# 1 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.

1

# 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 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 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 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

# 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

# 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

# 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.

# 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 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 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.

# 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 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 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) | – – • • |

# 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.

# 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.

# 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.

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# 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 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

# 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.