electricity flows through it.

(ii) Provide the children with a wide range of materials. Make sure that in the table, the children refer to the material the object is made of and not the object itself.

(iii) Test the pencil before you demonstrate it to make sure that the bulb will light. The children will probably predict that it will not conduct, associating the lead with the wood in the pencil (which is an insulator). This serves as a good example of the need for testing even when a pattern (i.e. only metals conduct electricity) seems to have been established.

QUESTIONS

Name: ..... **Form:** .....

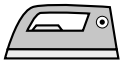
Q1. Which of these items uses batteries?

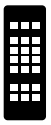
Tick the boxes:


Kettle ☐


Mobile phone ☐


Oven ☐


Iron ☐

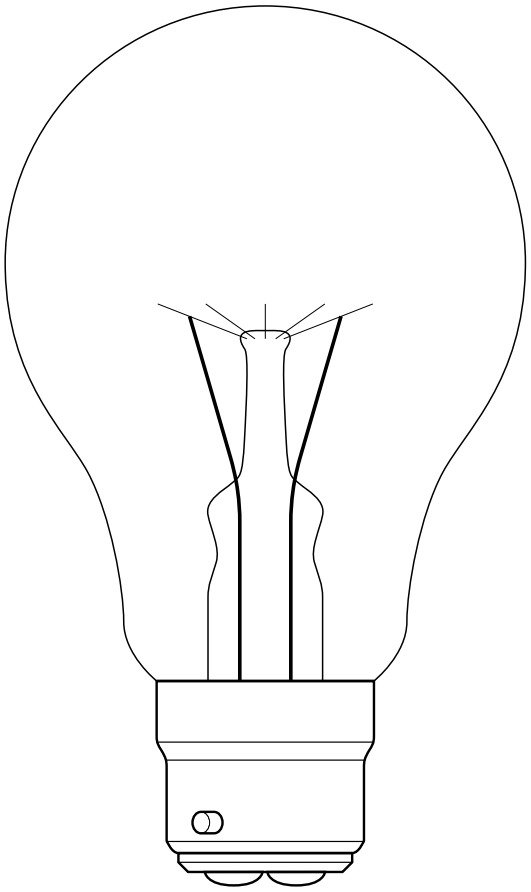

TV remote control ☐

Q2. Where does the electricity in the mains come from?

✎.....

Q3. Here is a light bulb.

(i) Draw in the wire that makes light in the bulb.



(ii) What is the name of this wire?

✎.....

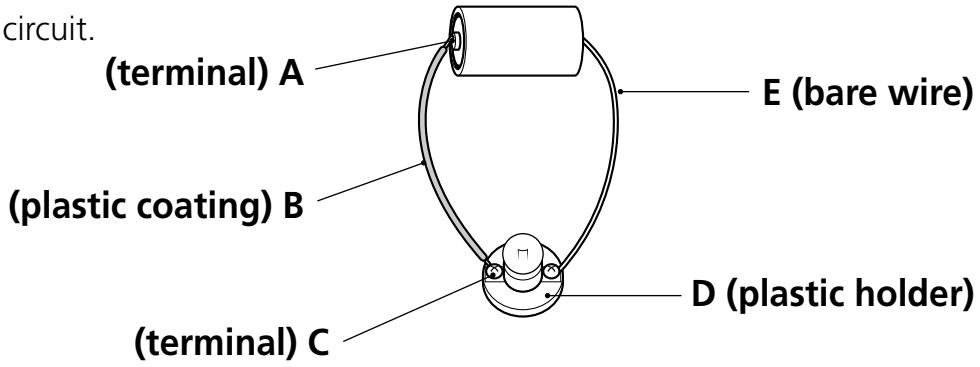
(iii) What is the name of the wire that heats up in a kettle?

✎.....

QUESTIONS

Name: ..... **Form:** .....

Q4. Here is a simple circuit.



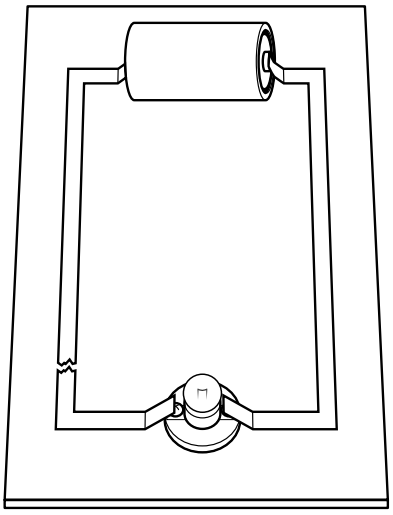
(i) Which parts of the circuit are conductors?

✎.....

(ii) Which parts of the circuit are insulators?

✎.....

Q5. Paul has made a circuit board but the bulb will not light.



What is wrong?

✎.....

✎.....

Q6. Jane has put three 1.5 volt batteries together in a circuit.

What voltage do they make? ✎.....

Q7. Paul has got a 3 volt bulb. How many 1.5 volt batteries does he need to make it shine brightly?

✎.....

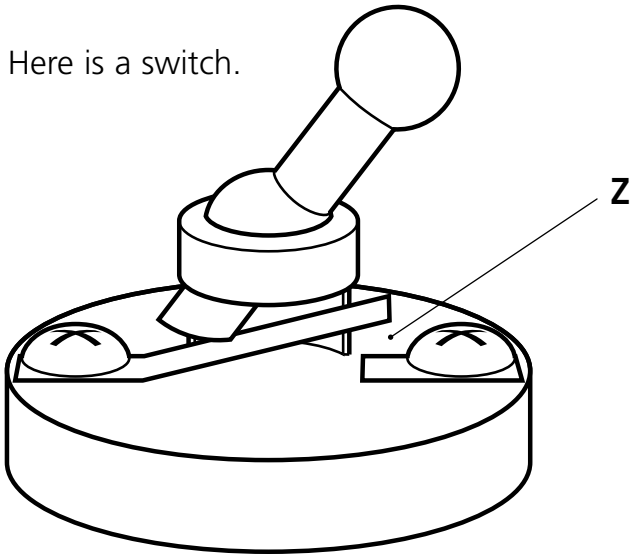
QUESTIONS

Name: ..... **Form:** .....

Q8. There are two terminals on this battery.

Put an X on each of the terminals.

Q9. Here is a switch.



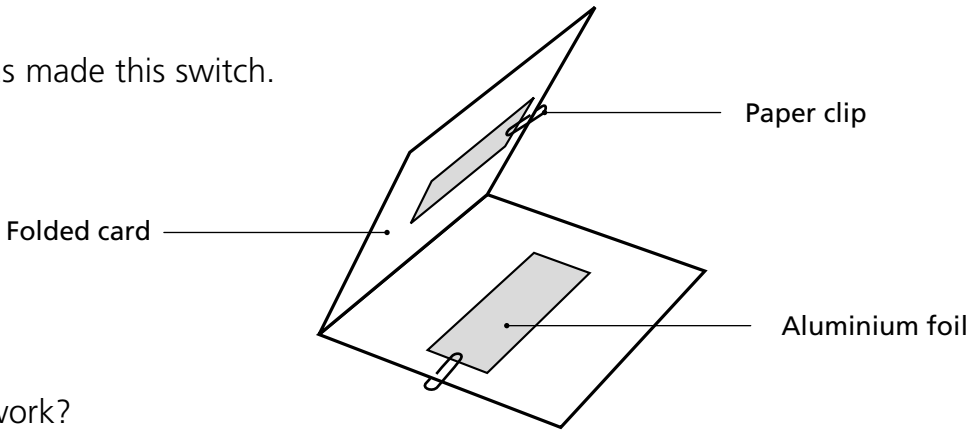
(i) Shade in the parts that conduct electricity.

(ii) Put a cross on each contact.

(iii) In the gap labelled with a Z there is an insulator you cannot see. What is it?

✎.....

Q10. Paul has made this switch.



How does it work?

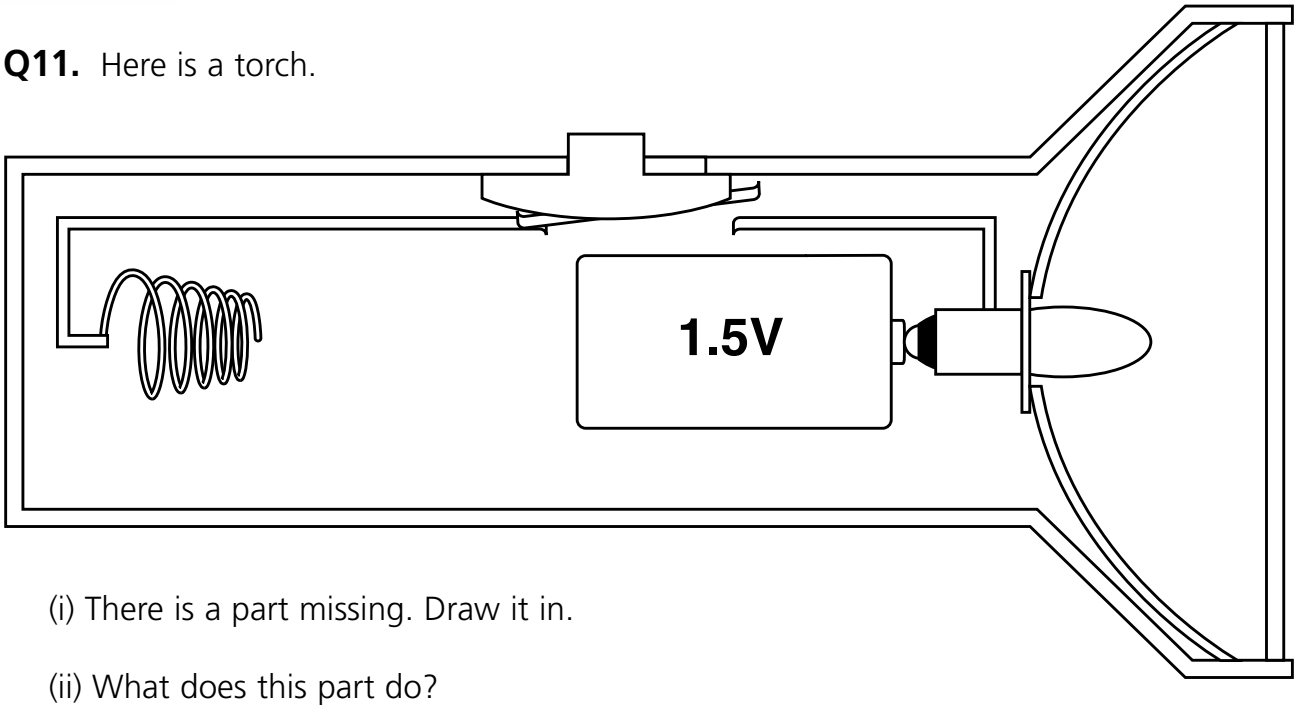
✎.....

✎.....

QUESTIONS

Name: ..... **Form:** .....

Q11. Here is a torch.



(i) There is a part missing. Draw it in.

(ii) What does this part do?

✎.....

(iii) Is the torch switched on or off? ✎.....

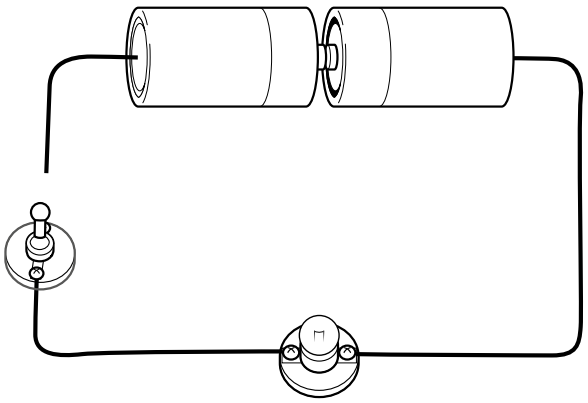
(iv) How can you tell?

✎.....

(v) What voltage of bulb is needed for the torch to shine brightly?

✎.....

Q12. Paul has made a circuit.



What has he done wrong?

✎.....

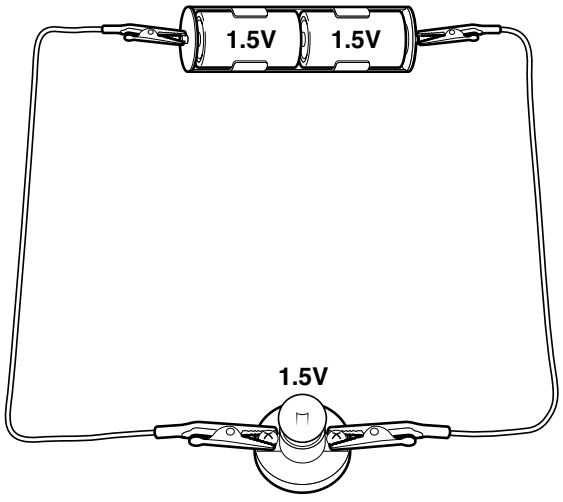
✎.....

QUESTIONS

Name: ..... **Form:** .....

Q13. Draw a circuit for Sarah to make. The circuit should have four batteries, a switch, two bulbs and three wires. Write the voltages on the batteries and the bulbs.

Q14. Paul has made this circuit.



(i) What will happen when he switches on the bulb and leaves it for a while?

✎.....

(ii) Explain your answer.

✎.....

✎.....

QUESTIONS

Name: ..... **Form:** .....

Q15. Ben has set up a circuit with one battery and one bulb in it. He has written down how the bulb shines.

	Number of bulbs		
Batteries	**One**	**Two**	**Three**
1	very bright		

Predict what will happen when he adds more bulbs into the circuit, and fill in the two empty boxes in his table.

Q16. Jane has set up a circuit with one battery and one bulb in it. She has written down how the bulb shines.

	Number of batteries		
Bulbs	**One**	**Two**	**Three**
1	dim		

Predict what will happen when she adds more batteries into the circuit, and fill in the two empty boxes in her table.

Q17. (i) Which of these materials are conductors?

Tick the boxes of the conductors:

Pottery ☐ Steel ☐ Wood ☐ Plastic ☐ Copper ☐ Silver ☐

(ii) What is a conductor?

✎.....

✎.....

(iii) What is an insulator?

✎.....

✎.....

ANSWERS

1. Mobile phone, TV remote control. *2 marks*

2. Power station. *1 mark*

3. (i) The filament should be drawn in. *1 mark*
(ii) Filament. *1 mark*
(iii) Element. *1 mark*

4. (i) A, C, E. *3 marks*
(ii) B, D. *2 marks*

5. There is a break in the aluminium strip. *1 mark*

6. 4.5 volts. *1 mark*

7. 2. *1 mark*

8. Both ends of the battery. (Make sure the terminal cap is labelled.) *1 mark*

9. (i) The contacts and the terminals should be shaded. *4 marks*
(ii) The two metal strips should be labelled. *2 marks*
(iii) Air. *1 mark*

10. When you fold the card, the pieces of aluminium come together so electricity can flow. When you open the card they separate and the current stops. *4 marks*

11. (i) A 1.5V battery. *1 mark*
(ii) Connects the spring and the other battery, completing the circuit. *2 marks*
(iii) Off. *1 mark*
(iv) The contacts are separated. *1 mark*
(v) 3 volts. *1 mark*

12. The batteries are facing each other, the switch is not connected. *2 marks*

13. All batteries facing the same way, all components connected to wires.
4 x 1.5V batteries, 2 x 3V bulbs. *2 marks*

14. (i) It will burn out. *1 mark*
(ii) The voltage of the batteries is too high for the bulb. *1 mark*

15. Bright, dim. *2 marks*

16. Bright, very bright. *2 marks*

17. (i) Steel, copper, silver. *3 marks*
(ii) A material that lets electricity pass through it. *1 mark*
(iii) A material that does not let electricity pass through it. *1 mark*

Total marks: 48