Pupil's Book C
Chapter 3
Energy and electricity

Rationale

This chapter develops pupils' understanding of electrical circuits and explores processes of energy transfer into circuits from 'power supplies' and outwards from circuits by heating (including lighting) and working. It also looks at aspects of safety and of environmental impact of electricity generation and distribution.

Building on previous learning

Pupils will have experienced Energy and Fuels and also Electric Circuits in Year 7, and will already have considered general energy issues along with resistors as energy transfer devices and measurement of current. Voltage will have been introduced as a means of making comparisons between power supplies. In Year 8, thermal energy transfers and the link between electricity and magnetism were introduced.

Future learning

At KS4, pupils will learn about mains electricity; efficiency, economy and environmental issues of electrical generation; and generators and transformers.

Framework *Common misconceptions*

Here we introduce measurement of voltage, and confusion with measurement of current is an undesirable possibility. One electrical meter can look much like another, and pupils may suppose that they all measure the same quantity. Circuit models help, allowing the idea that all sorts of circuits have, in simple terms, flow (of people, vehicles, energy by thermal processes, water, and electric current in electric circuits) and push or drive of the flow (height difference, pressure difference, temperature difference, and voltage in electric circuits). Thus current can be seen as a consequence of voltage. The ways in which a voltmeter and an ammeter are connected into a circuit are very different. Since voltage is a difference, the voltmeter is connected to the two points between which the difference exists. Since current is a flow, an ammeter is connected so that the current must pass through it.

Further difference between voltage and current concerns energy. A voltage source is also the circuit's energy source. A higher voltage source can supply energy to a circuit at a greater rate (that is, has a greater power) than a lower voltage source for the same circuit. A voltage also exists across resistive circuit components, of course, and in a series circuit the component with the highest power has the largest voltage across it. However, voltage is NOT the same thing as energy. At an introductory level it is enough to say that voltage is associated with the circuit energy or power source and is shared by series circuit components. (The behaviour of voltage in parallel arrangements, for example, should be left until later educational stages.) Current is associated with energy transfer out of the circuit, which takes place at components such as lamps, heaters and motors.

Match to

National curriculum references

4.1 Electricity and magnetism

a) how to design and construct series and parallel circuits, and how to measure current and voltage
c) that energy is transferred from batteries and other sources to other components in electrical circuits

4.5 Energy resources and energy transfer

a) about the variety of energy resources, including oil, gas, coal, biomass, food, wind, waves and batteries, and the distinction between renewable and non-renewable resources
c) that electricity is generated by means of a variety of energy resources
d) the distinction between temperature and heat, and that differences in temperature can lead to transfer of energy
e) ways in which energy can be usefully transferred and stored
g) that although energy is always conserved, it may be dissipated, reducing its availability as a resource.

Scheme of Work section

Unit 9I: Energy and electricity

Yearly teaching objectives

- ◆ Recognise the idea of energy conservation as a useful scientific accounting system when energy is transferred; use this to explain energy transfers in familiar situations, energy efficiency and energy dissipation.
- ◆ Develop, from a simple model of energy transfer in electrical circuits, the idea of electrical potential difference.
- ◆ Use ideas of energy conservation to explain how:
  – the potential difference measured across cells or components shows how much energy is transferred from the cells to the current and from the current to the components;
  – electrical energy can be generated using fuels, including the energy transfers involved; and recognise possible environmental effects of this

Suggestions

Key vocabulary

kinetic energy; potential energy

Answers

Answers to questions in Starter Activity and Finishing Off!

Starter Activity

1 They are all the same

2 a) Check pupils' diagrams.
b) Resistors in series; current must pass through all of the resistors, there is no choice of routes

3 a) 2 A b) 2 A c) 1 A d) 2 A

Finishing Off!

1 Diagram, arrow of constant width, from 'electricity supply' to 'heating the room'

2 The cooler wire gains energy from the hotter; arrow showing direction of transfer

3 Parallel arrangement of four wires each with a current of 1.25 A

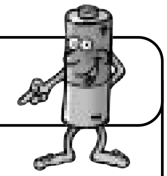
4 Heater has cooled, energy has spread first to room and then has spread further so that there is no longer much heating benefit.

5 a) Gas is cheaper for a given amount of energy
b) Gas produces 'smoke' and carbon dioxide.
Power stations produce 'smoke' and carbon dioxide.
Gas provides more heating benefit for the same amount of pollution.

Answers to End-of-unit test

1 True
2 True
3 False
4 True
5 True
6 Volt
7 Two from: iron, cooker, hair drier, etc.
8 Two from: hair drier, vacuum cleaner, washing machine, etc.
9 Provides energy. There is a *difference* between the ends.
10 Check that in the sketch, the voltmeter is in parallel with the battery/cell.
11 Three from: water stored high up, coal, oil, gas, nuclear
12 Check on the sketch that the heater arrow is twice as thick as the TV arrow.
13 Cost = 3 hours × 1 kW × 10p = 30p
14 Energy spreads out and is no longer useful.
15 Energy transfer uses resources and usually pollutes.
16 Accept any sensible answers, such as walk to school and turn off appliances not being used.
17 The answer could mention the following: climate change, non-renewable resources, renewable resources.

Chapter 3 Target sheet



Tick off the list as you work through Chapter 3 when you are happy that you understand the following:

YTOs	Target	Tick
	I can use a voltmeter to make measurements of cells (batteries).	
✓	I can name some energy transfer devices.	
✓	I can use a battery to provide energy to a circuit and I can measure its voltage.	
	I know that high voltages are hazardous.	
✓	I understand that electricity transfers energy from one place to another.	
✓	I know that some energy is wasted.	
	I know that energy transfer by electricity can cause environmental problems.	
✓	I understand that when energy is transferred it can become ‘spread out’ and dissipated.	
✓	I understand that voltage between the ends (terminals) of a cell or battery provides a measure of its ability to transfer energy.	
	I understand that a cell works by chemical processes.	
	I can give examples of the effects of high voltage on the human body.	
	I can describe how electricity is generated in power stations.	
	I know that generation of electricity can do environmental damage.	
✓	I can use a voltmeter to investigate patterns of voltage in circuits.	
✓	I can identify sources of energy.	
✓	I can identify devices that transfer energy.	
	I can use ‘power ratings’ of appliances to compare the costs of running them.	
	I understand that an electric generator uses the magnetic effect of electric current.	

Chapter 3 End-of-unit test

For Questions 1 to 5 say whether the statement is true or false.

1 We measure electric current in units called amps, or A for short. *(level 3, 1 mark)*
TRUE/FALSE

2 When all the components are in series, the current is the same at all points around a circuit. *(level 4, 1 mark)*
TRUE/FALSE

3 Resistors transfer energy by doing work (making things move). *(level 3, 1 mark)*
TRUE/FALSE

4 A battery acts as an energy store. *(level 3, 1 mark)*
TRUE/FALSE

5 Two batteries in series have a bigger voltage than one on its own. *(level 3, 1 mark)*
TRUE/FALSE

6 What unit do we use to measure voltage? *(level 3, 1 mark)*

7 Name two appliances that you use at home to transfer energy by heating. *(level 3, 2 marks)*

8 Name two appliances that you use at home to transfer energy by working (making things move). *(level 3, 2 marks)*

9 Explain how a battery is a bit like a ski-lift. *(level 6, 1 mark)*

10 Sketch a circuit diagram to show how you would connect a voltmeter to a circuit to measure the battery voltage. *(level 4, 1 mark)*

11 Where can the energy come from to generate electricity in a power station. Give three possibilities. *(level 4, 3 marks)*

12 If a heater has a power rating of 1 kW and a TV has a power rating of 0.5 kW, sketch energy transfer arrows for each of them. Use the thickness of the arrows to show the sizes of the powers. *(level 5, 2 marks)*

13 How much would it cost you to use the heater for 3 hours, if electrical energy costs 10p per kilowatt-hour? *(level 6, 1 mark)*

14 'All electrical appliances dissipate energy.' What does 'dissipate' mean here? *(level 6, 1 mark)*

15 Why is it important that each person tries to reduce their personal use of electricity for energy transfer? *(level 7, 1 mark)*

16 Give two ways in which you could reduce your energy transfer use. *(level 6, 1 mark)*

17 Write a few sentences outlining the problems of energy supply and suggest what the answers for the future might be. *(level 7, 2 marks)*

3.1 Energy transfer from circuits

Rationale

The spread deals with energy transfer from circuits to the world around by heating and working.

Learning outcomes

Most pupils will be able to describe energy transfers in laboratory and domestic situations.

The faster pupils will understand that:
- ◆ energy input and output of a circuit are ultimately the same
- ◆ output includes energy dissipation.

Those who progress less quickly will:
- ◆ recognise that in order to transfer energy outwards by working and heating, a circuit needs a power supply, which provides voltage
- ◆ describe some energy transfer devices.

Possible teaching strategies

It would be appropriate to introduce the key ideas by considering a range of energy transfer systems, both electrical and non-electrical. These could include clockwork toys, and systems which use fuels and foods. It should be pointed out that each system has an energy source or supply, and acts to transfer energy from that to the world around. These outward energy transfers all involve either energy transfer by heating (including lighting) or by working (which at this level can be described as 'making things move') or both. Electric circuits are energy transfer systems, having input from sources such as cells and batteries and outputs by way of heaters, lamps and motors.

Framework Lesson plan

2 hours/lessons

Suggested starter

The Starter Activity on page 33 of *Pupil's Book C* provides a reminder of ideas about current, as experienced in *Pupil's Book A*, Chapter 9. That chapter also went so far as to associate voltage with cells and batteries*, but did not deal with measurement of voltage. The text in this starter activity reviews the behaviour of current in series and parallel arrangements. The 'rules' can be seen to have predictive power, which can be explored further in the lessons main activity.

(Throughout the series we follow common usage of language on the issue of cells and batteries, and we use the word battery to refer to a single cell as well as to combinations of cells.)*

Main activities
- ◆ A simple investigation of the 'current rules' covered in the starter provides an opportunity for review and development of circuit construction skills.
- ◆ Pupils can be asked to set up a circuit and check the truth of Rule 1. Page 33 provides circuit diagram guidance, but some pupils will need further hints or direct instruction.
- ◆ Pupils can be asked to set up a circuit to check the truth of Rule 2. Creating parallel branches in a circuit and connecting an ammeter in appropriate positions requires rather more careful thought, and different pupils will depend on different levels of teacher guidance.
- ◆ Able pupils could carry out further open-ended investigation on parallel arrangements with equal and unequal numbers of lamps (of the same kind) in each branch. This should reinforce the idea that the total current through a parallel system is the same as that in the remainder of the circuit. It also reveals that branches with fewer lamps (and less resistance*) take larger shares of the current.

(Resistance may be dealt with in general terms. Its definition need not be covered here.)*

Suggested finisher

Finisher A Current predictions: Provides further consolidating practice, and can be used individually or as a focus for class discussion.

Homework

Pupils should prepare reports on their investigations. (Finisher A provides help which they can use at home for drawing suitable circuit diagrams.)

Suggested starters
- ◆ A class reading of Spread 3.1 on pages 34–35 of *Pupil's Book C*, could focus on revision of representation of energy transfer by broad arrows – how the energy transfer from a circuit can be affected by heating (as in a filament lamp) or by working (as in a motor), and how in all cases the surroundings are warmed. The energy does not cease to exist but is dispersed or dissipated in the surroundings.
- ◆ This would be a good opportunity to show a range of energy transfer devices (electrical, clockwork and chemical) and to discuss the flow of energy from an energy store through the device and to the ultimate and inevitable dissipation.

Main activities
- ◆ Activity 3.1 Heating and working: Provides practical experience of an energy transfer by a lamp (a very simple circuit), a motor (introducing the terms kinetic energy and gravitational potential energy), and a heater (investigating energy transfer to a metal body, and from the metal body to the surroundings).
- ◆ *Support Pack* Activity C3S1 provides additional work on the key ideas. The *Extension Pack* Activity C3E1 does likewise, but also extends ideas into particle behaviour and thereby encourages pupils to make thoughtful links between different areas of their science work.

Suggested finishers
- ◆ Finisher B Transfer devices: Provides a cut-and-paste summary exercise which emphasises central ideas on energy transfer through a range of devices.
- ◆ The remember box on page 35 of *Pupil's Book C* provides vocabulary exercise.

Homework

Homework 3.1 Domestic Power: This considers domestic appliances and their energy transfers by heating and working, using arrow representation.

Suggestions

Literacy, Numeracy and ICT

Pupils could be encouraged to consider the power of use of diagrams to represent energy transfers – that diagrams convey information very effectively. They could discuss these diagrams and apply them to a range of devices. Pupils might, for example, consider how diagrams for high power devices differ from those for low power devices. This might lead to preparation of a poster, including both text and images, which communicates ideas about energy transfers by electrical appliances. Posters should include diagrams, and might also include images downloaded from the web.

Sc1 Ideas and evidence

Activity 3.1 includes an investigation activity on heating a metal block, for the benefit of pupils who make rapid progress. The rate of change of temperature of such a block decreases, since the rate of energy supply by the heater is constant but the rate of transfer of energy to the surrounding air increases as the block's temperature rises, until an equilibrium is established.

Key skills

Communication, application of number, ICT

Cover friendly rating

3 star (homework); 0 stars (activity)

Technician's notes

Equipment	Quantity/group
Battery and holder	1
Switch	1
1.5 V lamp	1
Test tube with 2 cm of water	1
Spirit thermometer	1
Stop clock	1
Motor	1 per class for demonstration
10 g mass	1 per class for demonstration
Specific heat capacity blocks*	1
Electric heater for above	1
Power supply†	1
Eye protection	1/student

Experimental notes

* Place a drop of mineral oil in the thermometer hole of the metal block to aid the transference of heat.
† This will be needed for the electric heater.

Advice on practical activity

Be prepared to modify the equipment in order to match the voltage of the lamp or motor to the voltage of the battery/batteries used. Similarly, experiment to find a suitable mass for the motor. It is impossible to control the speed of the motor – it is either very fast or nothing at all. This is therefore better done as a demonstration.

Be aware that the heater, depending on its power rating, may become very hot; do not leave it on the bench whilst plugged in. Pupils must be told not to touch it or the metal block when hot.

Answers

1 Working (or doing work, or making things move); Heating

2 a) Power supply (such as a cell or battery)
b) Spread into the surroundings (dissipated) (some energy may be stored, such as in the form of potential energy of a mass that has been raised)

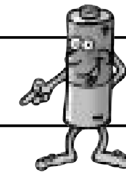
3 Brighter lamp

4 a) Because some of the electrical energy has been.
b) No (although *all* energy is dissipated ultimately by thermal processes)
c) Some electrical energy is transfered straight away by heating

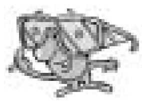
Match to

National Curriculum references

4.1 c and 4.5 g



Chapter 3 Activity sheet

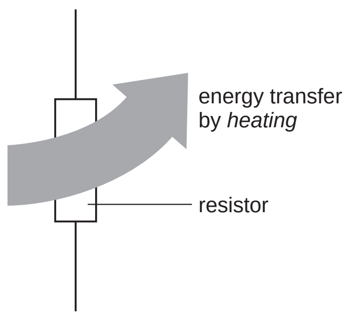


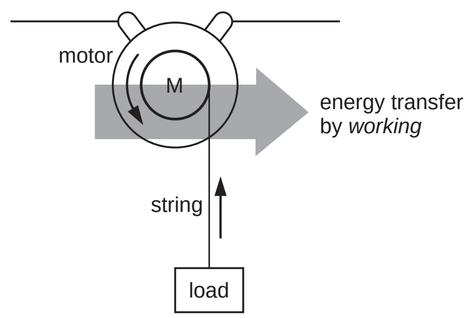
3.1 Heating and working

Electric circuits can transfer energy to their surroundings.

Resistors get hot. They transfer energy by heating their surroundings.

Motors go round and round. They provide force and produce motion. They can lift loads or pull objects to overcome friction. They transfer energy to their surroundings by doing work.



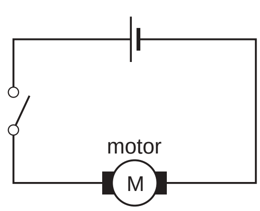


So try this

Set up a simple circuit with a battery, a switch and a lamp. The lamp contains a resistor. It gets very hot and heats its surroundings. Draw a circuit diagram of your circuit.

Now watch this

Have a look at a simple circuit with a battery, a switch and a motor. This is the circuit diagram.



The motor can do work by lifting a load. Draw a diagram of the motor and the load.

The motor gives energy to the load. The load can gain **kinetic energy** (energy of movement). It can also gain **gravitational potential energy** (energy from being high up).

On your diagram show where:

★ the load has most potential energy
★ the load has no kinetic energy

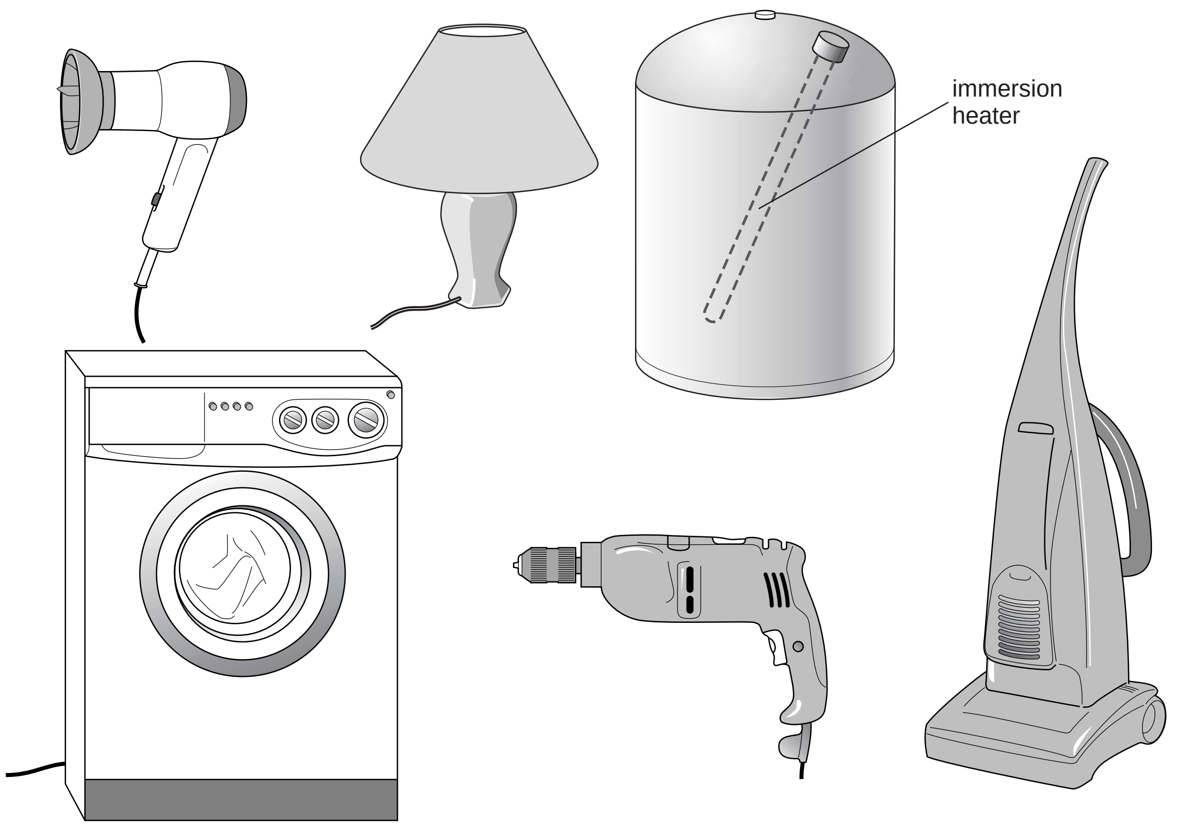
Does the motor transfer energy by heating its surroundings?

Investigate

Use an electric heater to investigate the temperature change of a block of metal. Does the temperature of the metal go on and on rising when you heat it? Write down what you would expect to happen. Make measurements to find out what really happens. Discuss your results with your friends and your teacher.

3.1 Domestic power

These are some domestic electrical appliances.



Questions

1 Sort the appliances into a table to show which transfer energy:
- ★ mostly by heating themselves and their surroundings
- ★ mostly by working (providing force and producing motion)
- ★ by a mixture of heating and working.

2 What is the source of energy for all of the appliances?

3 We can draw arrows to show the energy that is transferred by heating and the energy that is transferred by working.
Draw energy transfer arrows for:
a) the electric light
b) the washing machine.

4 Make a sketch of the hair drier and add an energy transfer arrow. Use your arrow to show energy transfer by working and by heating.

5 What would happen in a closed room which had lots of hair driers working?

6 What happens eventually to all of the energy that the hair driers transfer to their surroundings?

3.2 Circuit power

Rationale

The spread and activities compare the role of a battery with that of a ski-lift in supplying energy that can be transferred to the wider world by means of circuit activity.

A second analogy is made with supply and 'spending' of money. Pupils are asked to consider the usefulness and the limitations of analogies.

Learning outcomes

Most pupils will:

- realise that the voltage of a battery relates to its potential to transfer energy to a circuit. (Actual energy transfer also depends on the amount of charge involved, just as for the ski-lift the height difference makes energy transfer possible but the amount of energy transferred depends on the amount of mass (number of people) involved as well as the height difference. The model need not be taken this far unless the brightest pupils raise the issues in discussion.)
- discuss and assess the value of models used
- creatively and meaningfully investigate voltage provided by fruit 'cells'.

The faster pupils will:

- provide critiques of models used
- evaluate their investigations.

Those who progress less quickly will set up circuits and use voltmeters, including for measurement of fruit 'cells'.

Possible teaching strategies

Voltage is a difficult concept in that it measures potential for energy transfer rather than energy transfer itself, as discussed above. There is scope for confusion here and care should be taken not to suggest that voltage is, or can, be the same thing as energy. Voltage is important at this level primarily because it relates to the current that can flow in a given resistor, and can be seen as the cause of the current.

At this point pupils should see a variety of different voltage supplies, including, where possible, a simple cell, a dry cell or battery and mains supply. The voltages should be compared, and the relatively large value and high hazard of mains voltage should be emphasised.

Framework *Lesson plan*

2 hours/lessons

Suggested starter

- Starter A Differences: Reminds pupils that we compare circuit power supplies in terms of their voltages. It shows that voltage is a difference, and compares it with other differences that result in flow processes. The differences shown on the sheet are in water level (and hence pressure), temperature, height (or gravitational potential energy), and pressure.

Main activities

- Activity 3.2 a Fruit cell investigation: Provides an interesting introduction to the use of a voltmeter. The electrodes should be pointed out as being the 'terminals' of the cell or 'battery'.
- *Support Pack* Activity C3S2 can be used here or in the next lesson to provide additional support on key ideas.

Suggested finisher

Finisher C Write up: Provides guidance on stages of writing an investigation report.

Homework

Pupils should use their practical experience and the results of Finisher C to write an investigation report.

Suggested starters

- Starter B Good models?: Takes pupils back to circuit models and re-emphasises the important idea that a flow must be driven in order to overcome resistance. It also provides a focus for discussion which should encourage them to take a constructively critical approach to models, and to see differences as well as similarities between a model and the reality to which we are applying it.
- This is the optimum time for pupils to consider Spread 3.2.

Main activities

- Activity 3.2b Voltages in circuits: Shows that batteries (cells) in series have individual voltages and a combined voltage which is a sum of these. It goes on to show that circuit components, lamps and buzzers, also have a combined voltage which is equal to the total supply voltage and is shared between them. The component with the highest power also has the highest voltage. (This should not be taken to mean that voltage is the same thing as power, and certainly not that it is the same thing as energy, but merely that behaviour of voltage correlates with behaviour of power in series circuits.)
- *Support Pack* activity C3S2 can be used here or in the previous lesson.
- *Extension Pack* activity C3E2 provides additional critical assessment of a circuit model.

Suggested finishers

- Activity sheets C3S2 and C3E2 could be used to provide a consolidating finisher activity.
- The remember box on page 37 of *Pupil's Book C* emphasises key vocabulary.

Homework

None.

Suggestions

Literacy

Pupils could look at existing printed or film material on the hazards of mains voltage. They could discuss the material critically, to consider how the presentation could be improved.

Numeracy

The work also provides opportunity for consideration of values of height differences and potential differences (see the Support Sheets).

Sc1 Ideas and evidence

Pupils are invited to investigate fruit 'cells' and initial open-ended discussion of how this might be done should be encouraged, followed by a systematic approach to observations and measurements.

Key skills

Communication, application of number and ICT

Cover friendly rating

0 star (practical activity)

Technician's notes

Equipment	Quantity/group
Simple cell*	1 per class
Dry cell (battery)	1
Switch	1
Batteries and holders	3
Voltmeter	1
Electricial leads	6
Bulbs of different voltages	1 of each
Sandpaper	Small piece
Buzzer	1
Selection of fruit	1
Selection of electrodes†	2 of each type

Experimental notes

* Energy conversion kits may contain suitable simple cells.
† Suitable metals to use include copper, zinc, magnesium, aluminium, nickel and tin. Use sandpaper to clean the metal and make sure that it is stiff and without sharp edges, so that it can easily be pushed into the fruit.

Advice on investigation

See notes about modifying equipment for Activity 3.1.

Answers

1 a) amp, A
b) volt, V
2 Cell or battery
3 Skier is not moving downhill and transferring energy (by way of friction and air resistance) to the surroundings when at a rest place.
No energy transfer to the surroundings takes place from (zero-resistance) connecting wires.
4 a) The same
b) The same

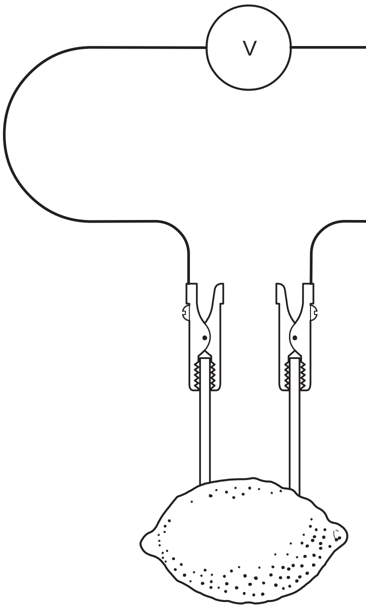
Match to

National Curriculum references

4.1a, c

3.2a Fruit cell investigation

Some kinds of fruit can act as cells or 'batteries'. They can provide voltage and they can transfer energy to circuits. This happens when two pieces of different kinds of metal are stuck into the fruit. The pieces of metal are called **electrodes**. A voltmeter can be connected to the electrodes to measure the voltages.



So try this

You are going to investigate how to make a fruit 'cell' that provides the highest possible voltage. You could try the following as part of your investigation:

★ different types of fruit

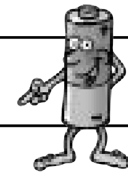
★ electrodes made from different types of metal

★ different sizes of electrodes.

Make a record

Make a plan of your investigation. In this plan, write down which **variables** you are investigating.

Write a report on your investigation. Explain what you did and what you found out.

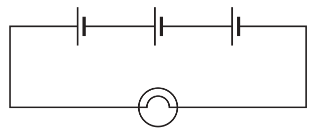


3.2b Voltages in circuits

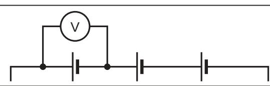
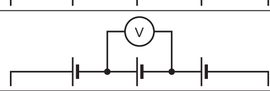
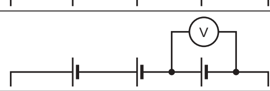
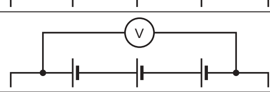
A voltmeter measures potential difference, which is also called voltage. We can use a voltmeter to measure the voltage (or potential difference) between the two connections to a battery.

So try this

Set up a circuit with three batteries like the one shown below.

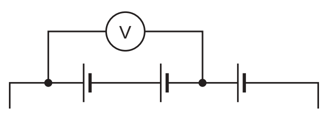


Use a voltmeter to measure the voltage between the two connections to the three batteries in your circuit. Do this one at a time and then do it for all three batteries together. Copy this table and add your measurements.

voltmeter connection	voltmeter reading in volts
	
	
	
	

Predict

What will the voltage be if you connect a voltmeter to the ends of two of the batteries in your circuit?



Use a pencil to write down your prediction. Then use a voltmeter to make the measurements. Was your prediction right or wrong? Use ink to write down what happened.

Now try this

Set up a circuit with batteries, a switch, two different kinds of light bulb and a buzzer. The light bulbs and buzzer are connected in series. They all have the same current.

Which do you think transfers energy most quickly to its surroundings – one of the light bulbs or the buzzer? You can find out by using a voltmeter.

Measure the voltages between the ends of the buzzer and the ends of each lamp, one at a time.

The one with the biggest voltage is the one that is transferring energy the quickest. Write them in order, starting with the quickest energy transfer device and ending with the slowest.

Appliances that you have at home work from the 230 V mains, but they do not all transfer energy at the same rate. Can you suggest what else can make a difference to how quickly an appliance or device transfers energy to its surroundings?

3.3 Meeting the demand

Rationale

The spread and activities introduce the electrical generator and compare conventional and pumped storage power stations.

Learning outcomes

Most pupils will be able to:
- describe the key parts of a power station
- suggest a range of energy resources that commercial power stations can use.

The faster pupils will:
- know that a generator works by magnetic interactions
- explain the benefits of a pumped storage scheme.

Those who progress less quickly will:
- understand that high voltages are hazardous
- recognise that electricity provides convenient energy transfer to homes and places of work.

Possible teaching strategies

Pupil could be asked about their personal attitudes to power stations, either through family connections with people who work in the industry, through visits they've made, or simply through having seen power stations. They should be asked to think about their importance.

Framework *Lesson plan*

1 hour/lesson

Suggested starter
- Starter C Power stations: Moves the focus of attention to generation of electricity at a national level. It requires pupils to match energy resources, turbines and the main usual descriptions of types of generation. It can be used as a stimulus for discussion, which might include what is meant by 'turbine' and to review ideas about the role of the Sun as the ultimate source of nearly all of our energy. Spread 3.3 can be used to consider key ideas, and in so doing it uses a 'new' context to avoid excessive repetition of contexts experienced by students in *Pupil's Book A*.

Main activities
- Activity 3.3 Power stations internet reasearch template: Pupils should use print and IT resources to gather material about power stations and the generation of electricity. They could present their material in a scrapbook or other format, such as a leaflet or poster.
- This is the opportunity for coverage of the fact that electricity distribution lines use high voltage, and that this has important safety consequences. The Electricity Council film *Electric Graffiti* should be shown. Pupils wishing to go further could explore the significance of the work of Nikola Tesla. Few will have heard of him, and they could usefully compare the impact of his work on our lives with that of others (whether contemporaries of Tesla or of ourselves) who are more famous.

Suggested finisher
Finisher D Power crossword: Reviews vocabulary and energy transfer associated with electrical generation.

Homework
Homework 3.3 Power stations: Deals with key ideas about power stations. It could, alternatively, be used as a lesson activity, and a homework activity could be based on the creation of a presentation format for material gathered during the research process.
Good sources of internet material at the time of writing include:
www.london-power.co.uk
Information on Sutton Bridge gas turbine power station and visitor centre.
sprinfieldbiz.com/sw/educate.html
An American site.
The UK electrical generation and distribution industry currently shows little interest in engaging the school population through valuable National Curriculum support by way of the internet.

Suggestions

Literacy

Pupils could write an account of their personal interaction with power stations. They should use personal knowledge wherever possible, and should be encouraged to acknowledge that they, as users of electricity, are in daily personal contact with power stations. Accounts might be illustrated with images as appropriate.

ICT

Pupils could download images of power stations from the Internet to embellish their accounts (see above).

Key skills

Communication, application of number, ICT

Cover friendly rating

3 star (textbook); 3 star (Homework sheet)

Answers

1 motor; input = electricity (voltage or current)
output = motion
generator; input = motion
output = electricity (voltage or current)

2 a) People use a lot of appliances and want to transfer a lot of energy, for example when they get up on a winter morning.
b) Power stations can't always supply energy as fast as people want to transfer it.
c) Pumped storage can store energy and supply it quickly.

3 Renewable

Answers to Finisher D

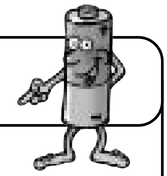
Across: 2 fuel, 3 energy, 5 nuclear, 7 miners, 8 hydroelectric, 10 turbines.
Down: 1 kinetic, 2 fossel fuels, 4 generator, 6 current, 8 heat, 9 cables.

Match to

National Curriculum references

4.1 c, 4.5 a, c, d, e

Chapter 3 Activity sheet



3.3 Power stations internet research template

Use the internet to find out about a particular power station.

Suggested key words:

power station **fossil fuel** **renewable energy**

Key words used:

Websites and organisations:

Website: Organisation:	Website: Organisation:
Website: Organisation:	Website: Organisation:

Power station name:

Power station location:

Either print a map showing where the power station is, or use an atlas to find its location.

Energy source used by power station:

Power output:

Turbine driven by:

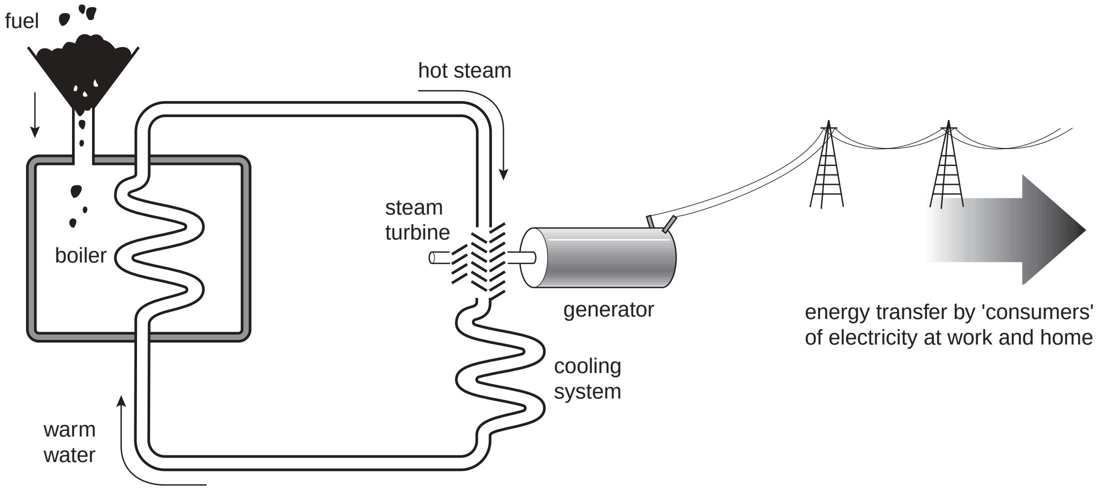
What is the difference between a turbine and a generator?

Print a photo of your power station.

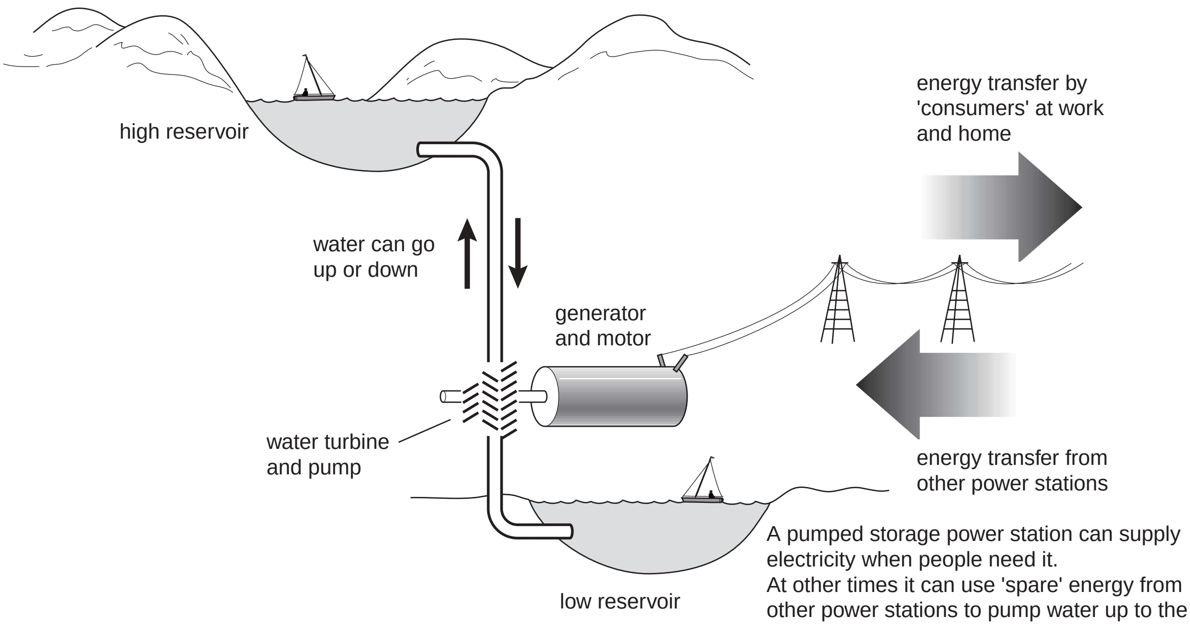
Keep this sheet, the map and the photo as your record of your internet research.

3.3 Power stations

1 What are the sources of energy for each of the power stations in the diagram?



A conventional power station



A pumped storage power station can supply electricity when people need it. At other times it can use 'spare' energy from other power stations to pump water up to the high reservoir and so store energy

2 Make a list of energy resources, including fuel such as oil or gas, that different power stations can use. List as many as you can.

3 On the diagram of the conventional power station, show:
a) where energy is transferred quickly and only by heating
b) where energy is transferred by working.

4 Explain how the pumped storage system 'stores' energy. When is the pumped storage system especially useful?

3.4 Energy rates

Rationale

This spread looks again at appliances, and in particular at their power ratings.

Learning outcomes

Most pupils will be able to:

- compare the power ratings, and hence rate of transfer of energy, of different appliances
- perform aided calculations on power ratings and costs
- use the kilowatt-hour as a unit of energy.

The faster pupils will be able to perform open-ended calculations on power ratings and cost.

Those who progress less quickly will:

- know that electricity bills are based on total energy transferred, which is called energy consumption
- be familiar with the watt and the kilowatt as power rating units.

Possible teaching strategies

Pupils should examine labels on some appliances and be encouraged to identify the power rating. The data from the labels provides plenty of opportunity for numeracy exercises.

Framework Lesson plan

1 hour/lesson

Suggested starter
Spread 3.4 should be studied and initial links should be made between power and cost per hour.

Main activities

- Activity 3.4 Power ratings: This is a paper exercise which continues to develop the ideas of energy, power and cost.
- *Support Pack* Activity C3S3 provides a template for consideration of costs.
- *Extension Pack* Activity A3E3 looks at energy transfer through the series of processes from generator to domestic appliance, and engages pupils with the need for energy economy.

Suggested finisher
The remember box on page 41 of *Pupil's Book C* provides vocabulary support.

Homework

- Homework 3.4 Appliance spaces: Pupils have to calculate power, energy transferred and the cost of using an appliance using the data supplied.
- Activities C3S3 and C3E3 can, alternatively, be used as a homework activity.

Suggestions

Numeracy

The work involves considerable practice in use of number in the context of energy bills. Work on copies of actual up to date electricity bills would make a useful addition to pupils' collections of evidence.

Key skills

Communication, application of number, ICT

Cover friendly rating

3 stars (textbook); 3 stars (Homework sheet)

Answers

1 Heater arrow thicker (by approximately ×2.5)
2 a) 26.4p
b) 60p
c) 30p
d) 20p
e) 20p
3 The energy has dissipated into the room.
4 By heating and working.
5 By heating and working.

Match to

National Curriculum references

4.1 c, 4.5 e, g

Chapter 3 Homework sheet

3.4 Appliance spaces

Fill in the spaces in the table.

applience	power in watts	power in kilowatts	energy transferred every hour in kilowatt-hours	energy transferred every 5 hours in kilowatt-hours	cost of using appliance for 5 hours in pence*
high power lamp	200	0.2	0.2		
TV	400				20
Fridge			0.5	2.5	
Washing machine	1200	1.2			
Kettle	2000				100

*Base your calculation on energy cost of 10 pence per kilowatt-hour.

Challenge

By what number must you multiply the power in kilowatts to find out the cost in pence?

3.4 Power ratings

Every appliance has a power rating. It is measured in watts (W) or kilowatts (kW) and it tells us how quickly the appliance transfers energy. A kilowatt is a thousand watts (1 kW = 1000 W).

These are the power ratings of some appliances, in watts and kilowatts:

Appliance	Power rating in watts (W)	Power rating in kilowatts (kW)
Low power lamp	40	0.04
Medium power lamp	100	0.1
Radio	200	0.2
TV	400	0.4
Fridge	500	0.5
Lawnmower	500	0.5
Hair drier	600	0.6
Washing machine	1200	1.2
Room heater	1500	1.5
Kettle	2000	2.0

The longer we use an appliance for, the more energy it transfers, and the more it costs. So to work out the cost of running a particular appliance for a particular length of time, we start by multiplying the power rating in kilowatts by the time in hours. The answer is a number of **kilowatt-hours**. This is a measurement of energy.

energy transferred in kilowatt-hours = power in kilowatts × time in hours

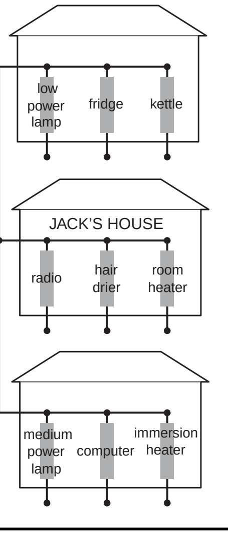
The electricity companies make a charge for each kilowatt-hour of electrical energy that you transfer in your home. They measure this using the electricity meter that you have, perhaps in a cupboard, at home.

The cost of electrical energy is *about* 10p per kilowatt-hour. So the cost of running an appliance is the number of kilowatt-hours it has transferred, multiplied by 10p.

approximate cost in pence = power in kilowatts × time in hours × 10p

For example, for the computer used for 3 hours, approximate cost in pence = 0.5 × 3 × 10 = 15p

Questions



1 Work out the cost of using each of the following appliances for 4 hours:
a) medium power lamp, b) radio, c) fridge,
d) washing machine

2 The diagram shows a mains electricity supply to a group of houses, and the appliances that are used in the houses.
a) Copy Jack's house and add energy transfer arrows. Use the thickness of the arrows to represent the different power ratings of the appliances.
b) If all the appliances are on in all three houses, which house is transferring energy the fastest?

3.5 Future homes

Rationale

This spread and activity examine domestic energy consumption and environmental impacts.

Learning outcomes

Most pupils will be able to:
- recognise environmental impacts of electricity generation
- make considered suggestions for reduction of environmental impacts.

The faster pupils will be able to consider and discuss commercial and political factors affecting electricity generation and environmental impact.

Those who progress less quickly will:
- know that generation of electricity causes environmental problems
- be able to give practical examples of how energy can be wasted in the domestic situation.

Possible teaching strategies

Leaflets on electrical energy consumption are available from several sources. Pupils should compare these and some may find it a strong learning experience to use ICT resources to develop their own leaflets for their peer group audience.

Pupils should be reminded of work on thermal insulation, covered in year 8, as applied particularly to the context of housing.

Pupils should have contact with solar cells.

Framework *Lesson plan*

2 hours/lessons

Suggested starter
Starter D What do you think? Provides statements about energy resources, transfer and economy. Pupils should examine and discuss the statements at the start of the lesson, and 'pencil in' their first ideas. They should then return to them as a finisher activity, and 'ink in' their developed views.

Main activities
- Spread 3.5 can be used first as a review of ideas about energy resources as experienced in *Pupil's Book A*. It then takes those ideas further into more specific issues of methods of reducing domestic energy transfer and the importance of thermal insulation in particular. Note that this builds upon pupils' experience in thermal ideas (*Pupil's Book A* Chapter 3 and *Pupil's Book B* Chapter 3) as well as in electricity.
- Activity 3.5 Renewable energy internet research template: Pupils should carry out internet research on alternative energy issues.
- *Support Pack* Activity C3S4 provides a further activity on energy economy at home.
- *Extension Pack* Activity C3E4 provides an engaging and motivating activity on broad issues of energy economy.

Suggested finishers
- Pupils should return to Starter D to review their learning.
- The remember box on page 43 of *Pupil's Book C* consolidates key vocabulary.

Homework
- Homework 3.5 Environmental impact: Reviews energy economy issues.
- Pupils should also prepare for the end-of-unit test.

Suggested starter
Finishing Off! on page 44 of *Pupil's Book C*, can be used to remind pupils of key ideas.

Main activity
Pupils should complete a test for this unit. A new short Key ideas SATs-style test can be found on the CD-ROM. In addition test material can be found in the *Hodder Science Assessment Pack*. This includes for each unit, a SATs-style test, a very simple low-level-test for slower learners, extension questions to add to tests for faster learners and Ideas & Evidence questions to add to tests.

Suggested finisher
If time allows go through the end-of-unit test answers (pupils could mark each other's papers).

Homework
None.

Suggestions

Literacy

Discussion of the issues of how the homes we live in might be in the future, together with the information gathering activity (see above and below) provides an excellent basis for creation of evidence of development of key skills in communication.

Key skills

Communication, application of number, ICT

Sc1 Ideas and evidence

The work presents an opportunity for consideration of the present day work of scientists, in the context of environmental impact of electricity generation. Information on the work of scientists can be obtained from The Natural Environment Research Council (www.nerc.ac.uk) and The Engineering and Physical Sciences Research Council (www.epsrc.ac.uk).

Cover friendly rating

3 star (textbook); 3 star (Homework sheet)

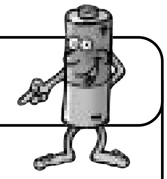
Answers

1 a) Double glazing, loft insulation, cavity wall filling, efficient appliances
b) Passive heating, solar panels
2 Pupil's own opinion
3 Pupil's own opinion

Match to

National Curriculum references

4.5 a, b, c, d, e, f, g



3.5 Renewable energy internet research template

Use the internet to find out more about alternative energy resources. Visit several websites, and gather key information.

Suggested key words

renewable energy **solar energy** **wind energy** **hydroelectric**

Key words used

Websites visited

Website 1

Name of organisation:

Organisation's reason for producing the website:

Involvement of organisation with renewable energy:

Key information obtained:

Website 2

Name of organisation:

Organisation's reason for producing the website:

Involvement of organisation with renewable energy:

Key information obtained:

Website 3

Name of organisation:

Organisation's reason for producing the website:

Involvement of organisation with renewable energy:

Key information obtained:

If you find any images with useful information then print them out. Share your key information with other people. Keep this sheet and images, if you printed any, as part of your record.

3.5 Environmental impact

We can reduce the environmental impact of our energy needs by:

★ using renewable energy resources such as wind and solar cells

★ living in energy efficient houses which have
  - good insulation
  - windows facing the Sun for natural warming
  - solar cells
  - appliances (such as refrigerators) which don't waste energy.

Questions

1 Name two ways of reducing environmental impact that are used at The Centre for Alternative Technology, Machynlleth.

2 Make a large sketch of an energy-efficient home, showing its important features.

3 Why don't we:

a) ONLY use renewable resources?

b) ALL live in energy-efficient houses?

