

Answers

7A Cells, tissues, organs and systems

7Aa Life processes

Student Book

1: 7Aa Doctors past and present (Student Book)

- 1 a symptoms b bad cold, flu
 2 a lot of pimples or spots on the skin
 3 a an organ b pumps blood

2: 7Aa Life processes (Student Book)

1

Organism	Not an organism
cow	car
daffodil	chair
goldfish	coal
mouse	robot
octopus	rock
snake	Sun

- 2 Mrs Gren
 3 Animals can usually move their whole bodies from place to place but plants can only move parts of themselves.
 4 one of: make seeds, make fruit, produce flowers, use insects
 5 two suitable answers such as: pupils getting smaller in bright light, moving a hand away from something hot
 6 Humans stop growing after a while, trees continue to grow.
 7 Fish get oxygen from water/using gills but humans get oxygen from air/using lungs.
 8 a A car will move, it will sense certain things (e.g. being broken into) and it will respire in the sense that it uses oxygen to release energy from fuel. Most cars will excrete exhaust gases and require a source of energy (nutrition).

b A car will not grow and will not reproduce; something can only be an organism if it shows all seven life processes.

Activity Pack

7Aa-1 Life processes

- 1 excretion, growth, movement, nutrition, reproduction, respiration, sensitivity
 2 any living thing

3 excreting – getting rid of waste; growing – increasing in size; reproducing – making copies; respiring – releasing energy

4 a car

b it does not grow and it does not reproduce (see answer to Q8 in SB above).

7Aa-2 Life processes in seedlings

E measuring cylinder; grow; seeds; respiration; carbon dioxide; excreted; limewater

1 After several days, the limewater will become milky.

2 The limewater went milky. This is evidence that plants respire.

7Aa-5 Trees and growth

1 growth

2 X – 11 years old, Y – 23 years old, Z – 11 years old

3 a X – 1998, Y – 2005, Z – 2008

b These are the years corresponding to the widest rings.

4 a X – 1994 or 1995, Y – 1991, Z – 2006 or 2007

b These are the years corresponding to the narrowest rings.

7Aa-6 Living and non-living

1 these words should be underlined: cactus, gerbils, birds, eggs

these words should be circled: Sun, clouds, water, nest

2 reproduction

3 grow; move/reproduce; move/reproduce; food; organisms; organisms; grow/reproduce/move

7Aa-7 Life processes and robots

1

Question	Life process	ASIMO	Human
Can it move?	movement/ moving	✓	✓
Can it produce babies?	reproduction/ reproducing		✓
Does it grow?	growth/ growing		✓
Does it need oxygen?	respiration/ respiring		✓
Does it produce waste products?	excretion/ excreting		✓
Can it sense things around it?	sensitivity/ sensing	✓	✓
Does it need a source of energy?	nutrition	✓	✓

2 respiration and excretion

3 No. A fire does not sense things around it or reproduce. A fire could be said to do all of the other life processes.

Teacher and Technician Planning Pack

7Aa Homework 3

1 life processes and if they are found in each item – suitable presentation (e.g. multicolumn table)

Life process	car	cow	fish	river	robot
movement	✓	✓	✓	✓	✓
reproduction		✓	✓		
sensitivity	✓	✓	✓		✓
growth		✓	✓	✓	
respiration	✓	✓	✓		
excretion	✓	✓	✓		
nutrition	✓	✓	✓		✓

2 Students' own ideas about how we can tell that a life process is occurring in a certain item/organism.

3 The life process that can never be said to occur in non-living things (for the moment) is reproduction.

Student Book

1: 7Ab Organs (Student Book)

1 any five organs and their functions copied from diagram B on the Student Book spread 7Ab Organs (extra credit should be given for a neatly drawn table with correct headings; further credit could be given for ordering the organs in some way, e.g. alphabetically)

2 lung

3 food pipe/gullet/oesophagus, stomach, small intestine

Some students might have included mouth, even though it is not labelled on the diagram. Note that the large intestine has little role in getting nutrients into the body, only reabsorbing water.

4 kidney, lungs, liver

5 rectum, bladder

6 leaf

7 a photosynthesis

b Light is needed for photosynthesis – with less light, less food will be made.

8 liver, as it makes and stores some substances and destroys other substances

Activity Pack

7Ab-2 Organs

[first picture] intestines – breaks up food and takes it into the blood

[second picture] lungs – gets oxygen into the blood

[third picture] heart – pumps blood

[fourth picture] liver – makes and destroys substances

[fifth picture] leaf – makes food

[sixth picture] stomach – breaks up food

[seventh picture] brain – controls the body

7Ab-6 Investigation reports

1 Aim, Prediction, Method, Results, Conclusion, Evaluation

2 It makes it easier for all scientists to find/ understand/compare information.

3 Aim – Does temperature affect how many cress seeds germinate?/ I wanted to find out which material was the best insulator out of wool, cotton, paper and felt./ My aim was to see whether adding salt to water changed its freezing point.

Prediction – I predict that if a surface is rougher then it will take more force to move it across another surface./ I think that the warmer the water, the greater the amount of salt that will dissolve.

Method – I measured out 20 cm³ of water using a measuring cylinder./ I used a Bunsen burner that was set to a blue flame./ We put on eye protection in case the liquid splashed in our eyes.

Results – There were a total of 140 daisy plants growing in the lawn./ We found that 10 woodlice moved into the dark and damp area of the dish.

Conclusion – More photosynthesis happens when there is more light./ My evidence shows that when you double the mass you also double the amount the spring stretches by.

Evaluation – I would repeat my measurements to be more sure of my results./ Next time I will use a tape measure because it was difficult to take measurements using a short ruler.

7Ab-7 Where the organs are

1 *Students' own answers:* diagram correctly labelled

2 Credit should be given for placing the heart in a reasonably central position between the two lungs but drawn so that more of it is on the right (see the Student Book spread 7Ab Organs).

3 *Students' own answers:* two organs and their correct functions

4 *Students' own answers:* two organs and their correct functions

5 part of an organism with an important job

7Ab-8 Organ evidence

1 a It makes it easier for people to understand quickly, even if they don't speak English.

b 9.5 people per 100 000 for liver disease; 68.8 people per 100 000 for heart disease; 21.5 people per 100 000 for lung disease; 3.2 people per 100 000 for kidney disease

c ordered list of the data in part b, either alphabetically or ascending/descending death rates

d Students' own answers

e A major cause of death in the UK is heart disease.

f liver – makes and destroys substances; heart – pumps blood; lungs – get oxygen into the blood; kidneys – clean the blood/produce urine

2 a B, E or F

b A or D

c C

3 nutrition

7Ab-9 A new organ

1 a kg, m

b It makes it easier/quicker for all scientists to understand information, even if they don't speak a certain language.

2 a sensitivity

b nutrition, movement

3 a sensitivity – skin, eye, ear, nose, tongue (students are not expected to get all of these); nutrition – oesophagus, stomach, small intestine; movement – brain, tongue, heart, diaphragm (students are not expected to get all of these)

b descriptions of organ functions

4 Brain because it receives and sends out information/controls things. Credit could also be given for skin, eye, ear, nose, tongue, since they are all organs that sense things in the same way that the 'new organ' senses krill.

5 The list should be presented in order: krill detection – jawbone movement downwards and tongue flattening – jawbone movement upwards – tongue pressing water out – krill swallowing.

7Ab Medical doctors (STEM)

1 science, technology, engineering, maths

2 a use X-rays (to see the bones inside the leg)

b to see how the heart is pumping/working (without having to cut the patient open)

3 the ear

4 a it pumps blood

b two suitable ideas from things such as: listening to the chest, measuring the pulse, using a scanner/X-ray

5 a It makes and stores some substances, and destroys other substances – it removes toxins from the blood.

b liver disease

c results of a urine test

d kidney

e bladder

6 To help athletes recover from injury and ensure that the athletes they are on top form and can win medals for the country.

7 a doctor who specialises in the heart

7Ac Tissues

Student Book

1: 7Ac Tissues (Student Book)

1 magnifies things

2 Students should spot that it has different parts that are different colours.

3 a fat, muscle (there are others, e.g. nerve tissue, but these have not been mentioned yet)

b Fat protects the heart; muscle moves the heart.

4 Students should spot that the two livers are not the same colour and the one in photo D appears to have spots in it. The spots are the same colour as the fat tissue in the heart in photo B: this is evidence that the liver in photo D has fatty liver disease.

5 muscle

6 a storage organ

b at least two of: From photo F, a central disc can be seen surrounded by an outer disc with slightly different colouration. These are essentially two tissues. There are also smaller areas of different colours and these are other tissues (e.g. phloem tissue that carries sugars down into the root to be stored).

7 a root hair tissue, xylem tissue

b Root hair tissue takes in water; xylem tissue transports water in the plant.

8 stem or leaf

9 nutrition

2: 7Ac Microscopes (Student Book)

1 There are two types of lenses: eyepiece lens and objective lens.

2 a and **b** Rules might include: never run when carrying a microscope; handle the glass slide very carefully; do not point the mirror at the Sun; do not use the coarse focusing wheel when the objective lens is close to the slide.

3 focusing wheels

4 the object that you look at under a microscope

5 ×150

6 so that the light from the microscope can get through it

7 to keep the specimen flat/hold the specimen in place/stop the specimen drying out

8 any two plant and animal tissues (e.g. fat tissue, muscle tissue, root hair tissue, xylem tissue)

9 Student plans should include step-by-step instructions on slide preparation and microscope use. Plans should include safety advice. Additional credit should be given for writing a simple aim for the plan (e.g. to see what rhubarb stem tissue looked like) and possibly an introduction about what a microscope does.

Cells, tissues, organs and systems

10 The light source is not on or is not adjusted properly, the objective lens may not be straight over the hole in the stage, there may be a cap over one or both lenses or the specimen is too thick.

Activity Pack**7Ac-1 Tissues**

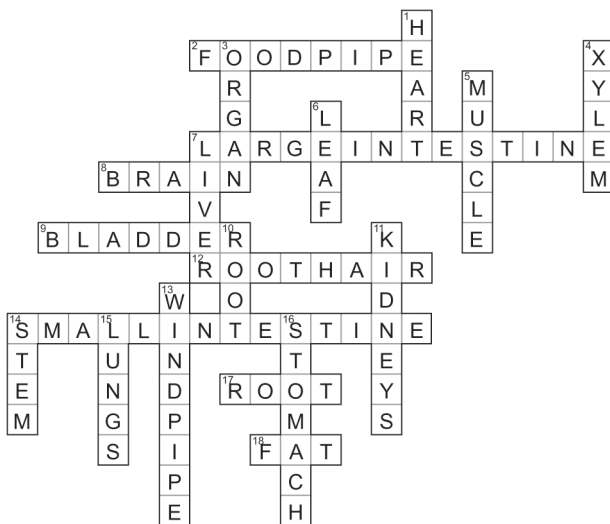
- 1 tissues correctly labelled
- 2 that different areas are different colours
- 3 tissues, tissue, root, hair, water, xylem

7Ac-2 Microscopes and slides

- 1 to make things appear larger
- 2 diagram correctly labelled:
coarse focusing wheel – adjusts the clearness of the image in large amounts
fine focusing wheel – adjusts the clearness of the image in small amounts
eyepiece lens – part you look through
objective lens – lens closest to the specimen
mirror – directs light through the specimen
coverslip – stops the specimen drying out
stage – supports the slide
slide – supports the specimen

7Ac-4 Microscope card sort

The instructions should follow the order of those on the Student Book spread 7Ac Microscopes.

7Ac-5 Tissues and organs crossword**7Ac-6 Using microscopes**

1 1 Place the smallest objective lens over the hole in the stage; 2 Turn the coarse focusing wheel until the objective lens and the stage are as close as possible; 3 Place the slide on the stage; 4 Look into the eyepiece lens; 5 Adjust the light source; 6 Turn the coarse focusing wheel until what you see is clear.

2 The instructions should follow the order of those on the Student Book spread 7Ac Microscopes.

3 to hold the specimen in place; to stop the specimen drying out

7Ac-7 Organs and tissues

1 fat tissue (which protects) and muscle tissue (which moves) found in the heart; root hair tissue (which takes in water) and xylem tissue (carries water in the plant) found in the root; xylem tissue (which carries water in the plant) found in the stem

2 The definition should include reference to an organ being something that has a very important job in an organism and to an organ being made out of different types of tissues.

7Ac-8 Microscope problems

1 a The mirror is pointing in the wrong direction.

b Viewing through a microscope using direct sunlight will damage eyesight.

c Liquids should be added with a dropper or pipette.

d The specimen is too thick so not enough light will get through it.

2 $\times 50$; $\times 200$; $\times 15$

3 makes parts of a specimen stand out

7Ac-9 Microscope magnification

1 a Microscopes have two lenses, the *eyepiece* lens and the *objective* lens.

b A coverslip is used to *hold a specimen in place and to stop a specimen drying out*.

c To start using a microscope, you should turn the focusing wheel so that the objective lens and the stage are as *close* as possible.

d You should not aim the mirror of a microscope at the Sun *because it will damage your eyes*.

e A stain is used to *make parts of the specimen stand out*.

f The magnification of a microscope is worked out by *multiplying* the magnifying power of the two lenses together.

2 a an air bubble

b Lower the coverslip down onto the specimen slowly and carefully.

c 0.05 mm (width of hair on drawing = 5 mm ; magnification = $5 \times 20 = 100$, so actual width = $5 \text{ mm} \div 100 = 0.05 \text{ mm}$)

3

Total magnification required	Magnification of eyepiece lens	Magnification of objective lens
$\times 30$	$\times 2$	$\times 15$
$\times 100$	$\times 5$	$\times 20$
$\times 300$	$\times 7.5$	$\times 40$
$\times 400$	$\times 10$	$\times 40$

Teacher and Technician Planning Pack**7Ac Homework 5: Organs and their tissues**

Indicative answers are in the table. For a full discussion of tissues and their subtypes, see Background information.

Organ	Tissues	Job of tissue
heart	fat	protection
	muscle	movement
	nerve	communication/control
brain	nerve	communication/control
	connective	supports and connects tissues
	muscle	movement
skin	fat	protection
	epithelial	sweating, protection, sensing
	connective	joining tissues
plant stem	xylem	carrying water
	phloem	carrying dissolved substances/sugars
	cambium	growth
	epidermis	protection

7Ad Cells**Student Book****1: 7Ad Cells (Student Book)**

1 the basic building block from which all organisms are made

2 Granville's microscope had a better magnification. You could mention to more able students that Hooke was observing dead cells that had not been preserved. The quality of the glass in Granville's microscope is also likely to have been better.

3 cells

4 a nuclei

b control the cell

c cytoplasm, cell surface membrane, mitochondria

d cytoplasm is where the cell's activities occur; the cell surface membrane controls what goes in and out of the cell; mitochondria release energy for the cell by respiration

5 a widest part is approximately 2.8 cm; actual size is $28 \text{ mm}/600 = 0.047 \text{ mm}$

b length is approximately 6.2 cm; actual size is $62 \text{ mm}/275 = 0.23 \text{ mm}$

6

Part of cell	Animal cell	Plant cell
cell surface membrane	✓	✓
cell wall		✓

Part of cell	Animal cell	Plant cell
chloroplast		✓
cytoplasm	✓	✓
mitochondria	✓	✓
nucleus	✓	✓
vacuole	*	✓

*Note that animal cells can have vacuoles but they are small and not permanent.

7 a chloroplasts (or chlorophyll)

b Chloroplasts are clearly visible in photo E but mitochondria are not.

8 The shape of the root hair cell should be similar to that shown in photo F on the Student Book spread 7Ad Cells. There should not be any chloroplasts shown. The following should be labelled: nucleus, cytoplasm, vacuole, cell surface membrane, cell wall.

Activity Pack**7Ad-1 Cells**

1 a The microscope on the far right.

b It has the highest magnification.

2 Label lines as for diagrams C and E on the Student Book spread 7Ad Cells.

3 See Student Book answer to Question 5 (above) although there are no mitochondria on this sheet.

7Ad-7 Discovering cells

1 1590; 1932; 1830; 14th century, 18th century

2 a cell surface membrane – controls what goes into and out of a cell; chloroplast – makes food in plant cells; nucleus – controls the cell; mitochondrion – where respiration happens

b nucleus; chloroplast; mitochondrion; cell surface membrane

c Smaller things have been discovered as the magnifying power of microscopes has increased.

7Ad-8 Plant and animal cells

1 a Labels as for diagram E on the Student Book spread 7Ad Cells.

b chloroplast – makes food; nucleus – controls the cell; cell wall – helps support the cell; cytoplasm – where the cell's activities happen; vacuole – stores substances; cell surface membrane – controls what goes in and out

2 a nucleus, cell surface membrane, cytoplasm.

Additional credit should be given for 'mitochondria'

b change shape

3 a to carry liquids

b It is hollow, like a straw.

7Ad-9 Plant or animal?

1 a x500

b i flagellum

ii light detector

iii chloroplast

c mitochondrion

d It has features of both plant (e.g. chloroplast/vacuole) and animal cells (no large permanent vacuole/no cell wall/it can move).

2 a animal cell – it has no chloroplasts and no cell wall

b cell wall – some plant cells (e.g. in roots) don't have chloroplasts, whereas some animal cells have large storage areas

3 a thicker cell wall because cell walls help to support cells

b more mitochondria because muscle cells need a lot of energy to move

c lots of chloroplasts since the cells are in a good place to trap light energy from the Sun for photosynthesis

d no chloroplasts because no light gets to the roots

7Ad-10 Cells and organelles

1 a W – an animal cell; X – a plant cell; Y – an animal cell; Z – a plant cell

b W – no cell wall, no chloroplasts; X – has a cell wall; Y – no cell wall, no chloroplasts, no vacuole; Z – has a cell wall, has a vacuole

c W – has a large storage space; X – no chloroplasts, extended/no vacuole (depending on how you look at it), strands running through it, large holes in the cell wall, no nucleus; Y – branched; Z – has a hair-like bit sticking out of it, has no chloroplasts

d W – storing substances. This is in fact a human fat cell; X – transporting things, since the holes allow the flow of substances from one cell into another. This is in fact a phloem sieve cell, which transports dissolved sugars around a plant; Y – movement or high amounts of substance production because the cells are packed with mitochondria; Z – absorbing liquids because it has a large surface area

2 chloroplasts, mitochondria, nucleus

3 Lysosomes can be seen with a laser microscope and an electron microscope. At 0.1 μm (100 nm) in diameter they are too small to be resolved by a light microscope. Melanosomes and peroxisomes can be seen with all three types of microscope.

7Ae Organ systems

Student Book

1: 7Ae Organ systems (Student Book)

1 nerves, muscle, fat

2 a They only saw blood vessels in dead bodies, by which time the blood had drained out of the tubes and they contained air.

b any suitable answer, from surgical procedures to internal scanning of the body

3 a group of organs working together

4 trachea/windpipe, lungs, diaphragm

5

Organ system	Organs it contains
breathing	trachea/windpipe, lungs, diaphragm
circulatory	heart, blood vessels
digestive	gullet/oesophagus/food pipe, stomach, small intestine, large intestine, rectum
locomotor	muscles, bones
nervous	brain, spinal cord, (nerves)
urinary	bladder, kidneys

Consider awarding extra credit if the table is ordered in a logical manner (e.g. alphabetical order).

6 C nutrition; D excretion; E sensitivity

7 a root, stem, leaf b xylem

8 See the planning strand of the Working Scientifically Investigation assessment grid in the ASP.

2: 7Ae Transplants (Student Book)

1 a Cell copied with nucleus, cytoplasm and cell surface membrane labelled.

b sample Y

2 Diagram should look similar to one of figures B–E and one of figures F–G from the Student Book spread 7Ae Organ Systems.

Activity Pack

7Ae-1 Organ systems

1 a Completed diagram, showing smooth muscle cells making smooth muscle tissue and nerve cells making nerve tissue, with both tissues going into the stomach.

b digestive system

2 a group of organs working together

3

Organ system	Function	Organs
circulatory system	to carry food and oxygen to all parts of the body	heart, blood vessels
digestive system	to break down food and take it into the blood	gullet/oesophagus/food pipe, stomach, small intestine, large intestine, rectum
locomotor system	movement	bones, muscles
nervous system	communication, sensing things	spinal cord, brain, nerves
urinary system	to get rid of waste	bladder, kidneys

7Ae-5 Organ systems wordsearch

I	N	T	E	S	T	I	N	E	S
H	E	A	R	T					
				O		M	W		G
				M		O	I		U
		L		A		U	N		L
		U		C		T	D		L
		N		H		H	P		E
		G					I		T
V	E	S	S	E	L	S	P		
				L	I	V	E	R	

7Ae-7 Organs in systems

1 nutrition – digestive system – stomach, small intestine

respiration – breathing system – lungs, windpipe

excretion – urinary system – kidneys, bladder

sensitivity – nervous system – spinal cord, brain

2 roots, stem, leaves

3 a breathing system

b circulatory system

c The breathing system only takes oxygen into the body. It is the circulatory system that carries this oxygen to all parts of the body.

4 a tissue

b organ

c organ system

7Ae-8 Human organ systems

1 a digestive system; any two of food pipe/oesophagus/gullet, stomach, small intestine, large intestine, rectum, anus, liver

b nervous system; any two of brain, spinal cord, nerves

c locomotor system; bones, muscles

d breathing system; any two of diaphragm, lungs, windpipe/trachea

2 a *Students' own numbering* – ensure that no numbers are repeated

b 'I wanted to find out whether tissue X was the same as tissue Y.'

c 'I had taken a small piece of tissue and put it on some stain on a slide. Then I lowered a coverslip onto the specimen in order to keep it flat and stop it drying out.' And 'I looked at them under the microscope.'

d 'The cells in tissue X were long and thin.' And 'Its cells were rounded.'

e 'Tissue X was not the same as tissue Y.'

f an organ

7Ae-9 Kidney failure

1 digestive system (breaks down food and takes it inside the body); circulatory system (carries food and oxygen to all parts of the body); urinary system (removes wastes like urea)

2 a and **b** gullet (carries food to stomach); stomach (starts to break down food); small intestine (breaks down and absorbs food); blood vessels (carry blood that carries oxygen and food); heart (pumps the blood); liver (breaks down extra protein and stores substances like glycogen); kidneys (remove waste from the blood, like urea, and produce urine); bladder (stores urine)

3 a It helps to remove substances that the body does not need.

b It has many functions (e.g. storing glycogen) and so is not just an organ that gets rid of things that the body does not need.

4 Heart attack. Urea at too high a concentration damages organs like the heart.

5 The body does not have a use for the red substance.

6 It filters the blood and removes waste from the blood.

7 It is the additional protein in the diet that causes urea production. Urea production will be lower if there is less protein in the diet.

8

Treatment	Advantages	Disadvantages
dialysis	does not rely on donors; does not require person to take medicines	time consuming; expensive
transplant	cheaper than dialysis; allows a more normal life	may not work; have to take medicines for rest of life; relies on suitable donors

9 A transplant allows them to lead a more normal life (e.g. going on holiday).

7B Sexual reproduction in animals**7Ba Animal sexual reproduction****Student Book****1: 7Ba Escaped zoo animals (Student Book)**

1 They have reproduced.

2 For reproduction in lynx and most other animals both a male and a female are needed.

3 photographs

4 Only one big cat has ever been found in the wild in the UK, dead or alive.

Sexual reproduction in animals

5 two of: they give birth to live young, they look after their young and protect them, they feed their young on milk, they both use sexual reproduction

2: 7Ba The scientific method (Student Book)

1 reproduction

2 They often saw rats in rotting rubbish; they saw more rats in rotting rubbish than anywhere else.

3 a an idea that answers a question and can be tested

b If there is no mud, then no frogs will appear.

c no

d Change the hypothesis or think up a new hypothesis.

4 a result **b** hypothesis **c** prediction

5 a Do rotten bananas produce flies?

b Rotten bananas produce flies. The hypothesis must relate to the question in part a.

c If flies are not able to get into a jar containing rotting banana peel, then no flies will be found in the jar after two weeks (or similar, as long as it is related to the hypothesis in part b).

6 a The presence of maggots does not depend on (rotten) meat.

b If flies cannot get to the meat, then no maggots will appear in the meat.

c His results showed that maggots only appear in the meat that flies can get to and therefore the maggots must have something to do with the flies and not the meat itself.

3: 7Ba Animal sexual reproduction (Student Book)

1 young/babies

2 sexual reproduction

3 a egg cells

b If students measure the widest part of the egg cell on the photo it is about 75 μm . If they measure the narrowest part it is about 50 μm . Dividing each by the magnification ($\times 600$) and rounding to one decimal place gives 0.1 mm (or 100 μm). This is of the right order. For the sperm cell, a measurement of width across the head is about 1 mm. So the real life width is calculated as 0.002 mm (or 2 μm). This is slightly small, the average width being about 3 μm but the error is caused by difficulties in measuring small distances accurately with a ruler. The length of the head is measured as 3 mm. So the real life length of the head is calculated as 0.005 mm or 5 μm (which is about right). The visible part of the tail measures about 12 mm in the photo, which gives a real life length of 0.02 mm (or 20 μm). However, much of the tail cannot be seen in the photo and the real length is more of the order of 50 μm .

4 a sperm cell

b It fuses/joins with an egg cell/ovum.

5 a *students' own answers* (e.g. fish, frog)

b Not all the egg cells/ova will get fertilised and many of the fertilised egg cells/zygotes will be eaten.

6 a *students' own answers* (e.g. human, mammal, dog, bird)

b Internal fertilisation helps to make sure that sperm cells reach the egg cells; the animals usually look after their developing offspring.

7 There is no water/fluid for the sperm cells to swim in and reach the egg cells/ova.

8 Fewer, because the female looks after the fertilised egg cells/zygotes (and the hatchlings) and so more of them survive.

Activity Pack**7Ba-1 The scientific method**

1 everyday observations \rightarrow scientific question \rightarrow hypothesis \rightarrow prediction \rightarrow experiment \rightarrow data (results)

2 a Mice should be drawn in the upper right drawing.

b If the grain is covered, then there will not be any mice in the grain after two weeks.

3 If the number of foxes increases, then the number of rabbits will decrease.

7Ba-2 Animal sexual reproduction

1 Two parents produce offspring by sexual reproduction.

Sperm and egg cells fuse during fertilisation.

Fertilised egg cells are produced by fertilisation.

Internal fertilisation happens inside a female's body.

Frogs are organisms that use external fertilisation.

2 Labels should include: sperm cell or male gamete; egg cell or female gamete or ovum; the gametes fuse/join, they form a fertilised egg cell or zygote, this process is called fertilisation.

3 1 – frog; 2 – dog; 3 – human

4 in an egg, under a female – blackbird; inside a female's body – human; in an egg, away from parents – goldfish

7Ba-5 Reproduction questions

1 a chicks

b sexual reproduction

c Scientists have noticed that there used to be millions of these birds but now there are only about 15 000 males and 15 000 females.

d Why have the numbers of Henderson petrels gone down?

e The number of petrels depends on the number of rats (the rats eat petrel chicks).

f If rat poison is spread on the island, then the numbers of petrels will go up.

2 Henderson petrel, human

- 3 a sperm cell
b fertilisation

7Ba-6 Animal reproduction

1 a The length of time it takes for an animal to develop from a fertilised egg cell until it is born or hatches.

- b stickleback
c 8.5 months
d 2.5 years

2 a any two from: gorilla, grey squirrel, grey wolf, hare, harvest mouse, lion, polar bear, rat, tiger

b any two from: black rat snake, king penguin, sea turtle

c any two from: bullfrog, cod, salmon, stickleback

3 Some mammals have lots of offspring but do not spend much time looking after them. Other mammals have fewer offspring but spend more time looking after them.

4 internal fertilisation and internal development

5 No, as there is only one amphibian on the sheet (bullfrog). Several more examples are needed.

6 Less offspring are produced by animals that use internal development.

7 a 1% of 5000 = 50

b two from: some egg cells are not fertilised because the sperm cells are washed away; some fertilised egg cells are eaten; some (fertilised) egg cells are damaged (e.g. by drying out, wave action)

8 a The more aftercare, the higher the survival rate.

b Students might consider the provision of food to help the offspring grow quickly or the protection that the parent(s) provide.

9 a any one from: protection from predators; supply of food; protection from physical shocks; more chance of offspring surviving

b any one from: protection from predators; supply of food

10 a any from: good medical services; good food; good hygiene; lack of predators. Accept other sensible suggestions. A higher-level answer will include more reasons and give examples (e.g. vaccinations, balanced diets, proper sewage disposal).

b any from: less good medical services; less nutritious food; less good hygiene (more diseases). Accept other sensible suggestions. A higher-level answer will include more reasons and give examples (e.g. lack of infrastructure links, lack of education about how to stay healthy, poor sewage disposal).

7Ba-7 Comparing animal reproduction

- 1 a fry
b none
c female

d Sperm cells; the salmon that release the egg cells are the females and they are the ones that build the nests. The salmon of the opposite sex are the males and males release sperm cells for fertilisation to occur.

e Some of the egg cells will not be fertilised.

f Fertilised egg cell (or zygote, but it will be unlikely that students know this term).

g It ensures that all the eggs get fertilised and so cuts down on waste.

2 a lambs

b Fertilisation is external in salmon but internal in sheep.

c Salmon do not care for their young but sheep do, and feed them with milk.

d 1 or 2. The sheep in the drawings have 1 or 2 lambs each.

e The sheep produce fewer egg cells because the sperm cells are more likely to come into contact with the egg cells. Also the fertilised egg cell develops inside the mother where it is protected and fed and so less likely to die.

7Ba-8 Understanding animal reproduction

1 a X – people look like their fathers *and* their mothers

b Take photos/videos using high-powered microscopes.

2 a The diagram should show a sperm cell moving towards an egg cell and then the two cells fusing together. Labels should include: sperm cell, male gamete; egg cell, female gamete; the gametes fuse/join, they form a fertilised egg cell, this process is called fertilisation.

b Sea urchins release their egg cells and sperm cells into sea water, which are easy conditions to recreate on a microscope slide. The conditions inside a mammal are much more difficult to recreate. Some students may also suggest that sea urchin gametes are large and quite easy to see, which should be given credit.

3 internal fertilisation: advantages – fewer eggs wasted, more reliable, less energy needed to produce eggs; disadvantage – more energy needed to find mate

external fertilisation: advantages – quicker, mate-finding can be unimportant; disadvantages – egg cells wasted, more energy needed to produce more egg cells

7Bb Reproductive organs

Student Book

1: 7Bb Reproductive organs (Student Book)

1 urethra

2 a in the testes b cooler, the testes are not inside the body

Sexual reproduction in animals

3 It has a tail (to push it along) and a streamlined shape (to help it move through fluids easily).

(A higher-level answer will include the reasons as well as the features; the question asks students to 'explain'.)

4 Infertility, as the swollen gland may stop sperm cells passing through the urethra/difficulty urinating, as the swollen gland may stop urine passing through the urethra.

5 $365/28 = 13$ egg cells per year; $13 \times 35 = 455$ egg cells

or, number of leap years in her reproductive span = $35/4 = 8$; number of days = $(365 \times 35) + 8 = 12\,783$; $12\,783/28 = 456$ egg cells

6 ovaries

7 cervix and uterus

8 It is moved along the oviduct/fallopian tube by hairs called cilia.

9 It has a store of food in its cytoplasm, which is there because the fertilised egg cell is created by the fusing of the sperm and egg cells and the egg cell's cytoplasm contained a store of food. (A higher-level answer will include an explanation of where the food store came from.)

10 Answers such as: she has not gone through puberty, she has reached menopause, she is pregnant, she has something wrong with her ovaries.

Activity Pack**7Bb-1 Reproductive organs**

1 a cervix

b ovary

c oviduct

d egg cell

e sperm cell

2 W – urethra; X – testis/testes; Y – sperm duct; Z – penis

3 urethra

4 uterus

5 testes

6 to attack the jelly around the egg cell

7 She has reached the menopause. She has not yet reached puberty.

7Bb-5 Reproduction dominoes

Note that the chain may start at any point:

What has chemical substances in its head to attack a jelly coating? – sperm cell

What organ stores urine? – bladder

Inside what organ does a baby develop? – uterus

What tube carries both urine and sperm cells? – urethra

In what organs are sperm cells made? – testes

What has a jelly coating around it? – egg cell

Where are egg cells made? – ovaries

What tubes connect the testes to the urethra? – sperm duct

What is the singular of testes? – testis

What is another term for fallopian tube? – oviduct

What tube leads to the cervix from outside? – vagina

What adds liquids to sperm cells? – gland

What protects the head of the penis? – foreskin

What holds the testes? – scrotum

What part of an egg cell contains a store of energy? – cytoplasm

What ring of muscle is at the entrance to the uterus? – cervix

What does a sperm cell use to swim? – tail

What organ does a man's urethra run through? – penis

When does a woman stop producing egg cells? – menopause

What is the removal of the foreskin called? – circumcision

What is a mixture of sperm cells and special fluids called? – semen

What sweep egg cells along, inside the oviduct? – cilia

7Bb-6 Human reproductive systems

1 a Correctly labelled diagrams (see the spread 7Bb Reproductive organs in the Student Book).

b ovary A; uterus B; testis E; scrotum H; foreskin G; vagina D.

2 sperm duct, urethra

3 large cytoplasm containing a food store

7Bb-7 Endangered animal reproduction

1 a male on left, female on right.

b W – testes; X – penis; Y – ovary; Z – oviduct/fallopian tube.

2 a male

b testes

c tail to help it to swim; chemicals at its tip that can attack jelly coatings

3 a The female African wild dog releases egg cells/ova throughout her life.

b Even older female animals can give birth to young.

4 a females

b left ovary – F; right oviduct – E; left oviduct – G; right uterus horn – A; left uterus horn – D; cervix – B; vagina – C

c bladder

d The female oryx would not have offspring as the sperm cells cannot reach the egg cells/ova.

e To find out how they can be best helped to reproduce. Therefore, the numbers of the

endangered animals can be increased more quickly. (A higher-level answer will make both these points, or similar related points.)

7Bb-8 Eggs and egg cells

1 a thick albumin and thin albumin

b thick and then thin

2 any two from: the main part of the oviduct is coiled/twisted in the hen; there is only one tube leading into the uterus; the large intestine connects into the opening so that eggs and faeces leave from the same place; the hen's reproductive system is much longer

3 a infundibulum and magnum

b They sweep the egg cell/developing egg along.

4 Vitelline membrane. Students should have worked out that the egg cell is what is released from the ovary and the first coatings to be added are the albumin coatings. Therefore, the cell surface membrane of the egg cell must be inside these layers.

5 Blastodisc. The text says that the chick develops from the blastodisc, so students should know that the chick grows from a cell that contains a nucleus.

6 To support the egg cell/yolk and stop it hitting the sides of the egg.

7

Part of reproductive system	How the egg develops
ovary	the egg cell is produced
infundibulum	fertilisation can occur
magnum	two layers of albumin are added, two chalazae are also added
isthmus	the shell membranes are added
uterus	the shell is added
vagina	the egg passes out of the hen

8 Chicks need to complete their development outside their mothers and so all the food that they need to do this must be inside the egg. Human babies develop inside their mothers and can be given food from the mother.

7Bc Becoming pregnant

Student Book

1: 7Bc Becoming pregnant (Student Book)

1 a mixture of sperm cells and fluids (from glands)

2 oviduct/fallopian tube

3 It has chemicals on the top of its head to attack the jelly coating of the egg.

4 16 – you can see more than eight cells and so it must be the division of cells after the eight-cell stage (when all eight cells divide to become 16 cells). It is not quite as straightforward as this in reality and some cells may divide slightly quicker than others.

5 a the two girls

b Two different egg cells were fertilised: one of these then divided and the two resulting cells split apart and developed, forming two identical twin embryos.

6 a food, oxygen, water (accept nutrients/vitamins but not heat or warmth since they are not substances)

b carbon dioxide (that is the expected answer but urea is also acceptable)

7 embryo

8 a The placenta exchanges substances between the mother's blood and the embryo's blood.

b The umbilical cord carries blood between the placenta and the embryo.

c The amniotic fluid protects the baby (from physical shocks).

9 specialised cell in the embryo – one of: muscle cell, fat cell, nerve cell (students might also mention blood cells); specialised cell not in an embryo – one of: sperm cell, (fully developed) egg cell

Activity Pack

7Bc-1 Becoming pregnant

1 Drawings numbered clockwise from top left: 4, 6, 2, 1, 5, 3.

2 Drawings numbered clockwise from top left: 1 – fertilised, embryo; 2 – fertilisation; 3 – placenta, amniotic; 4 – ovary, oviduct; 5 – fertilised egg cell, implants; 6 – sperm, oviduct.

7Bc-5 Pregnancy

1 a A – oviduct; B – embryo; C – ovaries; D – uterus; E – fertilisation; F – implants, uterus

b clockwise from bottom right: F, C, A, E, B, D
c E

2 amniotic fluid – protects the baby;

placenta – takes oxygen and food from mother's blood and puts waste into mother's blood;

umbilical cord – carries oxygen, food and waste between mother and baby

7Bc-6 Making embryos

1 a *students' own diagrams*

b an embryo

c The embryo sticks/sinks into the uterus lining.

2 a S – oviduct; T – ovary; U – umbilical cord; V – placenta; W – vagina; X – amniotic fluid; Y – amnion; Z – uterus

b any two from: food; oxygen; water (accept nutrients, vitamins etc. but not 'heat'/'warmth' since they are not substances)

c carbon dioxide (that is the expected answer but urea is also acceptable)

d It protects the developing embryo (from physical shocks).

3 A, C, D

7Bc-8 Multiple births and fertility treatments

- 1** A birth in which two or more babies are born.
- 2** The treatment causes her to release more egg cells and so there are more egg cells available to be fertilised, raising the chances of a fertilised egg cell being produced.
- 3 a** It has been going up, since the 1980s.
b More and more women aged 40–44 are using fertility treatments, which are more likely to give multiple pregnancies. A higher-level answer would also include reference to the idea that fertility treatments have become more available since the 1980s.
c It has remained fairly constant.
d Women aged 20–24 are not making use of fertility treatments.
- 4 a** *Students' own responses.* Expect figure for 'women aged 20–24' to be around 10%, with the figure for 'women aged 40–44' to be above 25%.
b Students should be drawing lines of best fit through the existing points on the graph and then extending these lines to the current year.
c The source given for the data in the graph is the Office for National Statistics (ONS). This would make a good place to start to look for the data.

7Bd Gestation and birth**Student Book****2: 7Bd Gestation and birth (Student Book)**

- 1** seven months (nine months is the total gestation but the first eight weeks [two months] is the embryo stage)
- 2 a** X – amnion; Y – umbilical cord
b The amnion protects the foetus. The umbilical cord carries blood to and from the placenta.
- 3 a** It is less than 12 weeks old (an average 12-week-old foetus is 8.7 cm long).
b Development of the foetus is checked to make sure it is healthy. Answer will also consider the fact that scans can be used to work out the age of the foetus and therefore predict the date of birth.
- 4** Chemicals in the smoke will go through the placenta and can harm the foetus. Smoking also causes less oxygen to be carried in a mother's blood and so the foetus may not receive enough oxygen and can be born prematurely.
- 5** contractions start and become more frequent; the cervix opens/widens; the amnion breaks; when the cervix is about 10 cm wide, powerful contractions of the uterus push the baby out; the afterbirth comes out
- 6** the umbilical cord being cut
- 7** in order to allow the baby out
- 8** It is not expected that students will write all of these, but additional credit should be given to

students who have made notes from the whole of the spread and not just the section that deals with smoking, alcohol and drugs.

Women should avoid excessive alcohol because this can damage the foetus. Women should not smoke because chemicals in the smoke can harm the foetus and smoking reduces the amount of oxygen in the mother's blood stream, which can result in the baby being born prematurely. Women should not take illegal drugs because these can damage a foetus's brain. Women should make sure that they are vaccinated against rubella before having children, since the virus can cause deformations in the foetus. Women should be very careful about what medicines they take because some can damage the foetus. Women should have a healthy diet so that the foetus gets everything it needs for growth and development. Women should have scans to check on the development of the foetus.

Activity Pack**7Bd-1 Gestation and birth**

- 1** She gets heavier. She needs more food. Her uterus gets larger.
- 2** alcohol, chemicals, drugs, medicines, viruses
- 3** 1 – gestation period; 2 – labour begins; 3 – cervix widens; 4 – contractions push out baby; 5 – afterbirth; 6 – baby is fed semi-solid food
- 4 a** navel labelled on diagram
b a scar
- 5 a** rubella
b premature
c 9 months
d umbilical cord
e energy

7Bd-2 Pregnancy blog

- 1 a** Week by week, with the same headings for each week.
b It's easy to find the information you are looking for in any week. It makes it easy to compare the same items in different weeks and see the progression through the pregnancy.
- 2** Notes should be short. Answers include: gain in mass/weight, sleeplessness, restless feet/legs, food cravings, shortness of breath, back pain, increased frequency of peeing, feeling emotional.
- 3** Notes should be short. Problems (and solutions) include: restless feet/legs (soaking feet in very hot water); shortness of breath lying on back (roll onto side).

7Bd-3 Pregnancy and birth

- 1 a** labels clockwise from the top right: amnion; cervix; vagina; uterus; umbilical cord; placenta
b the placenta and umbilical cord

c alcohol; chemicals in cigarette smoke; illegal drugs like heroin; some medicines

2 1 – release of an egg cell; 2 – fertilisation; 3 – contractions start; 4 – cervix widens; 5 – baby is pushed out; 6 – umbilical cord is cut

3 a milk

b mammary glands

4 Correctly drawn bar chart. Credit should be given for neatness. Human pregnancy should be included (9 months). The animals in the table are all endangered. Students might like to find out a bit more about them.

7Bd-4 The developing foetus

1 a 3.6 cm

b 14–15 weeks

c foetus

d ultrasound scans

e 10 weeks

f between 4.8 and 5.8 cm

g premature

h 8.6 cm

i Smoking reduces the amount of oxygen in the mother's blood, which can mean that the baby gets less oxygen than it needs. This may cause the baby to be premature.

2 a contractions

b It widens to allow the baby through.

c mammary glands

d Antibodies help to stop the baby getting diseases caused by microorganisms.

7Bd-5 Foetal development

1 The last two drawings use a smaller scale.

2

Age of foetus (weeks)	Measured length of femur on diagram (mm)	Real length of femur (mm)
10	4	8
12	8	16
16	14	28
24	12	48
32	17	68

Students don't need to include the middle column in the table. Additional credit should be awarded for students who realise that the developing baby is an embryo at 8 weeks and not a foetus and so is not included in the table.

3 Correctly drawn line graph. Credit should be given for neatness, correct axes and scales, correct plotting and correct labelling.

4 From the graph, an estimate of between 33 and 41 mm.

5 It is too difficult to measure.

6 hair and eyebrows

7 The brain controls much of the development and so it needs to develop first.

8 Students should identify pros and cons and use those to state their own position.

Pros could include: adds extra checks on development, nice souvenirs of pregnancy.

Cons could include: expense, time, possible effect on foetus.

7Bd Endangered species (STEM)

1 a rhino/rhinoceros

b it is difficult to see them

c A drone could go in the air and use a thermal camera to take photos, and the animals can then be counted by a computer.

2 hunting

3 that there is 8 months from fertilisation of an Arabian oryx egg cell until the birth

4 One of: less likely to stress the animal (many large animals die when being transported), easier to transport, accept cheaper (but in fact it is often not cheaper because of the difficulties of extracting sperm cells and doing the insemination at the correct time). Accept other sensible suggestions.

5 Do an ultrasound scan.

Activity

It is hoped that students will prepare lists of the conditions given in the activity box in the Student Book and the conditions found outside in a zoo in your country. They should then compare those lists and identify areas which will need altering in the enclosure. This might include adding some trees, adding shade, adding an indoor area that can be air conditioned.

7Be Growing up

Student Book

1: 7Be Growing up (Student Book)

1 a when physical changes happen in the body

b sex hormones

c ovaries

2 the time when physical and emotional changes occur

3 three of: additional hair grows, gametes start being released, growth, stronger body smell, sexual organs enlarge

4 additional colouration on the male's face and backside, gametes start being released, growth, sexual organs enlarge, stronger body smell

5 Simple advice might include mentioning that acne is due to sex hormones, that remedies are available in chemists/from the doctor and that acne disappears with age.

Sexual reproduction in animals

- 6 about 28 days/one month
 7 ovulation/egg released
 8 her periods stop/menstruation stops
 9 to ensure that it can provide the placenta with a rich supply of nutrients and oxygen in the blood (some students may also mention that it helps to support and protect an embryo)
 10 A life cycle similar to that shown on Worksheet 7Be-6. Better answers will include accurate names of the different stages, perhaps a brief note about what happens and timings between the stages.

2: 7Be The work of zoos (Student Book)

- 1 They do not protect their offspring so many of them will be eaten/die. They need to make sure that at least a few will survive to adulthood.
 2 The time taken for a fertilised egg cell to grow and develop into a baby and be born.
 3 The expected answer is ultrasound (to check on the development of an embryo/foetus). Some students may have written about other techniques, which are also used. For example, IVF (to help a female animal become pregnant), or fertility treatment (to help a female animal become pregnant).
 4 Life cycle similar to that shown on Worksheet 7Be-6 drawn but with information for Sumatran rhinoceros. A better answer will include the length of time from birth until sexual maturity (seven years) and the gestation period (16 months).

Activity Pack**7Be-1 Growing up**

- 1 a menstruation/menstrual flow
 b period
 c ovulation
 2 about 28 days
 3 Give credit as long as the numbering shows correct order; it does not matter which diagram is placed at the start.
 4

	Girls	Boys
underarm hair grows	✓	✓
breasts develop	✓	
shoulders widen		✓
hair grows on face		✓
hips get bigger	✓	
pubic hair grows	✓	✓

- 5 The time when teenagers' bodies change is called puberty.

Body changes are controlled by sex hormones.
 Emotional changes take place during adolescence.

7Be-4 The menstrual cycle 1

- 1 correct sequence of drawings
 2 a ovulation
 b 17 January
 3 12 July
 4 correctly labelled diagram

7Be-5 The menstrual cycle 2

- 1 day 1: the lining breaks down; day 11: the lining gets thicker; day 14: an egg cell is released; day 21: the lining stays thick
 2 a ovaries
 b ovulation
 c fertilised egg cell
 d 11–17 days
 3 A sentence similar to: The **uterus** has a **lining** that thickens during the first part of the menstrual cycle. If **fertilisation** occurs, an **embryo** can **implant** into the thick uterus lining and be supplied with all the **nutrients** that it needs.

7Be-6 Puberty and adolescence

- 1 ticks in boys column for – underarm and pubic hair grows, start to make sperm cells, voice deepens
 ticks in girls column for – breasts develop and get bigger, underarm and pubic hair grows, ovulation starts, menstruation starts
 2 puberty – physical changes occur – many years of
 adolescence – emotional and physical changes occur – many years
 menstrual cycle – growth and shedding of the uterus lining, together with ovulation – about a month
 3 a human lifecycle
 b correctly labelled diagram

7Be-7 Problem page

- 1 Sex hormones affect the brain.
 2 Acne, caused by a rise in sex hormones.
 3 They are produced naturally by the body, in the testes or the ovaries.
 4 There is nothing wrong, different people go through puberty at different ages and at different speeds.
 5 There is nothing wrong, hair growth is part of puberty and is triggered by sex hormones. Mum probably shaves her armpits.

7Be-8 Cycles

- 1 a fertilised egg cell, embryo, foetus, baby, child, adolescent, adult
 b A life cycle is drawn, similar to that shown on Worksheet 7Be-6. Answers should include the

names of the different stages and additional timings (e.g. time from birth to puberty, length of puberty).

2 a use of sperm and egg cells; growth in size with time

b any two from: young look nothing like adults; external fertilisation; external development

3 a any two from: hips widening; pubic hair growing; breast development; menstrual cycle starting

b any two from: voice breaking; pubic hair growth; penis and testes enlarging; sperm cell production

4 a The uterus lining breaks down.

b blood vessels

c about day 14

d In order to receive a fertilised egg cell (should fertilisation occur) so that it can have a good supply of nutrients and oxygen.

e it stops

7Be-9 Acne

1 a blackhead, whitehead, pimple, cyst

b drawings showing blocked but open pore (blackhead), blocked and closed pore (whitehead), split follicle (pimple), split follicle with sebum and bacteria deep in the skin (cyst)

2 Sebum changes colour in air.

3 They cause the development of secondary sexual characteristics (although students will probably use examples rather than this terminology).

4 a hCG, because it goes up at the same time that acne rises to its peak.

b hCG is only produced by embryos, but males don't carry embryos.

5 The doctor will check the severity of her acne and whether she is pregnant (and sexually active). If she is pregnant (or likely to become so) she cannot be given Accutane because it will damage the embryo/foetus.

6 any one from: a certain hormone that causes acne declines as we get older; the ratio between certain hormones changes; a certain hormone increases as we get older; the skin changes as we get older (e.g. pores become wider)

7C Muscles and bones

7Ca Muscles and breathing

Student Book

1: 7Ca Fitness (Student Book)

1 Ideas could include:

dancers – suppleness (to be able to turn their bodies and wave their arms smoothly)

wheelchair athlete – speed (to go fast to win races)

bike rider – stamina (to go a long way without getting tired)

judo – strength (to throw competitors to the floor)

Accept all reasonable answers, as long as they are backed up with reasoning.

2 cell, tissue, organ, organ system

3 any three parts of the breathing/gas exchange system (e.g. trachea/windpipe, bronchi, bronchioles, lungs, diaphragm)

4

Breathing system	Digestive system	Excretory system	Circulatory system
windpipe/ trachea	oesophagus	kidneys	heart
lungs	stomach	bladder	
diaphragm	liver	(liver)	
	small intestine		
	large intestine		
	rectum		

5 any sensible criterion, e.g. decreasing resting pulse, less out of breath when running, ability to run further distances

2: 7Ca Muscles and breathing (Student Book)

1 respiration; for the cells in your body to respire and release energy.

2 heart, blood vessels (arteries, veins, capillaries)

3 a oxygen, carbon dioxide (other gases can also be carried, e.g. nitrogen, carbon monoxide)

b in the blood

c They swap places (carbon dioxide leaves the blood and goes into the lungs, oxygen leaves the lungs and goes into the blood).

4 It contains different tissues.

5 a They change shape to move things.

b They are long strands that can contract (and relax).

6 14 breaths per minute (units are important)

7 a The muscles in the diaphragm/attached to the ribs cannot move so well and so the chest/lungs cannot increase in size as much.

b If the lungs cannot get as big, they take in less air and there is less oxygen in the lungs that can get into the blood.

c They could be given pure oxygen to breathe/ put in a chamber with a greater percentage of oxygen in the air.

8 Respiratory system, because the breathing movements of the lungs are not any part of the process of respiration.

Activity Pack**7Ca-1 Muscles and breathing**

- 1 second largest slice shaded in
- 2 **a** respiration
b carbon dioxide
c gas exchange
- 3 **a** diagram corrected labelled
b D, A, B, C
- 4 **a** cell third from left circled
b It contains strands so that it can change shape.

7Ca-3 Breathing muscles model

- 1 W – spine; X and Y – ribs; Z – sternum/front of ribcage
- 2 **a** it shows how contraction of a muscle can pull ribs up; moving the ribcage up and outwards
b the string does not contract and relax like a muscle does; there are only two muscles/ribs shown

7Ca-4 Sport and you

- 4 **a** short and light
c sumo wrestling, throwing the hammer, etc.
d basketball – speed; cricket – stamina; fencing – speed; netball – speed; volleyball – suppleness; rugby – stamina; weight-lifting – strength; jockey – stamina; distance running – stamina; synchronised swimming – suppleness
e speed – measuring speed; suppleness – measuring how far someone can stretch; strength – measuring the amount of mass/weight someone can lift; stamina – measuring resting heartbeat rate or speed with which heartbeat rate returns to normal

7Ca-6 Breathing and respiration

- 1 to release energy from food
- 2 **a** correctly labelled diagram
b the muscles attached to the ribs contract; the diaphragm contracts (and moves down/flattens)
- 3 breathing – the movement of muscles to make the lungs get bigger and smaller; breathing rate – the number of times you breathe in a minute; exhalation – breathing out; inhalation – breathing in; ventilation – the flow of air in and out of the lungs.
- 4 **a** oxygen
b carbon dioxide
- 5 It gets shorter and fatter.

7Ca-7 Muscles for breathing

- 1 In gas exchange in the lungs, oxygen for respiration passes from the air in the lungs into the blood, reducing the amount of oxygen in the lungs. At the same time, carbon dioxide produced by respiration passes from the blood into the lungs, increasing the amount of carbon dioxide in the lungs.
- 2 It gets shorter and fatter.

- 3 **a** The sternum should be drawn higher and further to the right than on the original drawing, keeping the lengths of the ribs the same.

b diaphragm

- 4 **a** correctly labelled diagram

b It contains strands that can contract and relax.

7Ca-8 Vital capacities

- 1 **a** correctly labelled diagram
b It contains strands that can contract and relax.
c When they contract they pull the ribs up and this moves them outwards as well, so increasing the volume of the chest/lungs underneath them.
d diaphragm
- 2 **a** mean diameters: 0 – 20.3 cm; 10 – 20.4 cm; 20 – 20.5 cm; 30 – 20.6 cm; 40 – 20.7 cm; 60 – 20.8 cm and so mean vital capacities: 0 – 4360 cm³; 10 – 4450 cm³; 20 – 4530 cm³; 30 – 4600 cm³; 40 – 4670 cm³; 60 – 4730 cm³
b correctly plotted line graph
c about 4700 cm³
d vital capacity, running speed
e The muscles attached to his ribs and/or in his diaphragm are getting stronger and so able to expand the lungs more.
f More air can get into the lungs and so more oxygen can get into the lungs. Oxygen is needed for respiration to release energy.

7Cb Muscles and blood**Student Book****1: 7Cb Muscles and blood (Student Book)**

- 1 any two of: pulse/heartbeat rate; breathing rate; gases going into and coming out of athlete; temperature
- 2 **a** the heart beating/pumping
b 64 beats per minute (do not forget the units!)
- 3 relax
- 4 carbon dioxide (there are others, e.g. urea)
- 5 **a** Arteries carry blood away from the heart, veins carry blood towards the heart and capillaries carry blood between arteries and veins (or capillaries supply tissues with nutrients and oxygen and remove waste).
b They have very thin walls (so that the nutrients and oxygen can easily pass out of the capillaries).
- 6 The left side has to pump blood around the whole body. The other side only has to pump blood to the lungs.
- 7 • The blood is under greater pressure on its way from the heart, and under lower pressure on its way to the heart.
• Blood travels in arteries on its way from the heart and in veins on its way back.

- Arteries have a smaller diameter than veins, which means that the blood is under higher pressure.

- Arteries also have stiffer walls than veins, which help to keep the pressure high.

8 a plasma, red blood cells, white blood cells (there are also platelets but these have not been mentioned in the student materials)

b Red blood cells carry oxygen, white blood cells attack microorganisms and plasma carries dissolved substances like carbon dioxide, waste and nutrients (platelets are involved in blood clotting).

c in bone marrow

d They have a large surface area so that oxygen can enter and leave the cells quickly; they have no nucleus so that there is more room for haemoglobin.

9 On its way around a chicken's body, blood goes through the heart twice.

2: 7Cb Scientific questions (Student Book)

1 in the bone marrow

2 $65 \times 130 \div 2 = 4225 \text{ cm}^3$ per minute and so $4225 \times 60 = 253\,500 \text{ cm}^3$ per hour

3 There must be blood vessels connecting arteries and veins (capillaries).

4 He tested his ideas.

5 *students' own questions*: they must be testable questions

6 A scientific

B non-scientific and ethical

C scientific

D non-scientific

E scientific

Activity Pack

7Cb-1 Muscles and blood

1 a the circulatory system

b heart

c heart correctly labelled

d blood

e to make sure all your tissues get nutrients and oxygen

f muscle tissue

g contracts

h artery, vein and capillary correctly labelled

2 a plasma, red blood cells, white blood cells

b red blood cells

c bone marrow

7Cb-2 Scientific questions

1 If the heart pumps blood around the body, then there must be tubes connecting arteries to veins – prediction; hearts beat – observation; A microscope was used to look for tiny blood

vessels in tissues – investigation; Why do hearts beat? – question; The heart is a pump – hypothesis; Malpighi found tiny tubes connecting arteries to veins – data.

2 a Why are larger animals more interesting?

b It cannot be answered again and again using investigations.

3 a Should we put a tax on fatty foods?

b It is about what someone thinks is right or wrong, fair or unfair.

7Cb-4 Asking scientific questions

6 Students could refer to one or more of the inaccuracies in: counting pulse beats and/or timing a minute; not using the chart correctly in question 2; using a mean value in question 3 (when students may vary quite considerably in size at this age).

7Cb-5 Asking scientific questions

1 a, c, d

2 a e.g. Do people who exercise have hearts that pump more strongly?

b e.g. Do runners have lower resting pulse rates than weightlifters?

c e.g. Do people who watch more than 5 hours of TV a day have less strong leg muscles than people who watch less than this?

3 a e.g. Do fish have the same blood cells as humans?

b e.g. Do people who run marathons have hearts that have bigger volumes?

c e.g. Does offering people £5 to give blood increase the number of people who give blood?

4 a e.g. Do people who go swimming each week have stronger leg muscles?

Do people who go swimming each week have lower resting pulse rates?

Does increasing the cost of swimming by 50 p mean that fewer people will use the swimming pool?

b *Students' own outlines* for a practical investigation or survey.

7Cb-6 Blood and circulation

1 a oxygen

b carbon dioxide

c food/nutrients

d blood

2 a Andrew

b 68 beats per minute

c wrist, neck

d 66 beats per minute

3 a artery correctly labelled

b vein correctly labelled

c capillary

d bone marrow

e muscle tissue

f contract (and relax)

Muscles and bones

7Cb-7 Heart and blood

1 Blood flows into chambers, the heart muscle contracts, this pushes blood out of the heart, the left side of the heart has more muscle because it has to push blood around more of the body.

2 a C

b bone marrow

c haemoglobin

d white blood cells attack micro-organisms

e plasma

f carries wastes/carbon dioxide/nutrients/food

3 a Y. Smallest/narrowest; thinnest walls

b Arteries carry blood away from the heart. Veins carry blood towards the heart.

7Cb-8 Blood

1 a large surface area so that oxygen can enter and leave the cells quickly; haemoglobin to carry oxygen; no nucleus so there is room for more haemoglobin; flexible so can bend and fit through the smallest capillary

b If the gate is very wide more people can get into and out of the field in a shorter time. In the same way, if the surface of a red blood cell is larger, more oxygen can cross into and out of the cell in a shorter time.

2 a between 0.005 and 0.01 mm

b to fit through very small capillaries

c 5 000 000 000

3 a oxygen

b they lose more and more oxygen as they give it up to respiring cells around the body

c artery, capillary, vein

4 the liver

5 a to carry dissolved waste (e.g. carbon dioxide) and nutrients

b The expected answer is white blood cells, which attack micro-organisms. There are also platelets, which help with blood clotting.

7Cc The skeleton**Student Book****1: 7Cc The skeleton (Student Book)**

1 a nutrients (food), oxygen **b** respiration

2 It is a tube shape with a hollow middle and strong bone around the outside.

3 It contains different tissues.

4 ribcage

5 supports the body or protects the spinal cord

6 a skull **b** backbone/vertebrae

7 lungs, heart (there are others)

8 a fixed, hinge, ball and socket **b** ball and socket
c muscles

9 support, protection, movement; making blood cells

10 a thigh bone/femur

b dislocation

c *Students' own response*, e.g. torn ligament due to falling over.

Activity Pack**7Cc-1 The skeleton**

1 a collar bone

b from the neck to the shoulders

c cast/plaster/plaster cast, bones, grow/change

2 vertebrae

3 support, protection, making blood cells, movement

4 a skull

b protects the brain

c femur/thigh bone

d supports the body/makes blood cells

5 hard/strong, hard/strong, knocks, light, moved

7Cc-6 Bones and skeletons

1 – D; 2 – A; 3 – B; 4 – F; 5 – E; 6 – C

7Cc-8 Bodies and bones

1 correct labelling

2 backbone – supports the body; skull – protects the brain; ribs – protect the heart and lungs; knee cap – protects a joint

3 Brain injury. There is a hole in the skull.

4 a The bone is much harder-wearing than the other pieces of tissue/Bone does not rot.

b bone marrow

c It makes blood cells.

d It would be too heavy/Lighter bones are easier to move.

5 skull – fixed joint; hip – ball and socket joint; elbow – hinge joint

7Cc-9 Bones and joints

1 a hip/pelvis

b vertebrae

c They form the backbone, which supports the body.

d It has gaps between the bones/It is not complete.

e They will join/fuse together and form fixed joints between one another.

f to protect the brain

2 a to make it lighter

b There is a thinner layer of compact bone. AND The spongy bone gets bigger 'holes' in it.

c The bones become lighter or the bones become more brittle/fragile.

3 a V – muscle/biceps; W – tendon; X – ligament; Y – cartilage; Z – bone

b X – ligament

c hinge joint

7Cc-10 Different types of skeleton

- 1** support, protection, allow movement
- 2** They take the shape of their container; they do not compress/cannot be squashed.
- 3** The skull needs to protect the most important organ/the organ that is controlling development, which is the brain.
- 4 a** The skull may be easily damaged, which may damage the brain.
b It allows the brain to continue growing. (It also allows the baby's head to squash as it is pushed out through the cervix and vagina during childbirth, but students are unlikely to think of this.)
- 5** Difference: in an exoskeleton the muscles are on the inside; in an endoskeleton the muscles are on the outside. Similarity: the skeleton parts that make up the leg are both hollow tubes.
- 6** camouflage, waterproofing
- 7** There are many possible answers here but these are those that students are most likely to get from the text and study of this topic. Only one advantage and one disadvantage is expected for each skeleton.

Type of skeleton	Advantages	Disadvantages
endoskeleton	grows with increase in size	muscles on the outside that can be easily damaged
exoskeleton	muscles and organs are all inside and so well protected	limits the size of the animal animals cannot squash and squeeze into awkward spaces
hydrostatic	allows animals to squash and squeeze into awkward spaces	slow movement no protection

8 Young butterflies are caterpillars and their bodies allow rapid growth since their skeletons can stretch. The growth is not stopped by the speed with which the skeleton can grow. In order to grow, young babies need their skeletons to grow. Adult butterflies suddenly stop growing when they develop their exoskeletons (the adults do not moult). Humans gradually stop growing as they turn into adults.

7Cd Muscles and moving**Student Book****1: 7Cd Muscles and moving (Student Book)**

1 He exercised a lot and this increases the size of muscles (and bones).

- 2** right hand: the bones are thicker in the right arm
- 3 a** in the forearm, by the elbow
b They contract (become shorter and fatter).
- 4** bone, muscle
- 5** it relaxes (or gets longer and thinner but make sure students realise that this is not an active process)
- 6** because they can only pull, they cannot push
- 7 a** triceps/biceps, wrist flexor/extensor, biceps femoris/quadriceps, calf muscle/shin muscle
b calf muscle
c shin muscle
d An impulse is sent from the brain, along the spinal cord and down a nerve to the muscle. This causes the muscle to contract.

Activity Pack**7Cd-1 Muscles and moving**

- 1** bones/muscles mend when they are broken/torn
- 2** 190 N
- 3 a** muscles
b bones
c it gets shorter and fatter
d Y
e X – triceps; Y – biceps
f Muscles can only pull (they cannot push).
- 4 a** arrow shown coming from brain, along spinal cord and into nerve down to the muscle
b impulses

7Cd-3 Antagonistic muscle model

- 1 a** The lower arm is lowered.
b The lower arm is lifted.
- 2 a** triceps
b biceps
- 3 a** It shows how the movement of muscles can move bones; it shows the positions of two muscles that operate the lower arm bone.
b Muscles contract to move bones (the string doesn't contract); there are more muscles that operate the lower arm than just these two; it only shows one lower arm bone.
- 4** Suggestions might include using semi-inflated long balloons for the muscles instead of string (anything that will model the behaviour of real muscles in terms of getting fatter and shorter and longer and thinner when they contract and relax).

7Cd-5 Forceful bites

- 1** Correctly drawn bar chart, which should contain correctly plotted and neat bars along with the other criteria on Skills Sheet PD 3 *Bar charts*.
- 2 a** masseter
b The jaw needs more force to close and bite things than to open and the masseter is the bigger muscle. OR Muscles can only pull and the masseter

Muscles and bones

could not open the jaw because it would have to push to do so.

3 They work in opposite directions to each other.

7Cd-6 Moving bones

1 hamstring

2 During the 8 weeks the bones will grow back together.

3 92 N

4 a muscle drawn on right of humerus

b nervous system

5 joints, pull, push, pairs, contracts, relaxes, respiration

7Cd-7 Building up muscles and bones

1 a grams

b runners

c leg

d if bones did not change (and respond to the forces put on them) we would expect to see similar values for both groups of people

e The more (impact) force on a bone the more it grows. OR The bone mineral content of a bone depends on the amount of force placed on it over time.

2 a locomotor system

b quadriceps

c it contracts (shortens and gets fatter)

d antagonistic pair

e because muscles can only pull, they cannot push
f expected answer is: biceps and triceps, which (help) move the lower arm up and down.

g It contains strands that can contract (shorten) and relax (return to their original length).

3 brain makes/generates an impulse → impulse goes down spinal cord → impulse goes along nerve to quadriceps muscle → muscle contracts

7Cd-8 Forces and bones

1 a They hold bones together.

b It may allow the top of the femur to come further out of its socket and so make the head of the femur hit the inside of the socket when the person walks or runs, wearing it out.

2 a by covering bone ends in slippery cartilage, and having some joints filled with a fluid

b means the joints can move easily, means that less energy is need to move joints, means that joints are less likely to wear away (or they wear away more slowly)

3 difficulty in moving; pain in moving

4 a It causes too much friction.

b CoCr alloy for the ball and polyethylene for the cup because these two materials gave low friction readings in the investigation.

c suggestions might include: how hard-wearing the substances are; whether the body will react

badly to them; whether they can stand up to impact forces; how expensive they are

5 a smaller

b The readings for the investigation are for the substance sliding against steel, which has a high reading for friction in the investigation, and there is no steel naturally in the body. There is also a lubricating layer that forms in an artificial joint that will further reduce friction.

6 Cycling. The runners in the investigation have a greater bone mineral content in the leg, which shows that running puts more impact on the leg than cycling. Impact forces are more likely to cause problems for a weaker hip.

7Cd Artificial limbs (STEM)

1 They can't write/hold things with that hand. Accept other sensible suggestions.

2 a It helps them to balance and stand steady and walk. Accept other sensible suggestions.

b Any suggestions from: the person grew, the prosthetic toe wore away, the foot changed shape, the prosthetic became uncomfortable, or the prosthetic became less good at doing its job.

3 Four of: strong, light, comfortable, allows movement, safe to use, safe for others nearby.

4 When the shoulder is pulled back (by contracting muscles), the cord is pulled. This pulls open the gripper. When the shoulder muscles relax, the cord is relaxed and the spring in the gripper causes it to shut again.

5 a To make sure that the prosthetic can support the weight of the person without breaking.

b Two from: how light the material is, how well the material resists corrosion, how nice the material looks, how expensive the material is, how springy/flexible/stiff the material is.

7Ce Drugs

Student Book

1: 7Ce Drugs (Student Book)

1 a *students' own answers* (e.g. strained muscle)

b *students' own answers* (e.g. ibuprofen to reduce swelling) (see table on page 381)

2 The tubes going to and from the lungs are narrowed (and contain more mucus than normal).

3 a pain relief **b** liver damage

4 They are addicted.

5 caffeine (in the cola).

6 Coffee contains caffeine, which is a stimulant. Caffeine speeds up the activity of the nervous system/allows impulses to travel more quickly in the nervous system.

Name of drug	Stimulant or depressant?	Side effects
alcohol	depressant	liver damage, vomiting, confusion
caffeine	stimulant	stomach problems (or from students' personal experience, e.g. 'the jitters')
cannabis	depressant	memory loss, lung damage
cocaine	stimulant	blocked arteries
ecstasy	stimulant	mental illness, kidney problems
heroin	depressant	collapsed veins, vomiting, severe headaches
solvents	depressant	brain damage, stop heart and lungs working

7 The drugs with relevant information on the spread are in the table above. Students only need to have given information for four of them. Students are only expected to list one side effect for each drug. Additional credit should be given for ordering the table (e.g. alphabetical order).

8 a in the diaphragm and connected to and between the ribs

b Alcohol is a depressant. It slows down the speed of impulses in the nervous system, including those to the lungs. If there is too much alcohol, these impulses can be stopped altogether.

2: 7Ce Drugs and sport (Student Book)

1 a They affect the way the body works.

b They may be misused by some people, e.g. athletes may use them to cheat.

2 Salbutamol increases the width of air passages, allowing more air into the lungs.

3 It creates more red blood cells so more oxygen can be carried by the blood. Therefore more oxygen can get to respiring cells.

4 The quickly developing muscles put additional stress on the bones.

Activity Pack

7Ce-1 Drugs

depressant – cannabis – memory loss

stimulant – cocaine – blocked arteries

stimulant – ecstasy – mental illness, kidney problems

depressant – alcohol – liver and brain damage

stimulant – caffeine – stomach problems

depressant – heroin – collapsed veins, vomiting and severe headaches

depressant – solvents – heart and lungs stop working, brain damage

7Ce-5 Drugs quiz

a True

b True

c False. All medicines can have side effects. Paracetamol causes liver damage.

d False. Caffeine is a drug (it affects the body) and people use it for leisure (rather than as a medicine).

e True

f False. A stimulant will decrease your reaction time.

g False. Alcohol is a depressant. Caffeine is an example of a legal stimulant.

h False. Long-term effects of cocaine abuse include blocked arteries, and holes in the nose and roof of the mouth.

i True

j False. Drugs are mainly broken down in the liver.

7Ce-7 Cold and flu remedies

1 a It has an effect on the way the body works and anything that does this is a drug.

b paracetamol, pseudoephedrine, caffeine

2 a It is a dangerous/addictive drug.

b collapsed veins, brain damage, liver damage

3 a reduces pain and fever

b liver damage

c It is broken down by the liver.

4 People use it for leisure/fun/do not use it as a medicine.

5 a You should only take one sachet every four hours and no more than 4 sachets in 24 hours.

b It contains paracetamol and an overdose of paracetamol can cause serious liver damage.

c liver damage, brain damage

6 a It speeds up the passage of impulses through the nervous system (it is a stimulant).

b makes them contract

c If the blood vessels contract they take up less space and so allow more room for air

7Ce-8 The thalidomide story

1 a to help them sleep

b addiction, confusion

Ecosystems

2 It was not addictive and had no side effects (even in high doses).

3 in case they are pregnant; because thalidomide causes defects in developing fetuses

4 a They slow the speed of impulses in the nervous system.

b Liver damage because the liver is where alcohol is broken down. OR Brain damage due to a permanent slowing of the impulses in the brain.

5 a Experiments on more mammals including pregnant ones could have highlighted the problem with the drug.

b Thalidomide does not have the same effect on all pregnant mammals and therefore, if the wrong animals had been chosen for the experiments, the effect may have been missed.

c To look for any new side effects that have not been seen during the testing of the drug.

7D Ecosystems

7Da Variation

Student Book

1: 7Da Exploring the world (Student Book)

1 forest plants → deer → people

2 one of: shelter, water, a mate

3 two of: skin colour, nose shape, height, body piercings/tattoos, hair colour (accept any two reasonable suggestions)

4 a one of: helps us find useful new materials/resources, helps us study different people/cultures, helps us find useful sites on which to build homes/farms, to study organisms (accept any reasonable suggestion)

b harm to/exploitation of native people, damage to the environment, allows others to enter areas and cause damage (accept any reasonable suggestion)

2: 7Da Variation (Student Book)

1 village/town/city/countryside/farm (as appropriate)

2 two of: pond, river, ocean, sea, lake, stream, reservoir

3 The table below gives an example. Accept any two reasonable similarities and differences.

Similarities between the animals	Differences between the animals
backbones	different patterns on their coats/fur
hair	different sizes of body

4 in the pattern of stripes (there are also some differences in size)

5 It will have values that can be any number in a certain range of numbers.

6 Continuous: natural hair colour, length of hair, having naturally curly hair, height; Discontinuous: natural eye colour (although there are different shades of each colour, those shades fall into one of several main categories), having a cold, having a scar, blood group

7 a There is little obvious variation between them.

b Only members of the same species can reproduce with one another and Ringerl was of a different species from the other animals.

8 Lions and tigers are different species.

3: 7Da Charts and graphs (Student Book)

1 The dependent variable is the number of students. The independent variable is the tongue rolling ability (this is the variable whose values were chosen by the experimenter).

2 correctly drawn bar chart

3 a It is up to students to choose appropriate group sizes but they must be equal and non-overlapping. For example, lengths could be 26–30, 31–35, 36–40 and widths could be 16–20, 21–25, 26–30, 31–35.

b a correctly drawn bar chart of the data from the answer to question 3a

4 Suitably plotted scatter graph, with leaf length on the x-axis. The relationship is that the longer the leaf, the wider it is (or vice versa).

Activity Pack

7Da-1 Variation

1 a place where an organism lives

2 a dolphin, tuna

b any sensible difference (e.g. gills, blowhole, mouth shape, fin shape)

c any sensible similarity (e.g. fins, streamlined shape)

d variation

3 Continuous: height, length of hair; Discontinuous: shoe size, tongue rolling, having a broken arm

4 a cat

b Cats are a different species from dogs.

7Da-2 Frequency diagrams and scatter graphs

1 a correctly filled in bars (eight students have one filling, two students have three fillings)

b bar chart

c because it shows the numbers of things that have been counted

d the number of fillings (this is the set of values that the experimenters chose in their investigation)

e the number of students

2 a correctly plotted point (length 25 cm, width 20 cm)

b scatter graph

c yes

d The points form a pattern, showing that the width of the leaf depends on the length of the leaf (or vice versa).

7Da-6 Variation in animals

1 a jungle/rain forest

b habitat

c pattern on their coats/fur

d any reasonable suggestion (e.g. pattern on their coats/colour, head shape)

2 a They all have backbones. Accept other reasonable suggestions.

b any reasonable suggestion (e.g. skin covering, pattern on their skins, size)

c Bar chart showing four mammals, three birds and two amphibians. If students have included the puma and jaguar from Q1, they will have six mammals on the bar chart.

7Da-7 Continuous and discontinuous variation

1 eye colour, head width, abdomen length and number of stripes on abdomen

2 a head width or abdomen length (or other reasonable suggestion)

b eye colour, number of stripes

3 a Table thus:

Insect	Head width (mm)	Abdomen width (mm)
1	3	9
2	4	11
3	2	6
4	1	3
5	3	7
6	5	13
7	2	4
8	6	15
9	5	14
10	4	10

b Scatter graph drawn with a line of best fit.

c The wider the head, the wider the abdomen (or vice versa).

4 They are of the same type and so can breed together to produce offspring that can also reproduce.

7Da-8 Gone fishing

1 The warmer the water, the less oxygen dissolves. The warmer the water, the more gill movements per minute.

2 a The less oxygen dissolved, the more gill movements per minute.

b The graph should be the same shape as the one on the left of the worksheet.

3 1, 9 & 10; 3, 4, 6 & 7; 2, 5 & 8.

4 A group of organisms that can reproduce to produce offspring that can also reproduce.

5 length of fish (or other reasonable suggestion)

6 number of spots (on tail) (or other reasonable suggestion)

7 a Measurements:

Fish	Overall length (mm)	Spots on tail
3	20	9
4	10	3
6	15	7
7	29	15

Suitable scatter graph plotted with a line of best fit.

b The longer the fish, the more spots there are on its tail.

8 The drawing should show features from both fish.

9 reproduce

10 any suggestion of a hybrid and its parents (e.g. zebroid – horse and zebra; liger – tiger and lion; mule – horse and donkey)

7Da-9 Heights

1 a continuous

b There is a gradual range of heights.

c any sensible suggestion (e.g. eye colour, unlobed/lobed ears)

2

Height groups (cm)	Number of students in each height group
150–154	2
155–159	2
160–164	4
165–169	5
170–174	3
175–179	2
180–184	2
185–189	1

3 Correctly drawn bar chart using the data from the answer to Q2.

4 a bell-shaped

b normal distribution

7Db Adaptations

Student Book

1: 7Db Adaptations (Student Book)

1 light, temperature, wind

2 A – the desert shown is dry, hot; B – the Arctic habitat shown is cold, snowy; C – the grass savanna shown is sunny, hot

Ecosystems

3 *students' own answers*

4 thick fur to keep warm, small ears to stop losing too much heat

5 so that they doesn't lose too much water

6 Polar bears live in the Arctic, cacti live in deserts and jack rabbits live in deserts.

7 Meerkats have short hair so that they can lose heat and wolverines have thick hair so that they do not lose too much heat.

8 Students' drawings should contain ideas such as having a flexible stem so that water can flow over the plant easily and some way in which the plant is attached firmly to a rock or into the soil to stop it being washed away.

9 cold, snowy with polar bears, wolverines (you may include other animals and plants, such as pine trees)

10 *students' own examples* of features that they have inherited (e.g. nose shape, hair colour, lobed/unlobed ears)

11 K is mother of D and H; C is mother of A and E; B is mother of A; I is mother of G and F

12 a her mother

b because they have been produced from different gametes (each gamete contains a slightly different set of instructions/genes for features)

Activity Pack

7Db-1 Adaptations

1 a dry, hot in the day

b snowy, cold

c lots of light in the day, hot in the day

d salty, windy

2 Organisms have *adaptations* so that they can survive the *environmental* factors in their *habitats*. We say that the organisms are *adapted*.

3 gills (to get oxygen from the water), streamlined shape (to move easily through water), fins (to swim)

4 a to help keep them warm

b they got their white fur from their parents

c It camouflages them. Animals that the polar bear wants to eat are less likely to see it coming. Animals that want to eat the Arctic hare are less likely to spot it.

5 fox, rabbit, grass

7Db-4 Adaptations for tree living

This work is at level 5 if students design a logical ordering of the subtitles and either use the provided sentences or find some adaptations of woodpeckers and grey squirrels.

This work is at level 6 if students describe how certain adaptations allow the survival of the organisms.

7Db-5 Animals and their adaptations

This work is at level 4 if students simply recognise the habitat of each animal and describe a physical factor associated with that habitat.

This work is at level 5 if students identify adaptations of the animals for their habitats.

This work is at level 6 if students explain how an animal's adaptations allow it to survive in its habitat.

7Db-6 Bird adaptations for feeding

seeds – sparrow – the beak is short, thick and strong to allow the bird to crush its food

fruit – parrot – a wide curved and sharp beak, allows the bird to cut open its food and gnaw inside

flying insects – nighthawk – the beak is wide and short, with bristles on it to help trap the bird's food
meat – eagle – a short, sharp and hooked beak is used to tear flesh

fish – heron – a long, sharp beak that can be used like a spear to stab animals to eat (note that herons will usually only employ this for particularly large prey)

nectar – hummingbird – a very long, thin and delicate beak is used for probing inside flowers

insects in wood – woodpecker – the beak is shaped like a chisel and, like a chisel, it is used to chip away at wood

small animals buried in mud – curlew – a long, thin beak allows the bird to dig for small animals

tiny water plants and animals – duck – a wide beak can be used like a sieve to strain tiny organisms out of the water

7Db-7 Swordfish

1 a ocean circled in the text

b 'very cold' and 'very dark' have boxes around them

c one from: saltiness, high pressure, water

d to catch other organisms to eat

e 'it produces heat and this keeps the temperature of a swordfish's eyes about 20 °C' underlined in the text

f fins, streamlined body shape (some students may spot that the sword will help the fish 'cut through' the water, and this is also correct)

g gills

h They are 'warm blooded' and so their eyes are kept warm anyway.

i They inherited the swords from their parents.

7Db-8 Hares

1 one of: ear size, fur colour

2 a coat pattern

b Each hare is born from a different pair of gametes and so each hare has a slightly different set of instructions inherited from its parents.

3 a A – farmland/countryside UK; B – desert; C – Arctic

b any animal that lives in farmland/countryside in the UK

c ideally answer should include the name of another Arctic organism and one physical environmental factor of the Arctic (e.g. cold)

4

Hare	Adaptation	How it helps the hare
A	brown fur	camouflage so that it is less likely to be spotted by predators
	large, strong hind legs	running fast away from predators
B	large ears	good hearing to listen out for predators
	large ears	to lose heat, so that it doesn't overheat in the desert
	large hind legs	running fast away from predators
	no need to drink	doesn't need a source of water, which is scarce in the desert
C	thick fur	to help stop it getting too cold in the Arctic
	white fur	camouflage so that it is less likely to be spotted by predators
	small ears	so that it doesn't lose too much heat and get too cold in the Arctic
	very wide feet	to help stop it sinking into the snow as it runs away from predators, which would slow it down and make it more likely to be caught

7Db-9 Searching for coelacanths

1 dark, cold, sharks are all mentioned in the text although students may include other organisms or physical environmental factors found in deep oceans (e.g. high pressure)

2 hard scales – protection from being eaten by predators; blood contains an antifreeze – so that it remains a liquid and blood (carrying oxygen and nutrients) continues to flow around the fish's body even at very cold temperatures; blue colour acts as a camouflage – the fish is less likely to be spotted by predators; small gills – very good at getting oxygen out of water without much energy so that the fish can conserve energy and so needs less food; rostral organ allows it to find food; sensitive eyes allow it to find food and look out for predators

3 a uneven because it is only found between 90 and 200 m deep and not throughout the ocean

b The coelacanth cannot survive close to the surface because its gills do not extract enough oxygen from warmer water and the brightness of the light is harmful to its very sensitive eyes.

7Dc Effects of the environment

Student Book

1: 7Dc Effects of the environment (Student Book)

1 e.g. clothing, face paint, beard, jewellery

2 a A – yellow cress seedlings; B – few leaves; C – taller sunflower

b A – lack of light; B – storm; C – fertiliser

3 acidic

4 fading light levels

5 There are many paddyfield warblers in December and very few in July.

6 so that it stays camouflaged in the different seasons

7 a Hedgehogs hibernate so that they do not need to find food when there is not much food available.

b Oak trees lose their leaves so that they do not lose water at a time when they cannot get water from the ground because it is frozen.

c Paddyfield warblers migrate to places where there is food in the winter.

d Poppy plants die completely in the winter so that they do not need to photosynthesise to make food when there is little light (and the water they need may be frozen in the ground).

Activity Pack

7Dc-1 Effects of the environment

1 Scar on the face, earring, hair cut are environmental. Eye colour (unless changed by coloured contact lenses!) and ear shape (unless changed by wearing ear gauges) are inherited.

2 Changes in environmental *factors* during a 24-hour period are called *daily* changes. For example, most owls rest during the day and are active at night. These owls are *nocturnal*. Changes during a year are called *seasonal* changes.

3 Oak tree – loses its leaves in winter – to stop it losing water when the water in the ground is frozen. Dormouse – comes out at night – so there are fewer animals around that would attack it. Rabbit – grows thicker fur – to help keep it warm in winter. Ptarmigan – changes its colour – to match its surroundings. Hedgehog – hibernates – so it does not have to eat when there is little food in winter. Swallow – migrates – to find food in the winter.

7Dc-7 Changes

1 a temperature drops; light levels decrease/days get shorter

b grows thicker fur

c and d sensible suggestions

2 a any deciduous tree (e.g. oak)

b getting colder/shorter days

c seasonal change

3 b scar, earring, trendy clothes are environmental

c fashion

Ecosystems

7Dc-8 Changing habitats

1 a One tree has all its leaves and branches on one side.

b wind

c They lose their leaves in winter.

d It means that they don't lose water at a time when the water in the ground is frozen and so can't be used by the tree.

2 a e.g. temperature

b It goes up.

c They emerge from their cocoons.

d The warmer the temperature in March the earlier the butterflies emerge.

e It may make them emerge earlier.

f Global warming may make average March temperatures even warmer.

3 a it faces drying out, being attacked by land animals

b shell stops evaporation, provides protection

4 a migration

b To get away from the intense heat and dryness of the north African summer. There is more food in the UK. It is cooler in the UK.

c It has got earlier and earlier.

d There are numerous possible reasons:

North Africa gets hotter more quickly in spring than it used to, so food becomes more scarce more quickly and the birds leave; North Africa gets hotter more quickly in spring than it used to, so the baby chiffchaffs hatch and are ready to fly earlier; the UK gets warmer more quickly in spring than it used to, so attracting the chiffchaffs earlier.

7Dc-9 Learning

1 Inherited variation. Innate behaviour is something that is pre-programmed into an organism so it is inherited, even if there are slight variations in the behaviour.

2 a and **d**

3 a innate, **b** innate, **c** learned, **d** innate, **e** learned

4 Learning allows them to adapt to new conditions/situations.

5 a to find food

b The birds will automatically migrate to an area where there is food.

c The birds will carry on returning to an area that has changed and no longer has a supply of food, year after year, despite the fact that there is not enough food.

6 a they shiver

b they put on thick clothes, hats, etc.

7Dd Effects on the environment**Student Book**

1: 7Dd Effects on the environment (Student Book)

1 water, food, shelter

2 There is very little water and so fewer plants.

3 humans

4 a People cut down all the trees so there were no materials left to build boats with which to fish. The lack of trees also resulted in the loss of many birds, removing another food source from humans.

b People ate them and there were no trees, which the birds needed for shelter/food.

5 a aspen → beetle → thrush → goshawk → great horned-owl

b aspen – producer (makes its own food); beetle – herbivore, consumer (eats plants); thrush – carnivore, consumer (eats thrush); goshawk – carnivore, consumer (eats voles); great horned-owl – carnivore, consumer, top predator (eats goshawk, nothing preys on it)

6 They both eat snowshoe hares.

7 a There might be more voles because there are fewer snowshoe hares to eat the grass and so there is more grass for the voles to eat. There might also be fewer voles because the goshawks have fewer snowshoe hares to eat.

b There might be fewer voles because the whole food web depends on producers – if producers do not get water they will die and so will everything else in the food web.

8 a lynx – predator; snowshoe hare – prey

b one of: fewer lynxes, more plants to eat, milder weather meaning that more offspring survive

c two of: fewer snowshoe hares to eat, disease, increasing numbers of a predator, competition with another predator

Activity Pack**7Dd-1 Effects on the environment**

1 water

2 a birds or humans

b insects or birds

c It reduced the number of insects (that fed on the trees).

d Birds can live in trees, and they can also hide from predators in trees.

3 a

	Lettuce	Slug	Caterpillar	Hedgehog	Fox
producer	✓				
consumer		✓	✓	✓	✓
herbivore		✓	✓		
carnivore				✓	✓
top predator					✓

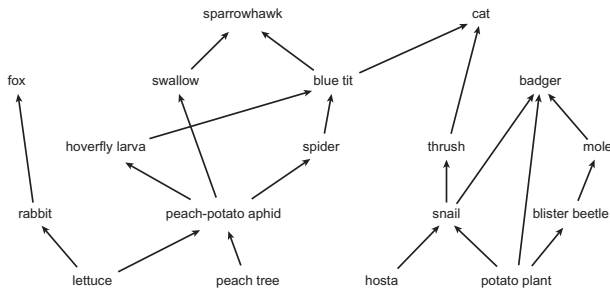
b lettuce

c caterpillar and slug

d food

7Dd-5 Building a food web

1



2 peach tree (producer), peach-potato aphid (herbivore, consumer), swallow (carnivore consumer), sparrowhawk (carnivore, consumer, top predator), potato plant (producer), blister beetle (herbivore, consumer), mole (carnivore, consumer), badger (omnivore, consumer, top predator), hosta plant (producer), snail (herbivore, consumer), thrush (carnivore, consumer), cat (carnivore, consumer, top predator), spider (carnivore, consumer), blue tit (carnivore, consumer), lettuce (producer), rabbit (herbivore, consumer), fox (carnivore, consumer), hoverfly larva (carnivore, consumer)

7Dd-6 River food web

1 a Either: pondweed → mayfly larva → greater water boatman → stickleback → kingfisher → sparrowhawk

Or algae → water flea → greater water boatman → stickleback → kingfisher → sparrowhawk

b pondweed (producer), algae (producer), water flea (herbivore, consumer), mayfly larvae (herbivore, consumer), greater water boatman (carnivore, consumer), stickleback (carnivore, consumer), kingfisher (carnivore, consumer), sparrowhawk (carnivore, consumer, top predator)

2 mayfly larva, lesser water boatman, freshwater shrimp

3 a one of: shelter, a mate, water, space

b one of: light, water, mineral salts

4 a stickleback

b they both eat the same food – water fleas

5 There would be fewer mayfly larvae because they have less to eat. There may be more lesser water boatman because, with more dead plants, there is more for them to eat.

7Dd-7 Populations and competition

1 a water, mineral salts (accept 'a supply of carbon dioxide')

b Wheat plants are found out in the open since they need full sun. Bramble plants and stinging nettles might be found in more shaded wooded areas or in hedges.

c They compete for the same food (dormice, wood mice, bank voles and blackbirds).

d for other resources, such as shelter and water
e It may go down because there would be fewer peacock butterfly caterpillars to eat.

f If the brambles are removed, the wood mice will eat more grass and so there will be less for the harvest mice, and so their population may decrease.

g because they both eat the same thing (brambles)

h The tawny owl population is not dependent on the populations of harvest mice or wood mice, and so the owls must have a broad, varied diet.

2 a The lichen population would go down.

b because there was still enough lichen to eat in those areas

c because there was very little left to eat on the island

d mates (there was only one male left and he was infertile)

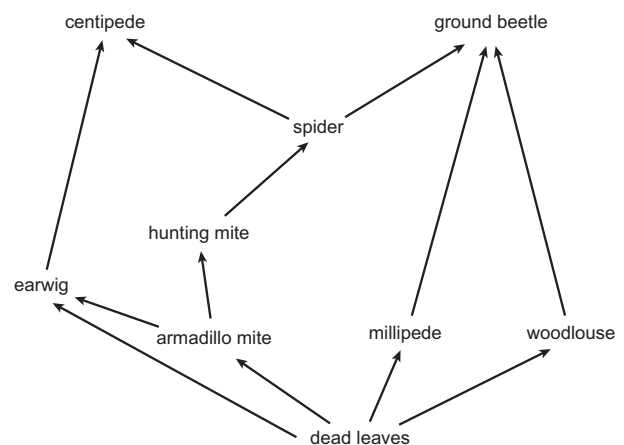
e The food web should show both lichen and sedge grass being eaten by reindeer and reindeer being eaten by humans.

7Dd-8 Leaf litter food web

1 a They move away from the light/heat of the lamp.

b They are more likely to find food amongst the rotting leaves, which are at the bottom of any pile of leaves.

2



3 a They will increase because there are fewer predators.

b They will decrease because there will be fewer hunting mites, which they depend on for food.

c centipedes because ground beetles have a greater variety of food sources

4 two named *carnivores* that share the same food source (e.g. centipede and ground beetle)

5 a It shows more of the organisms in a habitat/ecosystem; It allows you to see how some animals have a variety of food sources; It allows a better representation of omnivores.

b It doesn't show all the organisms in a habitat/ecosystem; It doesn't show what parts of plants

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animals eat (e.g. leaves, berries, bark); It doesn't show what proportion of an animal's diet is composed of each food source; It doesn't take into account the time of year; It doesn't take into account the time of day.

7Dd Greener cities (STEM)

1 Any suitable answer that refers to making space for more plants and animals as well as humans to live in

2 Any two from: light, water, nutrients

3 Different plants provide different kinds of food and shelter that will suit different kinds of animals.

4 Any suitable answer that links to growing plants well on buildings or attracting different animal species to the building, such as:

- how much space will the plants need to grow well?
- how can we make sure plants get the right amount of nutrients for healthy growth?
- which animals are most likely to do well in this environment?

5 A list of useful knowledge about growing plants on buildings, including:

- which plants would be the right size (not grow too tall or wide)
- which plants would attract animals
- which plants can cope with the different conditions (i.e. light intensity, wind speed) higher up on buildings
- how heavy will the plants and soil be – how much extra weight will the building need to support
- how will water and nutrients be supplied in the right amounts

6 Answers will vary according to local area.

7De Transfers in food chains**Student Book****1: 7De Transfers in food chains (Student Book)**

1 to release energy so that they can move.

2 a the transfer of energy from lettuce to rabbit

b some has been lost by the rabbit through respiration/moving/keeping warm/in waste

3 a *Students' own food chains*, with grass on the left

b *students' own pyramids of numbers* (bars do not need to be proportional)

4 a

Feeding relationship	Organisms
top (or apex) predator	grass snake
primary consumer	grasshopper
producer	grass
secondary consumer	frog
tertiary consumer	grass snake
herbivore	grasshopper
carnivore	frog, grass snake

b *Students' own pyramids of numbers* (bars do not need to be proportional)

5 Many fleas can live and feed on a single rabbit.

6 a It increased the populations of rats and rabbits.

b A predator of rats and rabbits had been removed.

7 It has risen because there are no longer cats and rats to eat the birds' eggs or rabbits to destroy their nesting sites.

8 a It may kill species it is not intended for.

b It may cause an increase in the aspens because they will not be eaten by the beetles.

It may cause a decrease in the thrush population because they will have less food.

9 Farmers used DDT, which passed up the food chain. The peregrine falcons ingested DDT from the blackbirds that they ate, which made them lay eggs with weak shells. The shells broke when the peregrine falcons tried to sit on them, killing the eggs.

2: 7De Nomads (Student Book)

1 predator – snow leopard; prey – yak

2 a They migrate down from the mountains when it starts to get cold in winter.

b Birds also migrate to warmer places in winter, where they can find food.

3 discontinuous (you either have measles or you do not)

4 They have very thick fur/hair.

5 a *Students' own pyramids of numbers*, e.g. grass, cattle, humans; grass, yak, snow leopard; grass, yak, human (these should be arranged as a pyramid of numbers with the first organism mentioned having the longest bar)

b students' pyramids of numbers should be labelled with producer, primary consumer and secondary consumer.

Activity Pack**7De-1 Transfers of energy and poison**

1 animals that harm things that humans want to use

2 the direction in which energy flows in the food chain

3 one of: respiration, keeping warm, moving, waste

4 a plant plankton → shellfish → fish → humans

b from bottom: plant plankton, shellfish, fish, humans

c The mercury was not destroyed inside the fish and people ate lots of fish and so ate lots of mercury.

7De-2 Working out food chains

The food chain, based on ordering the numbers of animals from most to least, is brazil nut tree → leaf-cutter ant → orb-weaver spider → blue-grey tanager → jaguarundi.

7De-3 Pesticides and birds

A pesticide (DDT) is sprayed over fields of crops to kill insect pests. Some of the pesticide is washed into lakes and rivers.

DDT is absorbed by tiny organisms in the water called plankton. Fish eat many plankton organisms.

Any pesticide in the plankton gets into the fish.

DDT builds up inside the fish.

Many wild birds, such as osprey and heron, eat fish.

DDT can alter the behaviour of birds, sometimes preventing them from building proper nests.

*DDT may cause wild birds to become infertile.

*DDT can cause birds to lay eggs with thinner shells. As a result more eggs are likely to be broken.

*In large amounts DDT can be poisonous to birds.

The populations of many wild birds have decreased over the last 30 years.

*The starred statements can go in any order.

7De-4 Energy flow and poisons

1 to kill organisms that harm the plants being grown

2 insects/ants, aphids, blackfly, whitefly, caterpillars and mites

3 fish and bees

4 Avoid getting it on the skin (wear gloves) or breathing it in (wear face mask/spray in direction of wind). Wash hands after use.

5 a the direction in which energy flows in a food chain

b There is less energy as you go along a food chain because animals lose it (in their activities and in waste).

c In food chain X – lettuces: more because fewer are eaten by insect pests; rabbits: no change or more because there is more lettuce to eat; fox: no change or more because there are more rabbits to eat.

In food chain Y – rose bushes: would look healthier as no aphids feeding off them; aphids: killed so far fewer; ladybirds: numbers decrease as fewer aphids to eat.

In food chain Z – pondweed: no change; tadpoles: no change; sticklebacks: some may die as Zymac is poisonous.

7De-5 DDT

1 a substance that kills pests (organisms that harm things that humans want)

2 the name of any pest

3 Advantage: one of less damage to environment, no expensive pesticides; sell produce for more money. Disadvantage: may lose a lot of crop to diseases; can be very labour-intensive.

4 A level 5 answer will be in terms of the fact that DDT kills an insect/pest that harms each of these organisms. A level 6 answer will give details for some or all of the organisms (e.g. the dog will

not have fleas; the tomato will not be damaged by insect pests; the human will not be bitten by insects/will be able to grow nicer vegetables/flowers; the cow will not be bothered by insects; the potato will not be damaged by insects; the chicken will not have fleas).

5 The DDT only needed to be applied once, which meant that less substance needed to be applied and it took less time to apply pesticides than other pesticides that required more than one application.

6 Level 5 will mention one advantage in terms of DDT killing pests. A level 6 answer will include a general drawback (such as 'harming wildlife'). A level 7 answer will be more detailed and explain why killing pests is an advantage and how DDT affected wildlife as a disadvantage.

7 Advert, explaining how DDT affects wildlife. A level 6 answer will explain how DDT in the body of a top predator may kill it or make it less likely to reproduce, or may explain that if DDT kills organisms lower in the food chain there will be less energy available for organisms higher in the food chain, resulting in a decrease in population. A level 7 answer will explain how a persistent pesticide gradually increases its concentration in the bodies of organisms as you go along a food chain, and explain how it is only when a certain concentration is reached that problems can be caused.

7De-6 Toxic chemicals and food chains

1 a the flow of energy from one organism to another

b pyramid of numbers drawn, with algae on the bottom and bars getting progressively shorter, with heron at the top

c Energy is lost at each step of the food chain so as you go along a food chain there is less and less energy available for the animals and so the populations of the animals are smaller and smaller.

d Because the herons eat many trout each, they get more doses of DDT than a single trout does.

2 a i animal P **ii** animal R

b pyramid of numbers drawn, with leaves on the bottom and bars getting progressively shorter, with animal P at the top

3 It was carried there by migrating fish.

4 The producer is a single very large organism compared with the animals that are living off it.

7De-7 Pyramids of biomass

1 It is lost in respiration (e.g. for keeping warm, moving) and as undigested waste

2 food chains drawn, starting with the organism in the bottom bar in each case

3 Table showing – Producers: phytoplankton, oak tree. Primary consumers: caterpillar, zooplankton. Secondary consumers: blue tit, herring. Tertiary

Mixtures and separation

consumers: owl, mackerel. Quaternary (allow 4th) consumer: tuna.

4 Energy is lost at each step of the food chain so as you go along a food chain there is less and less energy available for the animals and so the populations of the animals are smaller and smaller; however, for the oak tree, the producer is a single very large organism compared with the animals that are living off it.

5 **a** the dry mass of biological (living) material
b Both pyramids should be pyramid-shaped.

6 Factors such as the weather cause different organisms to have different amounts of water in them at different times.

7 It drops its leaves in winter.

8 Things that might be explained include: trophic levels; why the biomass decreases so rapidly; what the units mean; a calculation might be done to show that 99.99% of the producers support 0.01% of the other organisms.

9 Advantage of pyramids of numbers: relative ease of counting organisms in an area. Disadvantage: can produce strange-looking pyramids, which do not reflect the underlying loss of energy through a food chain. Advantage of pyramids of biomass: much more reflective of the true losses of energy in a food chain. Disadvantage: much more difficult to collect the data, organisms have to be destroyed to collect the data.

7E Mixtures and separation

7Ea Mixtures

Student Book

1: 7Ea Mixtures and separation (Student Book)

1 **a** any suitable answer, e.g. solid – glass (in beaker), sodium chloride crystals, steel (in furniture); liquid – water, hydrochloric acid, cola; gas – air, oxygen, carbon dioxide

b any suitable description, e.g. solid – holds its own shape; liquid – fixed volume but not a fixed shape, flows to fill bottom of container; gas – no fixed shape or volume, spreads out to fill all space, can be squashed/compressed to a smaller volume

2 **a** Gravel can be separated from water by sieving.

b Sand can be separated from water by filtering.

3 **a** A solution is a mixture where a solid has been dissolved in a liquid.

b evaporate the water

4 **a** You can return to the original constituents by the reverse/opposite process – in this case, evaporation.

b any suitable change, e.g. melting, freezing, condensation

3: 7Ea Mixtures (Student Book)

1 It contains substances other than water, such as mud, human waste and other solids.

2 **a** large solids or the names of some large solid items

b A screen (acts like a sieve); it has large holes/gaps that let everything through except large solids.

3 A suspension contains suspended solids; a solution contains dissolved solids.

4 A suspension, because it contains solids that settle out if left to stand (it is also a solution because there are dissolved solids in the water).

5 The polystyrene and air are mixed in a way that is not easy to separate again (so it is not a suspension), but the solid is not dissolved (so it is not a solution).

6 A colloid, because it is a cloudy mixture with no sediment after it has had time to settle.

7 filtered or left to settle and water removed from the top; because the solids are now large enough to settle from the liquid

8 flow chart similar to: waste water from homes → sieved to remove large solids → settlement or filtration to remove smaller solids → treated with chemicals to clump finest solids → settlement or filtration to remove clumps

Activity Pack

7Ea-1 Writing a clear method

1 A – action; B – sequence; C – apparatus; D – diagram; E – language

2 **a** unlock, open, put, close, sit

b A – Unlock the car. B – Open the car door.

c The steps are not in the right order as you can't put the seat belt on before you sit in the seat.

d C – Sit in the car seat. D – Put the seat belt on.

E – Close the car door. (Steps D and E can be in either position.)

3 Method should be written with one action per step, each step starting with an imperative verb, and sequenced in the correct order. For example: A – Place the ready-meal container in the microwave. B – Set the correct power for cooking the meal. C – Set the correct cooking time. D – Press the start button. E – Test to make sure the food is hot.

7Ea-2 Types of mixture

1 suspension – a mixture where the solid settles out of the liquid if left to stand still

colloid – a cloudy mixture where the solid doesn't settle out of the liquid if left to stand still

solution – a mixture in which the solid is dissolved in the liquid

2 large suspended solids

3 a polystyrene – solid; b air – gas

4 cloudy/opaque

7Ea-3 Ordering a method

Correct order:

Fold the filter paper in half, and then into quarters. Open out one layer of the filter paper to make a cone.

Place the filter paper cone into the wide end of the funnel.

Put the narrow end of the funnel into the top of the flask.

Carefully pour the sand/water mixture into the filter paper.

Leave the apparatus to stand until all the liquid in the mixture has filtered into the flask.

7Ea-5 Apparatus diagram

1 (In either order) They show the same pieces of apparatus. The pieces of apparatus are arranged in the same way.

2 (In either order) The picture looks like the real apparatus but the diagram doesn't. The diagram shows the apparatus as if cut through, but the pictures shows the apparatus as if seen from the side.

3 Any suitable answer, e.g. you don't have to draw as much; it's much simpler to draw the diagram.

4 It is easier for everyone to understand what the diagram shows.

5 A suitable drawing done using a ruler and showing the neck of the flask and bottom of the funnel open.

7Ea-6 The right steps

1 A – Anything that clearly describes how to fold the paper and open it out to make a cone that fits into the top of the funnel.

B – Anything that clearly states that the narrow end of the funnel is inserted into the neck of the flask.

C – Anything that clearly describes how the water is poured carefully into the filter paper, so that it filters through the filter paper.

2 Correct apparatus symbols for filter funnel and paper, and conical flask, neatly drawn with sharp pencil and a ruler.

3 Any suitable explanation, e.g. it is quicker and neater to use symbols; everyone understands what the symbols mean.

7Ea-7 Different mixtures

1 correct statements: The flour is a solid and the water is a liquid. The flour will settle to the bottom of the container if the mixture is left to stand.

2 hairspray – liquid; air – gas; gelatine – solid; water – liquid

3 Styrofoam cup – The air stops heat passing quickly through.

Hairspray – The air spreads the liquid droplets so you don't get too much in one place.

Gel in a disposable nappy – The water is absorbed and locked away.

Hand cream – The water helps it to spread more thinly.

7Ea-8 An emergency water filter

1 Labelled apparatus diagram of filter paper, filter funnel and container such as a conical flask or beaker.

2 Clearly written method, with one instruction in each step and in correct order.

3 The layers of stones, sand and moss will separate out the larger solids as the dirty water filters through them.

4 The water may also contain harmful microorganisms that would not be trapped in the filter because they are too small. Boiling the water would make it safer to drink. Also, the finest solids will probably not be removed by the filtering.

7Ea-9 Different kinds of colloids

1 Hairspray: liquid aerosol of liquid in gas.

Mayonnaise: emulsion of liquid in liquid. Smoke:

solid aerosol of solid in gas. Jelly: gel of liquid in

solid. Styrofoam: solid foam of gas in solid. Inks: sol of solid in liquid. Whipped cream: liquid foam of gas in liquid.

2

	Gas in ...	Liquid in ...	Solid in ...
gas	–	liquid aerosol	solid aerosol
liquid	liquid foam	emulsion	sol
solid	solid foam	gel	–

3 Hand cream – emulsion. Dirty water – sol. Fog – liquid aerosol. Pumice – solid foam.

4 a Suspension, because the liquids separate on standing.

b Emulsion, because it is a colloid of liquids.

c Any suitable answer that shows understanding of the problems caused by trying to group things that may not fit only one group in a classification.

7Ea Forensic science (STEM)

1 Anything similar to: the study of substances and objects from the scene of a crime to work out what happened

2 It makes it easier to identify the substances, which might help work out where a substance came from.

3 Filtering separates soluble substances in a sample from insoluble ones, which can make it easier to identify some of the soluble substances

Mixtures and separation

in the filtrate or the insoluble substances in the residue.

4 This provides a way for others to check their results, so that evidence from the analysis given in court can be trusted.

5 Any three of: fold (A and B), place (D and F), stir (E), pour (G) (they are all instructions to do something).

6 Steps A and B could be drawn as a diagram, which would be clearer as it would show clearly where the folds should be made.

7 The method should be written using clear language, one action per step, arranged in the correct order and using an imperative verb in each step. Steps should include a logical order for placing the equipment, e.g. place the tripod on the bench, put the gauze on the tripod, fill a beaker with water and then put this on the gauze.

7Eb Solutions

Student Book

1: 7Eb Solutions (Student Book)

1 The water contains dissolved substances/ solutes.

2 any two suitable solutes, e.g. sodium chloride, copper sulfate (other possibilities include any chloride, iodide, bromide, fluoride, calcium carbonate, magnesium), and any one gas, e.g. oxygen (other possibilities include carbon dioxide, ammonia)

3 It may be coloured (e.g. copper sulfate) but still transparent. It may taste or smell different from the solvent that does not contain the solute. Some students might also mention evaporation.

4 Propanone is the solvent, nail varnish is the solute.

5 $20 + 150 = 170$ g

6 **a** sodium chloride

b $5 \times 32 = 160$ g

c As the liquid cools, the copper sulfate will start to crystallise out. This is because the solubility of the copper sulfate decreases as the temperature decreases and so less of it can stay dissolved in the solvent.

Activity Pack

7Eb-1 Solution words and definitions

dissolves – when a substance splits up and mixes with a liquid to make a solution

soluble – something that will dissolve in a liquid

transparent – see-through

insoluble – something that will not dissolve in a liquid

solution – a mixture formed when a substance dissolves in a liquid

solute – the substance that has dissolved in a liquid to make a solution

solvent – a liquid in which other substances dissolve

saturated – when a solution contains the most solute that will dissolve in the solvent

solubility – the amount of substance that dissolves in a given amount of liquid

7Eb-2 Solvents and solutions

A matches with **2**, label **a**

B matches with **5**, label **b**

C matches with **7**, label **a**

D matches with **8**, label **b**

7Eb-3 Temperature and solubility 1

Students should find that more salt dissolves if the water is hot.

7Eb-4 Temperature and solubility 2

Students should find that the solubility increases as temperature increases.

7Eb-5 Graphing solubility 1

2 **a** goes up

b chloride

c nitrate

d 41

e 45

7Eb-6 Graphing solubility 2

2 **a** Solubility increases as temperature rises.

b potassium chloride

c potassium nitrate

d answers from graph – 15 °C, 24 °C, 27 °C, 31 °C, 34 °C, 37 °C

7Eb-7 Solution questions

1 **a** soluble **b** insoluble, soluble

2 solution 1: solvent is water, solute is copper sulfate

solution 2: solvent is propanone, solute is nail varnish

3 The amount of solute that dissolves in a particular amount of solvent.

4 **a** The amount of sodium nitrate that dissolves in water increases as temperature increases.

b no

c The solution was saturated.

7Eb-8 Solution questions

1 The copper chloride dissolves in ethanol.

2 solution

3 Copper chloride is the solute, because it is the solid that 'disappears' in the ethanol. Ethanol is the solvent, because it is the liquid in which the copper chloride 'disappears'.

4 **a** 220 g

b The mass of solute is added to the mass of the solvent.

5 a All the copper chloride would dissolve because this mass is lower than the solubility.

b Most of the copper chloride will dissolve, but 7 g of the copper chloride would remain undissolved at the bottom of the beaker, because this mass is greater than the solubility at this temperature.

c Some of the copper chloride would remain undissolved at the bottom of the beaker because 60 cm^3 can only dissolve $53 \times 60/100 = 32 \text{ g}$ copper chloride at this temperature.

d Possibly all of the copper chloride will dissolve because solubility usually increases with temperature.

7Eb-9 Hot water and oxygen

2 a It goes down/gets less.

b It is the opposite – most solids get more soluble as the temperature increases.

3 a fresh water

b Fresh water – the graph goes down more steeply (or, the solubility changes by 9.9 mg/dm^3 for fresh water as the temperature goes up from 0 to $60 \text{ }^\circ\text{C}$, but only goes down by 7.5 mg/dm^3 for sea water).

4 a answer from graph – should be approximately 12.8 mg/dm^3

b a half of 12.8 mg/dm^3 is 6.4 mg/dm^3 , and this solubility occurs at $40 \text{ }^\circ\text{C}$

5 Less oxygen would be dissolved in the warmer water, so there would be less oxygen for the fish and they may be harmed. (The warmth also encourages the growth of microorganisms that further deplete the oxygen supply, but students are not expected to know this.)

6 Heating sea water does not have as big an effect on solubility as heating fresh water. Also, the sea has a far greater volume than rivers, so the warm water spreads out and the overall temperature increase is very small apart from very close to the outlet pipe.

7Ec Evaporation

Student Book

1: 7Ec Safety when heating (Student Book)

1 to heat things

2 so the burner is lit with a safety flame, which is less hazardous than a blue flame

3 It is not very hot, like the noisy blue flame, so it is easier to stop the heating before the solution starts spitting; it is not smoky like/it is hotter than the yellow flame.

4 a hot apparatus that could burn on touch; spitting of liquid during heating

b Do not touch the apparatus until it is cool; if the apparatus must be handled, use heatproof tongs or gloves; switch the Bunsen burner off before all liquid evaporates from the solution.

5 The plan must identify the hazards of heating solutions and include instructions to minimise risk from these.

2: 7Ec Evaporation (Student Book)

1 a the water evaporates

b The salt does not evaporate, so it is left behind when the water evaporates.

2 Faster in the warm ponds, because the rate of evaporation increases as the temperature increases.

3 rock salt: water pumped into rock layers → brine pumped to surface → brine heated to evaporate water and leave dry salt

sea salt: salt water from sea taken into shallow ponds → water evaporates from salt water (warmth from Sun speeds up rate of evaporation) → dry sea salt left in ponds and collected for use

4 At $100 \text{ }^\circ\text{C}$ all the liquid water is trying to evaporate at the same time, causing many bubbles of water vapour in the liquid. Below boiling point, evaporation happens only at the surface of the liquid.

5 At $80 \text{ }^\circ\text{C}$ all the ethanol will turn to vapour and leave the liquid. Some of the water will be evaporating at this temperature too, but it will not be boiling because $80 \text{ }^\circ\text{C}$ is below its boiling point.

6 Measure the liquid's boiling point. If it is $100 \text{ }^\circ\text{C}$, it is pure water.

7 a They were heated gently until most of the water had evaporated. Then they were left to dry from the heat left in the dish.

b The tap water in the sample on the right contained dissolved solids but the pure water did not.

Activity Pack

7Ec-1 Safety when heating

2 a Small, but very hot blue flame. **b** Larger, bluer flame. **c** Large, yellow flame.

7Ec-2 Evaporation

1 Evaporation

2 Dissolved/dry salts/solids

3 Sodium chloride

4 Brine

5 Sea salt

6 Boiling

7 Boiling point

8 Heat to dryness

7Ec-6 Making salt

correct order: **B, F, E, G, J, A, C, I, D, H**

Mixtures and separation

7Ec-7 Dissolved salts in water

2 a Any one appropriate hazard, for instance hot apparatus or spitting of evaporating solution.

b Suitable risk reduction for hazard given, for instance don't touch apparatus until cool/wear heat-resistant gloves/use tongs or wear eye protection.

3 a using a bar chart

b same volume of each water was evaporated

c Bottled water 2, as it has the highest amount of dissolved solids.

7Ec-8 Gandhi and the Salt Act

1 Gandhi's salt would have been mixed with sand.

2 No, sea water has more than one substance dissolved in it. Also there would have been small animals and possibly some pollution in the sea water.

3 Mix the impure mixture with water, so the salt will dissolve in the water.

Filter the mixture. The sand will be trapped in the filter paper, but the dissolved salt will go through the filter paper.

Evaporate the filtrate. The water will evaporate, leaving the salt behind in the evaporating dish.

Students should draw a labelled diagram, using the correct apparatus symbols, illustrating each step in the process.

They should also identify hazards from hot equipment and from spitting liquid in the final stages of evaporation if the solution is still heated. Heat-resistant gloves or tongs should be used for handling anything hot. Eye protection should be worn. The source of heat should be switched off when there is still a little liquid in the evaporation basin, and the rest of the liquid left to evaporate naturally.

7Ec-9 Carry out a risk assessment

The full risk assessment should be laid out neatly and clearly.

It should identify all the hazards including hot equipment, spitting liquid and any chemicals used. Hazards of a large number of people include risk of bumping into each other, falling into equipment, tripping hazards from bags, etc.

Assessment of risk will vary but should be realistic. Ways of reducing risk should include safe ways of handling hot equipment or rules not to touch until cool, protection for eyes and clothing, switching off heat while still a little solution left.

Action needed if something goes wrong should include rapid treatment of scalds or burns, suitable advice for dealing with spills.

7Ed Chromatography

Student Book

1: 7Ed Chromatography (Student Book)

1 a technique that separates substances dissolved in a solvent

2 Substance A, because it has the higher peak on the graph.

3 Dots of the inks were placed near the base of the paper. The paper was then placed in the beaker. A small amount of solvent was placed in the beaker, so that the level of solvent was below the ink dots on the paper.

4 a Black ink contains blue, purple and red dye; brown ink contains yellow and red dye; red ink contains red and yellow dye; green ink contains blue and yellow dye; blue ink contains blue and purple dye; orange ink contains yellow and red dye.

b red

5 The solvent carries the substances at different speeds so they are spread out.

6 Evaporation leaves the solid substances still mixed up so it is difficult to identify them.

7 a tartrazine, carotene, natural orange

b Orange drink 3 because the chromatogram shows that it does not contain any tartrazine.

8 Any two suitable examples, such as: forensic analysis, testing for banned drugs, water analysis, food analysis.

9 a They separate out the substances in the mixture.

b The water analysis method shows how much of each substance is present, which paper chromatography does not.

c The water needs to be tested to show how much of some substances there are, because there are limits on how much of these substances is safe in drinking water.

Activity Pack

7Ed-1 How does chromatography work?

Chromatography can separate ... different coloured dyes in a mixture.

A drop of the mixture ... is put onto a piece of special chromatography paper.

The bottom of the paper ... is put into a solvent such as water.

The solvent dissolves the dyes and ... travels up the paper.

The different dyes in the mixture ... are carried at different speeds in the solvent.

The paper is dried ... to make a chromatogram. You can work out the number of different dyes in the mixture ... by seeing how many different colours are on the chromatogram.

7Ed-2 A chromatography method

1 Make the dots as concentrated as possible by applying the substance several times in the same place and letting it dry between times.

- 2** Use something that isn't soluble in the solvent, e.g. pencil when using water.
- 3** Along a line above the bottom of the paper, so that they all start at the same level and so that they don't dissolve into the solvent at the bottom of the beaker.
- 4** Do a test beforehand to make sure the substances dissolve in the solvent.
- 5** Spread the dots of the different dyes out across the paper at the same level.
- 6** Support it, e.g. by attaching it to a stick that is balanced across the top of the beaker, or roll it into a cylinder and clip it before putting it in the beaker.
- 7** Safety instructions will depend on hazards for any substances used, but always use eye protection when using solvents.

7Ed-4 Chromatography

- 1** correctly labelled diagram (clockwise from the bottom left): water, pencil line, beaker, paper, spots of ink
- 2 a** A, B and E
b These inks have all got only one spot on the chromatogram.
- 3 a** A and E **b** A and B
- 4 a** F
b It has not moved from its original position.

7Ed-5 Who scraped the gatepost?

- 1** Paint does not dissolve in water.
- 2** B
- 3** F
- 4** C and D
- 5** D
- 6** Test the paint from a Post Office van to see if it matched the sample. (Higher-attaining students may point out that manufacturer D may also make Post Office vans, in which case this would not prove anything.)
- 7** See if there was damage to the vehicle, or if any paint from the gatepost was transferred onto it.

7Ed-6 Gas chromatography in water analysis

- 1** They separate out the dissolved substances in the solution.
- 2** It is easier to identify the separate substances than if they are mixed together.
- 3** The gases and liquids are colourless, and they need detecting. Also spectrometry identifies the amount of substance, not just whether it is present or not.
- 4** Samples taken after treatment – check that the treatment processes are working properly. Samples taken from people's taps – check that nothing has leaked into the water as it travels from the treatment plant to the tap.

- 5** Because the internal standard is a substance never found in water, the graph produced will always be the same. This allows the machine to be checked between samples.
- 6** The known amount of dieldrin gives a peak height that can then be used by comparison to calculate the amount of dieldrin in the sample.
- 7** The amount of dieldrin in the sample was within safe limits. The known sample containing 62.5 ng/dm^3 produced a peak with a height of 0.9 on the vertical scale. The sample has a peak that reached 0.3 on the vertical scale, which suggests that level of dieldrin will be around 21 ng/dm^3 ($62.5/3 = 20.8$). 21 ng/dm^3 is the same as $0.021 \text{ } \mu\text{g/dm}^3$, which is lower than the safe limit of $0.03 \text{ } \mu\text{g/dm}^3$.

7Ee Distillation

Student Book

1: 7Ee Distillation (Student Book)

- 1** because it contains only small amounts of dissolved substances
- 2** because they do not get much rain
- 3** removing salts from water
- 4** They use sea water to produce fresh water by desalination.
- 5** concentrated salty water or solid salts, because the salts do not evaporate
- 6** sea water heated → water evaporates to form water vapour leaving behind dissolved salts → water vapour condenses on a cool surface to form liquid water → liquid water is collected for drinking
- 7** Adding anti-bumping granules to the liquid prevents violent boiling, which could cause a spill of boiling liquid, which could cause burns.
- 8 a** Sea water is dangerous to drink and once any fresh water has been used the people will soon need more.
b Bacteria in the water do not evaporate, so this is a good way to separate them from the water and make the water safe to drink.
- 9 a** similarities – they both use the processes of evaporating the water to separate it from the dissolved substances and condensation to collect pure liquid water; differences – the solar still uses heat from sunlight to warm the water while the still in diagram C uses heat from a burner; the solar still uses air to cool the cooling surface while the still in diagram C uses cold water
b The still apparatus will be the more efficient as it will heat the water to a higher temperature, increasing the rate of evaporation, and cool the water more rapidly in the condenser, therefore increasing the rate of condensation.

2: 7Ee Safe drinking water (Student Book)

1 Climate change could change the amount of water those countries receive in rain, causing longer periods of drought or flooding. Droughts can reduce the amount of water stored for use. Floods can damage pipes carrying drinking water and sewage, polluting the water supply.

2 a Water passes through the holes in the filter but the undissolved solutes are trapped in the filter.

b extremely small particles including disease-causing organisms (filters usually have bigger holes than this and therefore leave filtered water unsafe until it is treated with chemicals to kill these organisms)

c Dissolved solids are small enough to pass through most filters. If the concentration of some dissolved solids is too high, it can make the water dangerous to drink.

3 Any suitable answer that makes clear that different problems in different places need different solutions, e.g.: Areas at risk of flooding need emergency water supplies that would not be affected by the flooding, drought areas need safe sources of water that are below ground or processes such as desalination that can make salty water suitable for drinking.

Activity Pack**7Ee-1 Distillation apparatus**

1 correctly labelled diagram (clockwise from the bottom left): flask, thermometer, water out, Liebig condenser, beaker, water in, heat

2 a E inside the flask **b C** inside the condenser

3 The dirty water mixture is put into the flask. The mixture is heated.

The water evaporates and forms steam. The dirt does not evaporate.

The steam goes into the condenser.

The cold water flowing around the outside of the condenser cools the steam.

The steam condenses to form pure water.

The water runs into the beaker.

7Ee-2 Building a solar still

Suggested improvements should be well supported by a scientific explanation, for instance:

- Dark objects placed in the hole will heat up faster and increase the air temperature in the hole, so rate of evaporation will be faster.
- Cooling part of the sheet surface, e.g. by shading, will increase the rate at which water vapour condenses on that part of the surface.
- Digging a shallow hole reduces the volume of air inside the still and so reduces the amount of heat energy wasted.
- Placing fresh plant material, or dirty water, into the hole will increase the amount of water that can evaporate.

7Ee-4 A solar still

1 a heats **b** evaporates **c** condenses
d runs down

2 distillation

3 It helps the dirty water to stay warmer for longer so more water evaporates.

7Ee-5 How a solar still works

1 Heat from sunlight heats up the dirty water. Water evaporates to form water vapour, leaving the dirt behind as the dirt doesn't evaporate. Water vapour condenses into liquid water on the underside of the glass cover. The liquid water runs down the cover and into the collection trough.

2 Distillation is the separation of the solvent/liquid from a solution.

3 The insulation reduces heat loss from the water to the environment, so the water stays warmer. The warmer the water, the faster the rate of evaporation.

4 Any suitable answer with a good science explanation, such as:

- Paint the inside of the still black so it absorbs more heat and heats the water faster.
- Shade the lower part of the glass cover so it is cooler, so water vapour condenses faster.

7Ee-6 Distilling scents for perfumes

1 They evaporate quickly from warm skin carrying their smell, which makes us smell nice.

2 correctly labelled diagram showing: chopped material in flask, separate heated flask containing water, water evaporates to form steam, steam passes through the chopped material causing the volatile oils in the plant tissues to evaporate, the hot vapour is cooled as it passes through a condenser so that the vapour condenses to liquid, the cooled liquid is collected in a flask with the oil and water forming separate layers

3 a Dry distillation uses direct heating to evaporate the oils from the plant material. Steam distillation uses steam to warm the plant material so that the oils evaporate.

b Only oils that evaporate below 100 °C can be extracted using steam distillation. Also some oils are changed by high heat, so steam distillation is better for extracting those damaged by heat.

4 Cooler temperatures can be used when preparing absolutes than in the preparation of essential oils. So chemicals that are spoilt by heat are best extracted using the wax/ethanol method.

5 a The boiling point of water is 100 °C, which is much higher than that of ethanol at 78 °C. If the temperature is kept at just above the boiling point of ethanol but well below that of water, then all the alcohol in the mixture will evaporate but only some of the water.

b Water evaporates at any temperature, though it evaporates faster as temperature increases. So there is no temperature at which some water will not evaporate but the ethanol will.

7F Acids and alkalis

7Fa Hazards

Student Book

1: 7Fa Chemistry in the home (Student Book)

1 Solids: any two from salt, sugar, instant coffee etc. Gas: any one from oxygen, carbon dioxide, etc.

2 They might spill it on their skin or drink it.

3 Keep bleach locked away in a cupboard or use dilute bleach.

4 a So you know the harm that the substance can cause and how to reduce the chances of that harm happening before you use the substance.

b Young children cannot read; they may mistake a substance for something else.

2: 7Fa Hazards (Student Book)

1 a by adding water **b** It is a mixture as water has been added to dilute it.

2 *Students' own answers*, e.g. hydrochloric acid is used in the laboratory, ethanoic acid is used in everyday life.

3 a two of: metal, stonework, skin

b plastic or glass

4 A corrosive chemical will damage the skin. An irritant will not usually cause serious injury but can cause the skin to become red.

5 sour

6 a citric acid or phosphoric acid **b** They do not cause damage.

7 a dangerous to the environment, toxic, flammable
b caution

8 less volume to transport so transport costs are less

3: 7Fa Controlling risk (Student Book)

1

Hazard	Risk is increased because...	Precaution to reduce risk
Unattended lit Bunsen burner	this could set fire to someone's hair or jacket.	Never leave a lit Bunsen burner unattended.
Bottle of a flammable liquid beside lit Bunsen burner	the heat could make the liquid catch fire.	Remove the bottle of flammable liquid and store it safely.
Student heating test tube while not wearing eye protection	boiling liquid could spurt out of the test tube onto the student's face.	Wear eye protection (and point test tubes away from people).

Hazard	Risk is increased because...	Precaution to reduce risk
Student eating food beside bottles of chemicals	the student could eat something toxic.	Do not eat or drink in the laboratory.
Student heating beaker and fumes billowing out	fumes could be dangerous to all in the laboratory.	Carry out the experiment in a fume cupboard.
Bags left in corridors	a student could trip over the bags and fall.	Keep all corridors and working areas clear.

2 a concentrated sulfuric acid

b It can destroy certain substances such as metal, stonework and skin.

c the hazard label on the bottle

d Diluting it with water, wearing eye protection and wearing gloves would reduce the risk.

3 a Toxic gases are formed.

b Carry out the experiment in a fume cupboard.

4 a It could cause burns as temperatures reach over 100 °C.

b Leave to cool for 20 minutes.

Activity Pack

7Fa-1 Hazardous or safe?

Quick-light: flammable

Drain-clear: corrosive

Pest-gone: danger to environment

Super-clean: caution (irritant)

Home-fresh: explosive

Germs-away: toxic

7Fa-2 Comparing acids 1

1 *students' own answers* depending on acids selected

2 *students' own answers* depending on acids selected

3 It fizzed the least/slowest.

7Fa-3 Comparing acids 2

Students need to create a table with a row for each acid and a column for each concentration.

Students should see bubbles forming on the marble chips with each acid and at each concentration except perhaps with the most diluted acid. Ensure that students note the similarities and differences in their observations.

1 Most hazardous produces most bubbles/fastest/most vigorous. Least hazardous, the least/slowest.

2 Adding water makes the acids less hazardous as they react more slowly.

Acids and alkalis

3 Some acids are corrosive (react away substances), others are irritants (will sting).

4 Most hazardous: eye protection, rubber gloves, protective clothing, Corrosive warning symbols, special containers.

Least hazardous: eye protection, Caution warning.

7Fa-4 Hazard symbols

Match symbol to description and example:

Corrosive – concentrated sulfuric acid

Caution – dilute sulfuric acid

Flammable – petrol

Toxic – cyanide

7Fa-5 Hazard under control

The Pipeclear! label should show the Corrosive symbol prominently and explain that Pipeclear! can attack/wear away materials, burn skin and severely damage eyes. If spilt it should be diluted with cold water (adding a weak base like baking soda would be better but hasn't been covered yet) and mopped up while wearing rubber gloves, shoes, eye protection. If the product is used as suggested (poured from the bottle straight down the pipes) then the chance of coming to harm is small so the risk is low.

The diluted version label should show the Caution symbol and explain that the product can irritate skin and eyes. It should explain that the product contains water diluting the hazardous material (students will probably not understand the concept of concentration).

7Fa-6 The Hazchem code

1 a Corrosive

b B (a fog means a fine spray mist of water)

2 a True, the V in the code for P shows this.

b False, for P full protective clothing is recommended.

c True, for P the code says 'dilute'. It is safe to wash dilute sulfuric acid down the drain.

d False. There is no E in the code for sulfuric acid so evacuation is not needed.

3 a Use a fog and full protective clothing, dilute the methanol but evacuate the area. (NB methanol is flammable and toxic.)

b Use a fog and full protective clothing, contain the phosphorus and evacuate the area. (NB phosphorus is flammable and burns to form corrosive and toxic smoke.)

4 For those who know the code, single letters stand for a lot of information. It can be displayed clearly and is easily read (from a distance). It does not cause unnecessary concern to members of the public. The full safety instructions would have to be in small print and difficult to read quickly.

7Fa-7 Acids and hazards

1 any six examples: any named fizzy drink, yogurt, milk, vinegar, lemon juice, pickles, any citrus

fruit, blackcurrants, cheese, acid drops (or similar sweets), etc.

2 corrosive

3 from left to right: Caution (irritant), Flammable, Explosive, Toxic

4 Wear eye protection, rubber gloves and protective clothing; dilute the substance with water; mop it up and dispose of it.

7Fa-8 Nitric acid hazards

1 a E b B c no hazard **d F e A f C g D**

2 a By diluting the concentrated nitric acid with water (it is usually done by adding the acid to water).

b Wear eye protection, rubber gloves and protective clothing; do it in a fume cupboard; use a drip tray to catch any spillages.

c i Concentrated nitric acid is more hazardous than dilute so must be kept away from where it may cause harm.

ii There is a low chance/probability of people being harmed by concentrated nitric acid if it is kept securely out of people's reach and there is little chance of people being seriously harmed by the dilute nitric acid.

7Fa-9 Hazchem in action

The report should include the following points:

Risks: Petrol is flammable, people are at risk of being burned (and asphyxiated or poisoned by smoke).

Phosphoric acid is corrosive and people could suffer from chemical burns.

There could be a violent reaction if both substances are mixed or contact other chemicals.

When dealing with the petrol tanker the fire service will be: spreading foam; wearing breathing apparatus.

They will be trying to contain leaking petrol to stop it contaminating the environment and they will be evacuating people from the scene.

For the phosphoric acid lorry they will: wear full protective clothing; use a fog or fine spray mist of water to dilute the acid.

7Fb Indicators

Student Book

1: 7Fb Indicators (Student Book)

1 red cabbage and litmus

2 a red **b** red

3 It is alkaline.

4 by filtration (including students' own diagrams)

5 A – acid; B – neutral; C – neutral; D – acid; E – neutral; F – alkaline

6 soap

7 a i red **ii** yellow

b No, neutral solutions do not change the colours of indicators.

8

Substance added	Colour of red litmus	Colour of blue litmus
lemon juice	red	red
ammonia solution	blue	blue
pure water	red	blue

Activity Pack

7Fb-1 Indicators, acids and alkalis

Turn litmus solution red: sulfuric acid, vinegar, citric acid, lemon juice, hydrochloric acid, yogurt.

Turn litmus solution blue: toothpaste, sodium hydroxide, soap, baking soda, bleach, oven cleaner.

Do not affect litmus: salt, sugar, alcohol.

7Fb-4 Evaluating indicators

1 **a** red **b** blue **c** purple

2 Litmus is purple in a neutral solution.

3 Purple is the colour produced by mixing red and blue.

7Fb-5 Indicator colours

1 **a** indicator **b** red, alkali

2 sodium hydroxide – blue, salt – purple, sulfuric acid – red, soap – blue, vinegar – red, bleach – blue, citric acid – red, sugar – purple, pure water – purple, limewater – blue

3 It is an alkali.

7Fb-6 Colourful hazards

1 Answer depends on indicator chosen but could be: the distinctiveness of the colours, the association of particular colours with acids and alkalis.

2 Depends on the indicator. Some indicators show a mixture of the colours in neutral solutions (e.g. litmus), others show either the acid colour (phenolphthalein) or the alkali colour (methyl orange). Explanations could include that neutral is halfway between acid and alkali or a mixture/combination of the two.

3 *Students' own opinions.* They may point out that many acidic or alkaline substances are harmless so don't need warnings.

7Fb-7 Sort the labels

A citric acid **B** battery acid (sulfuric acid) **C** drain cleaner (sodium hydroxide) **D** baking soda (sodium hydrogen carbonate) **E** vinegar (ethanoic acid)

7Fb-8 Robert Boyle's indicator

1 It has a sharp/sour taste. It turns litmus paper red.

2 They feel slippery like soap. They turn litmus paper blue.

3 The dye acted as an indicator and some substances were acids and some alkalis.

4 **a** He found that these coloured substances turned one colour in acids and another colour in alkalis.

b Indicators could be used to identify which substances were acids or alkalis.

c He suggested that acids had a sharp taste because they were made up of tiny particles with spikes. Alkalis, however, were made up of soft slippery balls. When acids reacted with alkalis the acid spikes stuck into alkali balls.

5 He could have added the solution of violets to known acids and known alkalis and noted the colours.

6 Other people could use it to repeat his experiments and check his results. They could use his conclusions to investigate new substances and they could test his ideas to see if they were correct. Or, it spread his results and ideas around so that other people began to study chemistry in a similar way.

7 When the solutions were mixed they made a neutral solution.

7Fb-9 Indicators at home

1 good examples: red cabbage, beetroot, tea, blackcurrant, onion skins, etc.

2 acids – vinegar (preferably clear vinegar), lemon juice in water, lemonade

alkalis – detergent, baking soda in water (not baking powder), washing powder

3 Method should be logical and show the chosen indicator being added to the examples of acids and alkalis chosen.

Conclusions:

1 *Students' own opinions* based on the evidence collected.

2 See answer to question 1 above.

3 Not all coloured substances act as indicators. They have the same colour in acid or alkali.

7Fb-10 Comparing indicators

1 Daffodil – it is the same colour in all the test substances.

2

Indicator	Acid	Neutral	Alkali
litmus	red	purple	blue
red cabbage	red	purple	blue-green
phenolphthalein	colourless	colourless	purple
onion skins	colourless	colourless	yellow

3 **a** Litmus and red cabbage. They have a distinctive colour in acidic solutions (the others do not).

b Litmus and red cabbage. These are the only indicators that have a different colour for neutral solutions.

Acids and alkalis

4 Soap appears as neutral with phenolphthalein and onion skins and as an alkali with litmus and red cabbage. Sodium hydroxide and ammonia appear as an alkali with all four indicators. This suggests that sodium hydroxide and ammonia are more alkaline than soap.

Also red cabbage turns a different colour in soap (blue-green) than in sodium hydroxide and ammonia (blue).

5 Purple is a mixture of/halfway between the blue colour seen in alkali and the red colour seen in acids. Neutral is between acid and alkali.

6 *Students' own opinions.* Likely to choose litmus or red cabbage because of their distinctive colours in acid, neutral and alkaline solutions. Reasons should match the choice.

7Fc Acidity and alkalinity**Student Book****1: 7Fc Acidity and alkalinity (Student Book)**

1 a pH 4–5 b acid c not very acidic

2

Name of chemical	Colour of universal indicator	Acid, alkali or neutral	pH
hydrochloric acid	red	very acidic	1 or 2
pure water	green	neutral	7
sodium hydroxide	blue/purple	alkaline	10–14
carbon dioxide solution	orange	not very acidic	4–5

3 a 2 b 9 c 4 d 8

4 The hazard rating increases the lower the pH of the acid and the higher the pH of the alkali.

5 The pH would go up as washing soda is alkaline.

6 a probably not, as it is close to the pH of rainwater

b pH of river water at different places (above and below factory)

7 There is a hazard from the alkali. The man is reducing the risks of harm from the alkali by wearing gloves.

Activity Pack**7Fc-1 Indicator rainbow**

1 *students' own answers* – check colouring is correct

2 **A** – acidic, red; **B** – neutral, green;

C – alkaline, blue

3 stomach acid – pH 1 – red; soap – pH 10 – green/blue; pure water – pH 7 – green

7Fc-3 pH colours and numbers

1 Using two methods to measure pH means that one method can check that the other is correct, thus improving the reliability of the data.

2 *Students' own opinions.* Reasons should match the choice, e.g. pH meter gives a more precise measurement but it has to be calibrated and checked regularly, and it doesn't contaminate the solution. Universal indicator is quick and simple to use but less precise and contaminates the solution. (Students will not use the term 'precise' or 'contaminates' but may offer explanations covered by these terms.)

3 *Students' own answers.*

7Fc-4 pH indicators

1 Check that students have recorded the colours of their indicator over the pH range tested.

2 Students will probably find that their mixture does not differentiate between pH numbers across part (or all) of their chosen range.

3 The report should include an aim, a description of the work done, results and conclusions.

7Fc-5 Using pH

D Universal *indicator* is used to work out the pH *number* of solutions. If the pH is less than 7 the solution is an acid; if it is over 7 it is an *alkali* and if it is equal to 7 it is a *neutral* solution.

F Check that the correct colours are used for each box.

Acids: vinegar, fizzy drinks, stomach acid, rainwater, lemon juice, milk.

Alkalis: toothpaste, washing powder, oven cleaner, soap, hair dye, sea water, baking soda.

Neutral: pure water, salt water, sugar solution.

7Fc-6 pH applications

2 Examples of the keywords and pH in each box are:

Box 1: changes in pH; sea water; carbon dioxide in the air increases

Box 2: hairdressers; shampoo pH 9; skin pH 5.5; citric acid pH 3; hair dyes pH 11

Box 3: pH of drinks; mineral water pH 8; milk pH 6.5; yogurt pH 4.5; lemonade pH 5; most acidic cola pH 3; phosphoric acid

Box 4: coal; power stations; sulfuric acid; lakes pH 2; chalk streams pH 7.5; peaty streams pH 6

Box 5: cleaning metals; sulfuric acid pH 1 cleans iron and steel; pH 7 for cleaning aluminium; alloys clean with pH 12

Box 6: soil pH; crops pH 5.5; potatoes pH 5.5; sugar beet pH 8

7Fc-7 Inventing indicators

1 a methyl red (red below pH 4, yellow above pH 6.5)

b bromothymol blue (yellow below pH 6, blue above pH 7.5)

pH	0	1	2	3	4	5	6	7
colour	yellow	yellow-green	yellow-green	green	blue-green	blue	blue	blue

c thymol blue (yellow below pH 8, blue above pH 9.5) and phenolphthalein (colourless below pH 8, red above pH 10)

2 Only a little thymol blue is needed to produce an intense/bright colour.

3 Between pH 4 and 10 (none of the indicators changes colour below pH 4 or above pH 10).

4 e.g. using methyl violet and bromocresol green (see table at top of page)

Other mixtures may be used. Check that the colours of the mixtures match the pH ranges of each indicator.

5 From students' own research. pH meters are important as they give an accurate, precise and continuous reading without having to add any substances to the sample. Beckman was a physical chemist who had an interest designing measuring instruments. He founded Beckman Instruments.

7Fc-8 The pH test

1 **A** false; **B** true; **C** true; **D** false; **E** true

2 **A** Experiment 7, dilute sulfuric acid turned the indicator red, not blue.

B Experiment 3, vinegar turned the indicator orange, which is the sign it is an acid.

C Experiments 1, 5, 9 and 11 had no effect on the indicator paper.

D Experiments 2, 8, 10 and 12 were solutions that did not turn the indicator red, orange or yellow.

E Only substances that are solutions or are wet (e.g. toothpaste) changed the colour of the indicator.

3 Test more substances that are known to be acids or alkalis; add water to crystals and other dry substances to see if the indicator changes colour.

4 Dilute sulfuric acid. It made the indicator change to red, the other acids only turned it orange.

5 Washing soda has the higher pH because it makes the indicator turn more blue.

7Fc-9 A day of pH

Check that students star the most acidic and alkaline substances they recorded.

7Fc-10 pH colour changes

1 **a** yellow **b** yellow **c** blue

pH	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
colour	red					orange			green		black/brown				

2

pH number	Colour of methyl orange	Colour of thymol blue	Colour of a mixture of the two indicators
3	red	yellow	orange
7	yellow	yellow	yellow
10	yellow	blue	green

3 **a** yellow **b** yellow **c** purple

4 **a** The mixture would produce different colours across the range of pH numbers.

b 4 (red, orange, green, brown)

c See table at bottom of page.

5 A mixture can show whether a solution is more or less acidic or alkaline.

7Fd Neutralisation

Student Book

1: 7Fd Neutralisation (Student Book)

1 **a** below 7 **b** above 7

2 **a** cauliflower and mushrooms **b** leeks

3 **a** acid **b** The indicator colour is red.

4 **a** that the pH is 1 (or 2) **b** 12 (to 14)

5 **a** 7 **b** The indicator turns green.

6 **a** sodium hydroxide; **b** hydrochloric acid; **c** water, sodium chloride; **d** hydrochloric acid, sodium hydroxide; **e** sodium chloride, water

7 **a** lithium chloride; water **b** sodium hydroxide; water

8 ammonium hydroxide (ammonia) + sulfuric acid

9 neutralise with alkali and/or dilute with water

Activity Pack

7Fd-1 Neutralisation

1 Set 1: test tube 1 = red; test tube 2 = blue.

Set 2: test tube 1 = red; test tube 2 = blue.

Set 3: test tube 1 = purple; test tube 2 = blue.

Set 4: test tube 1 = blue.

2 **a** alkali **b** neutralisation (or chemical)

c reactants **d** neutralised, acid **e** neutralisation

f products

Acids and alkalis

7Fd-2 Acids and alkalis react

- 1 The indicator on the test tube changes colour.
- 2 5 cm³ (may be 4–6 cm³)
- 3 sodium chloride, water
- 4 New substances have been formed.

7Fd-3 Making salts**Part 1:**

- 1 10 cm³ (probably between 9 and 11 cm³)
- 2 The hydrochloric acid was neutralised by the sodium hydroxide solution.

Part 2:

- 1 a white solid, sodium chloride (common salt)
- 2 hydrochloric acid + sodium hydroxide → sodium chloride + water

7Fd-4 Changing pH

- 1 The pH should have risen by less than one unit.

Conclusions

- 2 graph – check axes and plotting of points (on this occasion it does not matter if the line is drawn as a ‘join the dots’ or a smooth curve).
- 3 should be around 20 cm³ (i.e. between 18 and 22 cm³)
- 4 sodium chloride and water
- 5 hydrochloric acid + sodium hydroxide → sodium chloride + water
- 6 It is an S shape with a rapid change of pH between about 18 and 22 cm³.
- 7 Neutralising. When diluting, the acid remains in the solution. When alkali is added, a salt is formed which is neutral.
- 8 Add an alkali to neutralise the acid.

7Fd-5 Neutralisation equations

- 1 hydrochloric acid + lithium hydroxide → lithium chloride + water
ethanoic acid + sodium hydroxide → sodium ethanoate + water
citric acid + potassium hydroxide → potassium citrate + water
nitric acid + ammonium hydroxide → ammonium nitrate + water
sulfuric acid + calcium hydroxide → calcium sulfate + water
- 2 **a** Neutralising nitric acid with ammonium hydroxide.
nitric acid + ammonium hydroxide → ammonium nitrate + water
b Makes the water neutral so animals and plants can live.
sulfuric acid + calcium hydroxide → calcium sulfate + water
c Makes the soil neutral so that crops can grow.
nitric acid + calcium hydroxide → calcium nitrate + water

- d** Neutralising citric acid with potassium hydroxide.
citric acid + potassium hydroxide → potassium citrate + water

7Fd-6 Using neutralisation

- 1 an alkali
- 2 **a** vinegar
b It is an acid.
- 3 **a** *physical*, should be chemical
b *adjudicator*, should be indicator
c *hydroxide*, should be sulfate
d *reactants*, should be products
- 4 *Students’ own answers* e.g. use of neutralisation in farming, medicine (indigestion), food, toiletries, etc.

7Fd-7 Changing soil pH

- 1 **a** 5
b 7
- 2 neutralisation
- 3 underline *nitric acid* and *calcium hydroxide*, circle *calcium nitrate* and *water*
- 4 new substances

7Fd-8 Sorting word equations

- 1 A product of the reaction of an acid and alkali:
salt (last)
Substances that react with acids. alkalis (all I ask)
The pH when all of an acid and alkali react. seven (evens)
The salts formed by sulfuric acid. sulfates (use flats)
It happens to an acid when alkali is added. neutralised (late side run)
Shows when an acid and alkali have reacted. indicator (a dirty coin)
- 2 **a** potassium chloride
b sulfuric acid, water
c sodium hydroxide (or oxide)
d hydrochloric acid, calcium hydroxide (or oxide)
- 3 Letter should suggest that the soil is too acidic and must be neutralised by adding an alkali such as calcium hydroxide (lime).

7Fd-9 pH changes**Dilution**

- 1 1 cm³ of the acid is diluted into 100 cm³, then 1% of this first solution is put into the second and final solution. 1% of 1 is 0.01 cm³. Another way to look at this is that the first solution contains 1 cm³ of acid. 1/100th of this acid is put into the second and final solution: 1 ÷ 100 = 0.01, so there is 0.1 cm³ in the final solution.

2 A very large volume of water is needed to raise the pH of the acid to 5 so it is not very effective ($100 \times 100 = 10\,000 \text{ cm}^3$ or 10 litres for every 1 cm^3 of pH 1 acid).

Neutralisation

1 Check the title, axes and the points plotted are correct. The line may be drawn as a smooth curve or 'join the dots'.

2 It is an S curve with a rapid change of pH close to 10 cm^3 of alkali.

3 The sodium hydroxide neutralises the hydrochloric acid.

4 new substances are formed

5 hydrochloric acid + sodium hydroxide \rightarrow sodium chloride + water

6 a sodium chloride, water and unreacted hydrochloric acid

b sodium chloride and water

c sodium chloride, water and unreacted sodium hydroxide

7 10 cm^3 . This is the amount needed to make the solution neutral/pH 7.

8 Yes – because much less of the sodium hydroxide is needed to make the acid safe than pure water.

No – If too much sodium hydroxide is added it becomes alkaline, which is also hazardous. (Students may note that adding an alkali of lower pH would be safe and effective.)

7Fd-10 Balancing pH

1 At first the pH does not change. The pH falls rapidly when between 8 and 12 cm^3 of acid is added. After this, the pH remains constant as more acid is added.

2 The shampoo is neutral at pH 7. Reading from the graph, 10 cm^3 of acid was needed to neutralise the shampoo.

3 If she doesn't use enough acid the pH remains high and if she uses too much the pH goes too low.

4 Citric acid is not as acidic/has a higher pH than hydrochloric acid so is safer to use in a shampoo.

5 nitric acid, potassium hydroxide (or oxide)

6 nitric acid + potassium hydroxide \rightarrow potassium nitrate + water

7 They should carry out experiments to measure how much potassium hydroxide is needed to neutralise a sample of nitric acid (or vice versa).

7Fd The chemical industry (STEM)

1 a The chemical industry produces useful materials.

b Products of the chemical industry include: paints; dyes; medicines and foods (other answers possible, e.g. plastics, fuels, cleaning products, etc.)

c Any reasonable answer, naming types of cleaner, e.g. kitchen cleaner, window cleaner.

2 a The chemists were trying to find a safer paint remover.

b They could start by trying to alter an existing product.

c It gives the scientists a product they can change and test (to see if it has improved properties).

3 a They test the bleach produced in a factory to make sure it contains what they say it should contain.

b They analyse more than one sample of the bleach so their results are more reliable.

4 a The bleach would turn universal indicator a blue or purple colour.

b The evening shift produced a non-standard bleach (pH of 8.1). This was non-standard as the pH was very different for most other samples tested.

c The morning shift was having difficulties with the timing of their sample taking. (The time between samples varied greatly.)

5 The apparatus needed was: 100 cm^3 measuring cylinder; evaporating basin; Bunsen burner; tripod stand and electronic balance.

7Fe Neutralisation in daily life

Student Book

1: 7Fe Neutralisation in daily life (Student Book)

1 a a base or an alkali **b** above 7

2 a neutralisation reaction

3 It would make the stomach too alkaline.

4 to neutralise acids in the mouth

5 aluminium hydroxide + hydrochloric acid \rightarrow aluminium chloride + water

6 Wasp stings are acidic and so is vinegar, so no neutralisation reaction can occur.

7 because the acid he is using is corrosive

8 calcium hydroxide + sulfuric acid \rightarrow calcium sulfate + water

9 Take a measured volume of hydrochloric acid in a beaker. Add universal indicator. Add an indigestion tablet and stir to dissolve. Continue adding indigestion tablets until neutralised. Repeat this exactly with other tablets. The one that requires the least number of tablets to neutralise the acid is the best indigestion tablet.

2: 7Fe Danger at home (Student Book)

1 (i) flammable (ii) corrosive (iii) dangerous for the environment (iv) harmful

2 *students' own answers*, e.g. **a** vinegar; **b** bleach; **c** methylated spirits; **d** drain cleaner

3 a Add universal indicator paper or liquid; you can tell the pH from the colour of the paper or solution.

Acids and alkalis

b pH numbers below 7 are acidic, pH 7 is neutral, pH above 7 is alkaline

4 a Heat was given out.

b neutralisation

c sulfuric acid + sodium hydroxide → sodium sulfate + water

5 *student's own safety information leaflets*

Activity Pack**7Fe-1 Using acids and bases**

1 Problem: Indigestion means there is too much hydrochloric acid in the stomach.

Solution: Indigestion remedies contain magnesium hydroxide, a base.

2 Problem: Burning fuels makes acid gases.

Solution: Lime (calcium oxide) is a base that is mixed with the gases.

3 Problem: Food leaves acids in the mouth which cause tooth decay.

Solution: Toothpaste contains aluminium hydroxide, a base.

4 Problem: Steel becomes coated with rust (iron oxide), a base.

Solution: Rust repair kits contain sulfuric acid.

7Fe-2 Indigestion 1

1 Tubes with Antac, Magplus and Superbase.

2 Probably both Magplus and Superbase (the others may remain cloudy if the mixture is not stirred sufficiently or the volume of acid was less than 10cm³).

3 *Students' own opinions.* Antac is probably the best as it neutralises the acid and has the least amount of magnesium hydroxide left over.

7Fe-3 Indigestion 2

1 The pH of the acid will rise when just enough antacid has been added to neutralise it.

2 a *Students' own opinions* based on evidence collected. Superbase should turn out to be the most effective as it contains the highest proportion of base.

b The 'best' antacid neutralises the most acid.

3 Repeat measurements. Other improvements will depend on how effective the student's own method was.

7Fe-4 Making crystals

1 sulfuric acid

2 sulfuric acid + copper(II) oxide → copper(II) sulfate + water (the (II) may be omitted)

Part 1

3 There is a change of colour.

4 Some copper(II) oxide powder remains unreacted.

5 universal indicator, litmus paper or pH meter

6 copper(II) sulfate, water and (unreacted) copper(II) oxide

Part 2

7 Filter the mixture and collect the filtrate. Filter funnel, filter paper, beaker.

8 The solution will be clear.

9 Heat the solution to evaporate the solvent (water). Evaporating dish, Bunsen burner.

7Fe-5 Useful salts

Suggestions:

Ammonium nitrate: mix nitric acid and ammonium hydroxide (ammonia) solution until neutral, measured by pH meter. Evaporate the water.

Iron sulfate: add solid iron oxide (or hydroxide) to sulfuric acid until in excess, filter and evaporate the water.

Both these methods have problems in practice, e.g. ammonium nitrate is explosive, iron sulfate decomposes on heating, but these difficulties can be ignored here.

Safety: acids and ammonium hydroxide may be corrosive at the concentrations used. Students should suggest standard safety precautions.

Word equations:

nitric acid + ammonium hydroxide → ammonium nitrate + water

sulfuric acid + iron oxide or hydroxide → iron sulfate + water

7Fe-6 Healthy teeth

1 a C b B c A

2 The advert should emphasise the benefits of the aluminium hydroxide in neutralising acids to prevent decay and cavities.

3 e.g. indigestion remedies, treating rust, treating waste gases from power stations, neutralising acid soils

7Fe-7 Acids and bases

1 iron

2 base

3 purple

4 reactant

5 product

6 indicator

7 alkali

8 chloride

9 salt

10 seven

Hidden word: neutralise

7Fe-8 Investigating indigestion

1 They all suggest using an indicator which changes colour when the base neutralises/reacts with the acid.

- 2** The remedy reacts with/neutralises the acid forming a salt and water.
- 3** The volume/amount of acid.
- 4 a** The pH after the remedy had been reacted with the acid.
b The volume of acid required to neutralise the remedy.
- 5 a** They both add one reactant to the other until the mixture is neutral/pH 7.
b Conrad adds the acid to the remedy, Amy does the reverse. Conrad adds the reactant in smaller quantities.
- 6** Amy's is better because she adds the remedy a little at a time and records when the mixture is neutral. Byron's experiment only tells if a fixed quantity of remedy will neutralise the acid. So Amy collects more evidence.
- 7** He measures the mass of remedy used. He adds the acid in small, precisely measured amounts. He says he will repeat the tests and take an average.
Accept any other valid response.

7Fe-9 Sulfuric acid

- 1** It has a low pH or, a pH less than 2, or it is a corrosive acid.
a rust/iron oxide, calcium hydroxide
b An alkali is a base that is dissolved in water.
- 2 a** iron sulfate + water
b sulfuric acid + calcium hydroxide → calcium sulfate + water
- 3** An acid reacts with a base to form a (neutral) salt and water.
- 4** e.g. antacids as cure for indigestion – neutralise excess acid.
Lime added to acidic soil – neutralise acid to allow crops to grow.
Toothpaste – neutralises acids that cause tooth decay.

7Fe-10 Acids, bases and salts

- 1 a** sulfuric acid + potassium hydroxide → potassium sulfate + water
Method: use an indicator that changes colour rapidly around pH 7. Potassium hydroxide is an alkali and neutralises the acid, producing potassium sulfate solution. Evaporate the solution to recover the potassium sulfate.
b hydrochloric acid + magnesium hydroxide → magnesium chloride + water
Method: magnesium hydroxide is a base that neutralises an acid but is insoluble. Some solid magnesium hydroxide will be left over when the acid has been neutralised. Filter off the magnesium hydroxide, then evaporate the solution to recover the magnesium chloride.

c nitric acid + iron oxide → iron nitrate + water
Method: iron oxide is a base that neutralises an acid but is insoluble. Some solid iron oxide will be left over when the acid has been neutralised. Filter off the iron oxide, then evaporate the solution to recover the iron nitrate.

2 a sulfuric acid + iron oxide → iron sulfate + water
Iron oxide is a base that neutralises sulfuric acid, forming a soluble salt that washes away.

b Sodium hydroxide is an alkali that forms a solution with a high pH that is corrosive/harmful. Magnesium hydroxide is an insoluble base which neutralises the acid but does not itself cause harm.

c sulfuric acid + calcium hydroxide → calcium sulfate + water

nitric acid + calcium hydroxide → calcium nitrate + water

Calcium hydroxide is a base that neutralises the acids.

d Aluminium hydroxide is a base that neutralises the acids that would attack teeth. Aluminium hydroxide is not soluble so it neutralises the acid whilst you are cleaning your teeth but does not cause harm.

7G The particle model

7Ga Solids, liquids and gases

Student Book

1: 7Ga Sorting rubbish (Student Book)

- 1 a** solid, liquid and gas
b solids – cardboard, clothing, copper scrap, food scraps, glass bottles, plastic containers, scrap wood; liquids – cooking oil, milk, paint, petrol; gases – carbon dioxide, heated air, methane

2 a soluble – something that is soluble can dissolve in a liquid to form a solution; dissolve – when a solid splits up and mixes with a liquid to make a solution

b A soluble fertiliser can dissolve in water and flow and spread out so it could find its way into any nearby water.

3 any suitable explanation, e.g. decrease in the future as we recycle more waste

2: 7Ga Solids, liquids and gases (Student Book)

1 Solids stay in one place and can be held; they keep their shape and do not flow; they always take up the same amount of space and do not spread out like gases; they can be cut or shaped.

2 Solid waste will not seep away as solids keep their shape.

The particle model

3

	Keeps its shape	Keeps its volume	Able to flow	Able to be compressed
solid	yes	yes	no	no
liquid	no	yes	yes	no
gas	no	no	yes	yes

4 Solids stay in one place so they can be transported in open lorries. However, liquids can change their shape and flow so they cannot be transported in open lorries: this is because the liquid would slosh around as it was moved and could spill.

5 volume = 4 cm × 5 cm × 10 cm = 200 cm³

6 When you squeeze a sponge you do not compress the solid. It is the air in the sponge that is squeezed out or compressed.

7 carbon dioxide gas, water, gold

8 a 5 g

b 39.5 g

Activity Pack**7Ga-1 States of matter**

1 a stay the same b stay the same c very hard

2 a true b false

3 a yes b yes c yes d yes e yes

7Ga-2 Properties

Observations	Solid	Liquid	Gas
a	yes	no	no
b	no	yes	yes
c	no	no	yes
d	no	no	yes
e	no	no	yes

7Ga-3 Solids, liquids and gases

solid: stone, metal (jewellery), rubber (tyres), jelly, sand, concrete, paper, sugar, modelling clay, foam rubber, pencil, (cold custard)

liquid: water, hot custard, (cold custard), honey, toothpaste, tomato sauce, jam

gas: air (wind), steam

7Ga-4 A lot of waste

1 a Germany b Germany

2 a Table 1 is ordered in terms of the amount of waste. Table 2 is in alphabetical order by country.

b It would allow you to make comparisons more easily.

c A lower-level answer would say EITHER that ordering the tables in terms of the waste is better because you can then see which country produces the most waste OR that ordering it in terms of alphabetical order would be better because that would allow you to compare how household waste

compares to total waste for each country. A higher-level answer would include both of these points.

3 *students' own bar charts*

4 a Because there are many more countries in Europe than are shown in the tables.

b Find out the amount of waste produced by all European countries.

5 a liquids and gases

b They will flow away into the ground or atmosphere (pollution).

7Ga-5 Summary of properties

1

Property	Solids	Liquids	Gases
have a fixed shape	yes	no	no
can change shape	no	yes	yes
have a fixed volume	yes	yes	no
volume can change	no	no	yes
can be easily compressed	no	no	yes
can flow easily	no	yes	yes

2 a Solids can be disposed of in landfill sites because they stay where they are put.

b Liquids can disappear from landfill sites because they can flow away.

c The states of matter that can be poured out of a container are liquids and gases.

d The three states of matter are solids, liquids and gases.

7Ga-6 Solid or liquid

1 keeps its shape; has a fixed volume; does not flow; is dense

2 A pile of sand can flow.

3 *students' own answers*

4 and 5 possible answers include facts such as: concrete, custard and jelly 'set'; bread dough changes shape and volume when it is baked; sand is solid particles, but lots of them together behave like a liquid and flow

7Ga-7 Oil leak

1 Any sensible description of an ordered method.

2 same volume of oil; same type of oil; clean funnel each time

3 to get more reliable results and/or to make sure the results were correct

4 The room temperature was 22 °C.

5

Temperature (°C)	Mean time (seconds)
22	131.3
30	54.7
40	34.7
50	25.3
60	22.0
70	19.7
80	18.7

Type of waste	Wood	Rubber	Polystyrene	Glass	Metal	Paper	Mixed waste	Plastic
% of total waste	2%	2%	5%	12%	13%	16%	16%	34%

6 a and b A correctly drawn graph including labelled axes and a drawn curve through the results.

7 80 °C

8 a Oil gets runnier when it is hotter.

b The liquid is runnier on hot days and flows easily through any small cracks in the tank.

9 viscosity

7Ga-8 A study of rubbish

1 plastic

2 60 kg. For students who may have struggled with the percentage calculation here, go through the steps for calculating the answer. 12% is the same as 12/100. To work out 12/100, we work out 1/100 of 500 = 5. Then we can multiply that answer by 12. Skills Sheet MS 2 will support understanding of percentages.

3 Plastic and polystyrene, as not yet invented. Packaging waste, as packaging not widely used.

4 a See table above.

b Order by: alphabetical; smallest to largest; largest to smallest; group by similar types; etc.

c Ordered from the lowest to highest, as it makes it easy to find information from the data.

5 a A table, as it is the easiest way to obtain data.

b A graphic, as it is the most attractive.

6 a Cooking oil is a liquid, so it can flow as its particles can move past each other. It cannot be easily compressed as its particles are already close together.

b Cooking oil is easily piped to tankers as it can flow through pipes. Solids cannot flow. Solids are easier to store in open containers as they don't flow and will stay where they are put. Liquids can flow so are harder to contain.

7Gb Particles

Student Book

1: 7Gb Hypotheses and theories (Student Book)

1 any two of: no fixed shape, difficult to squash/keep their volume, can flow easily

2 a If ice is heated, it turns into water and runs away.

b Ice is made up of a lot of little boxes with water in them. Heat breaks the boxes open, so the water can run out.

c In a way it explains the melting, but it leaves unanswered what holds the boxes together and where the box walls go when the ice melts.

3 A hypothesis is an idea used to explain an observation. A theory is a set of ideas that explains different observations and there is evidence for it to be correct.

4 observation → (question) → hypothesis → prediction → test experiment → theory

5 The balloon can be easily compressed.

6 A suitable scientific question might be: How much water do you need to add to an orange drink before the colour can no longer be seen?

7 Photo F: if you put a purple crystal into water, it starts to dissolve and turn the water purple – observation; How long would you need to leave the water before the purple colour spreads out completely through the water? – question. Photo G: if you put too much air into a balloon it can burst – observation; How much air can you put in a balloon before it will burst? – question.

2: 7Gb Particles (Student Book)

1 tiny particles

2 the freedom of movement of its particles

3 Liquids have a fixed volume and no fixed shape. Gases have no fixed volume and no fixed shape.

4 It gives them more movement/it allows them to move over each other.

5 a They can fill a container as the particles move about freely in all directions.

b The particles of sugar are separated from one another and spread through the water. The particles are so spread out that you can see through the solution.

6 The particles in solids vibrate, the particles in liquids move over each other and the particles in gases move about in all directions.

7 As liquid particles can move over each other, the shape of the liquid changes so they can flow over solids and move into the cracks between them.

Activity Pack

7Gb-1 Particle theory

solid: particles close together; particles vibrate in fixed positions; volume and shape don't change; not easily squashed; strong forces of attraction between particles

liquid: particles quite close together; particles can move over each other; fixed volume, shape can change; not easily squashed

gas: particles far apart; particles move freely in all directions; no fixed volume, no fixed shape; weak forces of attraction between particles; easily squashed

7Gb-5 Theory and practice

1 a Information collected in experiments (for example, what you see happening, measurements you make).

The particle model

b An idea that gives an explanation of why something happens.

c A way of explaining why things happen that has always been tested many times and found to work.

d Observations, data or measurements that scientists will use to test whether their ideas are correct.

e When scientists think up ideas to explain things and then test those ideas. The way scientists use hypotheses and experiments to prove theories that explain things.

2 Missing data from table (in order): liquid; drawing of a few particles far apart moving in all directions; very small spaces between particles; large spaces between particles; particles vibrate fixed in place; particles can move freely in all directions; fixed shape; shape can change to fit container; have a fixed volume

7Gb-7 Particle models

1 All matter is made up of particles: in solids they are close together and vibrate in place; in liquids they are close together but can move past each other; in gases they are far apart and move freely in all directions.

2 A hypothesis is an idea that explains why something happens. A prediction is a guess at what will happen in a test or experiment. A theory is a way of explaining why things happen that has been tested and shown to work many times.

3 examples include: How do gases spread out and fill a room? Why can gases be compressed but solids and liquids can't? etc.

4 a The air in the car tyre can compress when it goes over a bump and makes the ride more comfortable.

b The water can change shape to fit whoever is using it and so can be more comfortable.

5 Hypothesis: Particles in liquids are close together while particles in gases are far apart. Prediction: The syringe containing gas will compress more easily than the syringe containing liquid.

7Gb-8 Applying theories to matter

1 a Close together and fixed in position. (Diagram showing particles close enough to touch.)

b Metals are solids so their particles are fixed in place and cannot flow. This means that metal scrap can be transported in open skips as it will stay put.

2 Liquids have particles that can easily move over each other. This means that liquids can flow through pipes, but cannot be transported in an open truck without leaking out.

3 far apart – freely in all directions – weak

4 As particles in gases are far apart they can be compressed, which pushes the particles closer together.

5 As liquids and gases can flow this means that in a landfill site they would seep away/spread out and possibly cause damage to the surroundings.

7Gb-9 What's the matter?

1 what matter is like

2 a Parmenides

b Wood was thicker than air.

c Air has more gaps between its particles than the wood.

3 a Ideas may include: Parmenides – if we go up into space there will still be matter all around us that we can feel; Democritus – if you pump all the air out of a can eventually you won't be able to pump any more because there is nothing left to pump.

b Parmenides – go up into space and see if there is anything there; Democritus – pump all the air out of a can and see if there comes a point when you can't pump any more.

4 a ideas may include: the bulb has broken; there's no bulb; the fuse has blown; it's not plugged in; he hasn't switched it on; there's a power cut etc.

b and **c** ideas may include: replacing the bulb or fuse will cause it to work; plugging it in or switching it on will cause it to work; nothing else in the house is working either due to the power cut

7Gb-10 Using ideas about particles

1 1 = B; 2 = C; 3 = A; 4 = E; 5 = D

2 a The solid will get bigger when it is heated as the particles will move further apart.

b It will get smaller as the particles will move less and get closer together.

c Diesel will evaporate faster as it has weaker forces of attraction between its particles.

d It stays at the same temperature until all the ice has melted.

7Gc Brownian motion

Student Book

1: 7Gc Brownian motion (Student Book)

1 Brownian motion is the jerky, random motion of small pieces of matter (like dust or pollen grains).

2 Robert Brown talked to other scientists to see if they could think of an explanation for what he had seen.

3 Dear Mr Brown,

To explain Brownian motion you must understand the particle theory of matter. This states that all matter is made up of tiny particles, which are moving all the time, and the particles in liquids and gases are free to move in all directions. Therefore, with grains of pollen in water, the water particles will hit the grains all the time. As more water particles might hit one side of the pollen than the other, this will push the pollen in that direction. The direction

of the push will change all the time and so you get a jerky movement of the pollen grains.

Yours sincerely

4 It was important evidence that supported the particle theory of matter to all scientists.

5 because we are too large; the push on each side of us from particles is the same

6 1 000 000 000 (1 billion)

7 well – shows particles moving and hitting speck of smoke; poorly – relative size and number of particles of air incorrect

Activity Pack

7Gc-1 On the move

1 microscope

2 moving

3 particle

4 directions

5 colliding

6 push

7 many

8 change

7Gc-2 Explaining Brownian motion

1 He said they moved in a random, jerky way as if they were 'dancing on the water'.

2 At first Brown thought the pollen was alive.

3 He used 100-year-old pollen and this showed the same movements.

4 The particle theory of matter.

5 Einstein and others used the ideas of matter being made up of tiny moving particles to explain Brownian motion in detail. This was the conclusive proof of the idea and so the particle theory was confirmed.

6 Brownian motion is produced by the tiny water particles hitting the pollen unevenly, so if many water particles hit one side of the pollen it is moved in the opposite direction. As the water particles' movements are random the movement of the pollen is random. (Drawing of large pollen being hit by smaller water molecules, with more hitting one side than the other.)

7Gc-3 The story of Robert Brown 1

Correct order of 7Gc-4 pictures: C, A, F, D, H, B, E, G

1 a Robert Brown

b Albert Einstein explained the motion by predicting exactly how the pollen grains would be moved by the particle theory of matter.

2 a making predictions: F

b planning experiments: F

c making observations: C D G

d drawing conclusions and thinking of theories:

A B E

3 that the pollen grains might have been alive

4 Soot is suggested in the cartoon – treat other suggestions on their merits (e.g. grains of flour).

5 An experiment comparing the effect in ordinary water with sterile water would test this idea. Pupils may suggest the use of boiled water, or chlorinated water, or the use of some other disinfectant.

6 by reading a scientific journal

7 Perrin carried out a series of experiments that showed Einstein's prediction about the movement of the particles was correct.

7Gc-5 Using the nano scale

How many nanometres are in 1 metre? = 1 000 000 000

What do you call the science of very small particles? = nanotechnology

How many metres in 1000 mm? = 1

What is special about nanoparticles? = They are very, very small.

What do we measure particles of matter in? = nanometres

How many micrometres are in 1 metre? = 1 000 000

How many millimetres are in 0.01 metres? = 10

How many metres in 100 millimetres? = 0.1

7Gc-6 Brownian motion and the scientific method

1 observation: A, E and G

hypothesis: B and H

prediction: C and I

investigation: D, F and J

theory: K

2 Hypothesis: That the soot particles would move due to being hit by water particles.

Prediction: That the soot particles will show the same jerky motions.

7Gc-7 Measuring movements

1 random

2 a 120 mm **b** 750 mm

3 a 1.2 mm **b** 7.5 mm

4 speed = $0.0075/10 = 0.00075$ m/s

5 a too small to see

b The particles of air hit the dust specks unevenly. If many hit one side, the dust moves in the opposite direction. As the movement of the air particles is random, the dust also moves randomly.

7Gc-8 Sock theories

1 A hypothesis is an idea which explains why something happens. A theory is a set of ideas that explains why things happen that has been tested many times and shown to be correct.

2 a The stars would have appeared in their correct places in the photograph.

b The Sun is too bright normally so you can't see the stars behind it.

3 as papers in journals

The particle model

4 a that pairs of socks often end up as single socks having gone through the wash

5 b E – soccer was originally a game concerned with finding missing socks. This statement is wrong.

6 a Here are some suggested predictions. There are many others that can be made. However, all the predictions need to be able to provide evidence to definitively support or refute the theory.

A Some socks left in a sealed container for 60 years will all have a different pattern on them from that at the start of the experiment.

B Socks will be found behind radiators on which socks have been left to dry.

C Socks left on the side under a video camera will disappear when I stop looking at them.

D If you put some gnomes in a kitchen near some washing, and video them, you will see them steal socks.

E This is not a hypothesis.

F Opening up some washing machines will reveal some odd socks.

G A hundred pairs of socks put in the washing machine will not come out as a hundred pairs – but some coins will be found in the washing machine.

b Apart from E, which is not a hypothesis, the weakest hypothesis is D since it is impossible to detect or get hold of gnomes and therefore come up with a prediction that involves them.

7 A good scientific theory is one that can explain all of the existing observations and be used to make predictions that provide definite evidence for or against the theory.

7Gd Diffusion

Student Book

1: 7Gd Diffusion (Student Book)

1 a the movement of particles of one substance into the spaces between the particles of another substance, so the two substances mix together

b any suitable example such as tea diffusing out of a tea bag

2 The particles from the gases given off by the rubbish spread through the air in all directions and go up your nose.

3 a The gas particles move freely in all directions and move into the spaces between the particles of other gases, thus mixing together.

b They gradually move from where there are a lot of them (top jar) to where there are fewer of them (bottom jar).

4 Release a smelly substance in a room and have people placed at different distances from the smell. The speed of diffusion can be measured by how quickly the different people smell the gas.

5 The particles of the liquid chemicals are moving all the time in all directions so will mix with the water and spread through the water.

6 a solids

b much slower as the particles in solids, although moving, are not free to move anywhere but are fixed in place

7 because diffusion is another observation that can be easily explained by the particle theory

Activity Pack

7Gd-1 Moving on

1 Diffusion ... in a gas ... occurs faster than in a liquid.

The particle theory ... is useful ... for explaining the properties of matter.

Diffusion ... occurs when ... particles of one substance spread out and mix with another.

Particles ... in a liquid ... are closer together than in a gas.

2 a water **b** dissolve **c** spreads **d** diffusion

7Gd-7 Going down

1 The graph should have three lines sloping down. The helium would be the steepest and carbon dioxide would show the smallest loss in size.

2 a at the start **b** helium **c** carbon dioxide

3 The gas particles diffuse through the balloon and escape.

4 The smaller the particles of gas, the faster it will diffuse.

5 for helium: speed = $20.5/5 = 4.1$ cm/day

for oxygen: speed = $11.0/5 = 2.2$ cm/day

for carbon dioxide: speed = $2.0/5 = 0.4$ cm/day

6 You could repeat the experiment (and average the results).

7Gd-8 A rubbish problem

1 a diffusion

b Shading should show the diffusion of the soap in the pond, and this is less than the diffusion of the smell in the air.

c Mouse House.

d The smell/particles diffuse through the air over a period of time. Mouse House is the closest to the source of the smell and so the smell will get there first.

e Hodgepodge Lodge.

2 a saying what you think will happen

b Mrs Gupta's

7Gd-9 Thinking about diffusion

1 a The particles of one substance spread through and into the spaces between the particles of another substance.

b The part that states that liquids and gases are made up of particles which are moving and can move past each other.

c The hypothesis that explains that particles move faster at higher temperatures and so mix together faster at higher temperatures.

d Diffusion occurs faster at higher temperatures.

e It would be slower as the particles move more slowly.

2 I (the perfume particle) am moving and bouncing about inside the perfume bottle. When the lid is opened I move into the room and hit off particles of air. Eventually I travel up inside someone's nose and they smell me.

7Gd-10 Random motion

1 **a, b** and **c** *students' own responses*

2 **a** one particle hitting another one

b one particle moving into empty space

3 **a** More time, as the particles would hit off other particles more often and so change direction more often.

b Less time, as the particles would not hit off other particles as often and so travel in the same direction longer.

4 **a** Not very good as it is often hard to know in which grid the pencil landed.

b Use something like a dice with the directions on it.

c It only has eight directions, whereas real particles could go in any direction.

7Ge Air pressure

Student Book

1: 7Ge Air pressure (Student Book)

1 by the air particles moving and hitting surfaces

2 because there are more air particles inside the tyre so more particles are hitting the inside of the walls

3 **a** there are more air particles on the inside pushing out

b there are fewer air particles on the inside so the outside air particles push it in more

c As the air is removed from the inside of the can, there are no air particles inside pushing out. The air particles are still hitting the outside of the can and crush it in.

4 When you suck, you remove the air from inside the straw and the air pressure on the liquid surface pushes the liquid up into the straw.

5 If more and more methane is trapped in the landfill the gas pressure will build up until it eventually cracks the ground above open.

6 A full can contains more particles so will produce a higher gas pressure.

7 As the sucker is pushed down onto a surface, some of the air is pushed out. There is now less air pressure under the sucker so the outside air pressure, caused by the air particles hitting the outside of the sucker, holds it on the surface.

7Ge Forecasting the weather (STEM)

1 Answers could include the following:

a Crops grown by farmers depend on the weather. They might need to know:

- when the weather will be dry for harvesting
- if it will rain soon or if they should water/irrigate their crops

• if bad weather is expected and they may need to move their animals to a sheltered place.

b The aeroplane will be blown by the wind, so the pilot needs to know what the winds will be like to work out the best course. Some types of weather, like thunderstorms, are dangerous, so a weather forecast will help pilots to avoid these. A pilot in a small aeroplane might need to know how high the clouds are.

2 Any three from: air pressure, wind speed, wind direction, air temperature, temperature of the sea/oceans, humidity, how much rain has fallen.

3 Similarities: The scientist and meteorologist both use observations to make a hypothesis (the computer model for the meteorologist) and then predictions (the weather forecast). They both test their predictions and amend their hypothesis/model if necessary.

Differences: Meteorologists cannot do experiments to test their predictions, they have to compare the predictions with what actually happens to the weather.

Meteorologists do not update their computer models (the hypothesis) after every set of observations as a scientist might.

4 Weather forecasts depend on computer models.

5 Accurate predictions are no use unless the people who need them can understand what the meteorologist is telling them.

6 Weather affects all countries, and weather systems (storms, etc.) travel across the world. They need to share observations to gather as much information as possible.

7 Different people need different amounts of information, and different types of information.

3: 7Ge Waste (Student Book)

1 **a** It produces heat which can be used elsewhere.

b The gas particles move freely in all directions so any gases produced in incinerators will spread around the local area. These gases might be smelly or poisonous.

2 Heating the glass makes the particles able to move past each other and change into a liquid, which can flow and change its shape (be moulded).

Atoms, elements and compounds

- 3 The particles move with Brownian motion.
 4 Prediction: you can compress gases but not solids and liquids. Experiment: try to compress different states in a syringe – only the gases compress.

Activity Pack

7Ge-1 More air pressure 1

- 1 diagram should show more particles
 2 a move b hitting c more
 3 no particles; the air pressure on the outside pushes it in

7Ge-2 More air pressure 2

- 1 move – colliding – more – more – particles
 2 a The drawing should show the same number of particles but closer together.
 b more particles are hitting the sides

7Ge-6 Proving nothing

- 1 a There was a gap at the top; they could hear a hissing sound as air rushed in; they heard it ring.
 b so they thought this was a vacuum
 c They thought that if there was no air there, they would not be able to hear the bell.
 2 because sound cannot travel through a vacuum
 3 They heard the bell as the sound had travelled through the solid bar and the glass tube that the bell was attached to.
 4 because the original experiment was not a good one and people were drawing the wrong conclusions

7Ge-7 Air and particles

- 1 A hypothesis is ... an initial idea used to explain an observation.
 A theory is ... a collection of tested ideas that explain lots of observations.
 The theory that explains air pressure is called ... the particle theory.
 Our current theory of matter states that all matter ... is made up of tiny particles that are moving all the time.
 The particles in gases ... move fastest and have the largest spaces.
 Air pressure is caused by ... air particles hitting a surface.
 When the air is removed from inside a metal can ... it is crushed by the air particles hitting the outside.
 A vacuum is ... a space that contains no particles of any substance.
 2 The drawing should show more particles closer together in the high air pressure.

7Ge-8 Revision puzzle

- 1 a properties b particles c move d gas
 e diffusion f vacuum g vibrate h volumes

- 2 pressure
 3 several answers possible, e.g. what air particles cause when they hit the sides of a container

7Ge-9 A weighty matter

- 1 He had weighed a flask before and after putting extra air into it.
 2 The weight of air pressing on the water in the container pushed the water up the tube.
 3 The water falls to the 10 m level, leaving a vacuum at the top.
 4 Mercury is much denser than water, so the weight of air cannot hold up as much.
 5 a that liquids stay up in barometers because of the weight of air pressing down on the liquid at the bottom
 b that the air would not hold up as much mercury, because mercury is denser
 c He made a barometer with mercury instead of water.
 d That the height of mercury would get less if the barometer was taken up a mountain
 e His brother-in-law took the barometer up a mountain and measured the height of mercury at different places.
 f yes
 6 To make sure that the weight of air had stayed the same all day, and that the only reason that the other barometer's reading had changed was because it had been taken up the mountain.

7H Atoms, elements and compounds

7Ha The air we breathe

Student Book

1: 7Ha Our material world (Student Book)

- 1 One or more new substances are formed.
 2 a physical b physical c chemical d chemical e physical
 3 Particles in a liquid can move past each other and so liquid flows (and can take the shape of a container or mould).
 4 Heat the sea water to boil and evaporate off the water. The solid salt will be left behind.

2: 7Ha Sorting resource data (Student Book)

- 1 The amount of carbon dioxide is too small.
 2 a sort by increasing/decreasing years left
 b *students' own bar charts*: correctly plotted data, axes correctly labelled, appropriate title included
 c One of the variables is qualitative (type of metal).
 d Our sources of metals will run out if we do not use less of our reserves.
 3 a quantitative
 b scatter graph, as you are trying to find a relationship between the variables

- 4 The larger the volume of air, the longer it takes for the flame to go out.
- 5 Draw a line so there is the same number of particles on each side of the line and they are roughly equal distances on either side of the line.
- 6 Obtain more results by repeating the experiment more times.

3: 7Ha The air we breathe (Student Book)

- 1 The particles in gases are far apart and moving freely in all directions.
- 2 a nitrogen 78%, oxygen 21%, argon 0.9%, other gases including carbon dioxide 0.1%
b Air contains more than one substance so it is not pure, it is a mixture.
- 3 zinc, chlorine, gold, lead, magnesium, iodine
- 4 a An element contains only one kind of atom; a compound contains more than one kind of atom joined together.
b An atom is a single particle; a molecule is two or more atoms joined together in groups.
- 5 four
- 6 elements: gold and sulfur as they only contain one kind of atom
compounds: lead sulfide and water as they contain more than one kind of atom joined together
- 7 Sea water is not **pure** as it contains more than one substance; it is a **mixture**. Oxygen is an example of an **element** as it contains only one kind of atom. Water and salt are examples of **compounds** as they contain different elements (atoms) joined together. Water and oxygen are made up of **molecules** which contain groups of **atoms** joined together.

Activity Pack

7Ha-1 The air we breathe

- 1 Element – Simplest type of substance. Contains only one kind of atom.
Compound – Contains two or more kinds of atoms (elements) joined together.
Atom – The simplest particles of matter, which we think of as being like a tiny ball.
Molecule – Set group of two or more atoms joined together.
Mixture of elements – Contains different kinds of atoms jumbled up but not joined together.
- 2 nitrogen = element; argon = element; oxygen = element; and carbon dioxide = compound
- 3 molecules then atoms

7Ha-4 Elements, compounds and mixtures

- 1 different elements, atoms coloured differently
- 2 in order, going across then down from top left: element; compound; element; compound; element; mixture; mixture; compound

7Ha-5 Research a gas

- 1 Argon: single atoms; Ar; used in welding as totally inert (does not react); extracted from air.
Oxygen: two atoms joined into a molecule; O₂; fertilisers, coolant; extracted from air.
Nitrogen: two atoms joined into a molecule; N₂; medical, industrial and biologically vital element; extracted from air.
Carbon dioxide: three atoms joined together; CO₂; photosynthesis, brewing, fire extinguishers; combustion.

7Ha-7 Types of matter

- 1 In order, going across then down from top left: b, d, a, c, e, a.
- 2 air – mixture; argon – element; carbon dioxide – compound; oxygen – element

7Ha-8 Substances in air

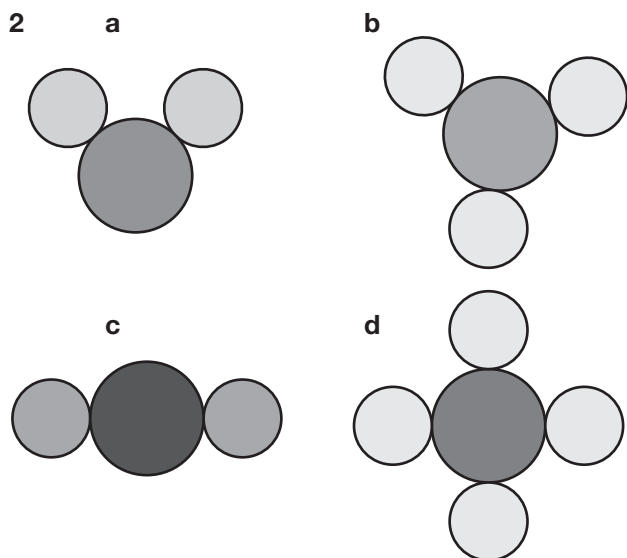
- 1 diagrams: argon – single atoms; oxygen and nitrogen – both two – atom molecules; carbon dioxide – three atoms joined together with the two outside atoms different from the middle atom in size/shading
- 2 4.
- 3 a carbon dioxide b as it contains different atoms joined together
- 4 It only contains oxygen molecules whereas air is a mixture of molecules so includes less oxygen per breath.
- 5 It would be a compound as it contains more than one element.

7Ha-9 About the gases in the air

- 1 a *students' own bar charts*: correctly plotted data, axes correctly labelled, appropriate title included
b *students' own pie charts*: correctly plotted data, sections correctly labelled, appropriate title included
- 2 because the quantity present is very small (0.05%)
- 3 nitrogen
- 4 oxygen
- 5 a Diagram labelled to show atoms, molecules, elements, compounds; e.g. single dark grey circle as 'atom, element', white molecules as 'molecule, element', white and black molecule as 'molecule, compound'.
b Air is a mixture as it is made up of different elements and compounds that are not joined together.

7Ha-10 Concept maps

- 1 In order, going across then down from top left: same kind of atoms; joined together; not joined together; molecules; compound.



7Hb Earth's elements

Student Book

1: 7Hb Earth's elements (Student Book)

- 1 tiny particles/atoms
- 2 In a compound the different atoms are joined together. In a mixture the different atoms are not joined together.
- 3 Si and O
- 4 A table of four gases from the air, with one use given for each. One could be oxygen and its use in producing high-temperature flames.
- 5 **a** sulfur **b** phosphorus **c** hydrogen
- 6 Iron was easier to get out of its compounds.
- 7 **a** two of: potassium (K), iron (Fe), silver (Ag), tin (Sn), antimony (Sb), tungsten (W), gold (Au) or lead (Pb)

b The symbols are an international code and so are quickly and easily understood by scientists all over the world, even if they do not speak the same language.
- 8 **a** An element is a simple substance that cannot be broken down. An element contains only one kind of atom.

b *Students' own answers*, e.g. indium will run out in less than 20 years if we use our resources at our current rate; recycling will save some of our reserves.
- 9 **a** ideas could include: hard, shiny, malleable
b ideas could include: hard, strong

Activity Pack

7Hb-1 Elements

- 1 true; false; false; true.
- 2 **a** Al **b** O **c** Fe **d** Ca
- 3 The most abundant element in the Earth's crust – O
A metal element known for thousands of years – Au

- The most abundant element in air – N
The element in diamonds – C
4 hard

7Hb-4 Elements names and symbols

- 1 *students' own answers*
- 2 silver – symbol for the Latin name *argentum* – Ag
californium – discovered at the University of California, Berkeley – Cf
copper – symbol from *cuprum*, meaning from the island of Cyprus – Cu
yttrium – after the town of Ytterby, Sweden – Y
mercury – symbol from *hydrargyrum*, the Greek for liquid silver – Hg
magnesium – after the district of Magnesia in Greece – Mg
polonium – after Poland, the homeland of Marie Curie, who discovered it – Po
rutherfordium – after the scientist Ernest Rutherford – Rf
strontium – after the village of Strontian, Scotland – Sr
tungsten – from the Swedish for 'heavy stone' (*tung sten*), with symbol from the source wolframite – W

7Hb-5 Names and symbols

- 1 Wordsearch: CARBON; GOLD; HYDROGEN; IRON; NITROGEN; OXYGEN; SILICON; SODIUM
- 2 **a** C **b** N and O **c** Au
- 3 so they can be understood by all scientists throughout the world
- 4 *students' own answers*

7Hb-6 Silicon and germanium

- 1 **a** silicon **b** einsteinium **c** americium (or europium)
- 2 **a** bromine **b** calcium
- 3 **a** i Ge ii Si
b It is not as abundant as silicon.
c price – germanium is more expensive due to its limited abundance
d electrical conduction
- 4 German, as he named his discovery after this country
- 5 so the name and the symbol can be agreed and understood by all the scientists throughout the world
- 6 **a** electrical conduction
b greater demand for fibre-optic cables
c in 40 years' time
d recycle and reuse

7Hb-7 Thinking about elements

- 1 earth, air, fire and water
- 2 The Greeks thought about things rather than doing experiments.
- 3 a scientist as he carried out experiments (to test ideas)

- 4 substances that couldn't be broken down into simpler substances
 5 substances that couldn't be broken down into simpler substances as they contain only one kind of atom
 6 Elements: gold, nitrogen, carbon, iron, hydrogen, platinum, lead and sulfur.
 Compounds: aluminium oxide, barium sulfate, magnesium oxide and calcium oxide.
 7 heat and light, both are forms of energy
 8 Au, N, C, Fe, H, Pt, Pb and S

7Hc Metals and non-metals

Student Book

1: 7Hc Metals and non-metals (Student Book)

- 1 They are solid and shiny.
 2 e.g. metals – tin (Sn), gold (Au), iron (Fe); non-metals – sulfur (S), oxygen (O), carbon (C)
 3 three of: high melting point, strong, flexible, malleable, good conductors of heat, good conductors of electricity
 4 **a** good conductor of electricity **b** good conductor of heat
 5 low melting point and flammable
 6 brittle, poor conductor of heat and poor conductor of electricity
 7 **a** copper: ductile and conductor of electricity
b iron: malleable and magnetic (other answers are possible)
 8 **a** both are metals as they are good conductors of heat and electricity
b X because Y would melt at high temperatures and would react with water

Activity Pack

7Hc-1 The difference between metals and non-metals

- 1 metals: **a, b, c** and **f**; non-metals: **d, e** and **g**.
 2 conductor of heat; strong; shiny; flexible.

7Hc-4 Properties and uses

- 1 metal: **a, c, f, g** and **k**; non-metal: **b, d, e, h, i** and **j**
 2 gold – jewellery – shiny
 copper – phone cables – conductors of electricity
 aluminium – cooking pots – conductor of heat
 iron – road bridges – strong

7Hc-5 Classifying elements

- 1 metals on the left
 2 non-metals on the right
 3 bromine and mercury
 4 11 gases: hydrogen, nitrogen, oxygen, fluorine, chlorine, helium, neon, argon, krypton, xenon and radon
 5 **a** solid **b** 105

6

	Metal elements	Non-metal elements
One element only	copper, aluminium	oxygen, nitrogen
More than one element	brass, bronze	silicon oxide, water

7Hc-7 Metal or non-metal 1

- 1 Missing words from metals are: high, flexible, shiny, heat and good.
 Missing words from non-metals are: low, brittle, dull, poor and electricity.
 2 **a** conductor of heat **b** flexible **c** strong
d conductor of electricity

7Hc-9 Metal or non-metal 2

- 1 in any order – conductor of heat: lets heat pass through them – strong: will not break easily – conductor of electricity: allow electricity to pass through them
 2 in any order – poor conductors of heat: do not let heat pass through them easily – poor conductor of electricity: do not let electricity pass through them easily
 3 **a** good conductor of heat (strong) **b** shiny **c** good conductor of electricity
 4 **a** It is too expensive.
b Copper is a good conductor of heat and the handle will get hot.
c It is a poor conductor of electricity.
 5 on the left
 6 **a** metal **b** non-metal **c** metal

7Hc-10 Metal or non-metal 3

- 1 **a** Metals: iv, v, viii and ix.
 Non-metals: i, ii, iii, vi, vii and x.
b Metals have good conductivity, are flexible and are solids at room temperature.
c element iii as it is a non-metal but a conductor of heat and electricity
 2 **a** i and vii **b** ii, iii and viii **c** iv **d** iii
 3 **a** v **b** x **c** i **d** iv **e** iii

7Hc Obtaining metals (STEM)

- 1 **a** The deeper the mine, the more expensive the mining operation, so the less profitable the mine.
b The further the distance to travel, the less profitable the mine.
c Any environmental problems will increase costs and make the mine less profitable.
d The harder it is to extract the metal, the greater the cost in time and machinery, thus the less profitable the mine.
 2 This mine is profitable because the use of machinery means that the money made by selling

Atoms, elements and compounds

the metal produced is greater than the cost of producing the metal.

3 1 – geologist / 2 – mining engineer or environmentalist / 3 – transport engineer / 4 – mining engineer / 5 – accountant / 6 – transport engineer

4 a magnetite

b because it contains the highest % iron

c 144 g

5 A hundred years ago the price of copper was lower so it would not have been profitable to extract metal from ores that containing less than 5% copper.

7Hd Making compounds

Student Book

1: 7Hd Making compounds (Student Book)

1 75%

2 Silicon dioxide is a solid and oxygen is a gas.

3 It starts to glow/give out energy.

4 The structure does not have a set size/it cannot be represented by a set number of atoms joined together.

5 They are not joined together in the mixture; they are joined together in the compound.

6 a Iron sulfide is black, not yellow like sulfur.

b Iron sulfide is not magnetic like iron.

7 Ores are rocks that contain metals (or metal compounds) that are used as a source of the metal.

8 copper sulfide, tin oxide, lead sulfide

9 a flames and new (white) solid produced

b aluminium iodide

Activity Pack

7Hd-1 The air we breathe

1 glowing

2 sulfur, iron sulfide

3 Missing words from top to bottom: magnesium sulfide; sodium; lead; oxygen.

7Hd-4 Making compounds

1 Missing words: react; heat (energy); mixture; elements; properties; -ide.

2 Missing words: iron; sulfur; mixture.

3 a 'burning brightly' and 'a white solid is seen forming'

b to start the reaction

c sodium chloride

7Hd-5 Another compound

1 Element – Simplest type of substance. Contains only one kind of atom.

Compound – Contains two or more kinds of atoms (elements) joined together.

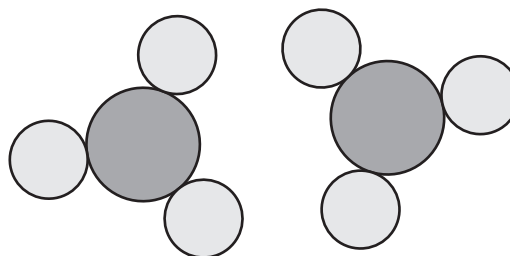
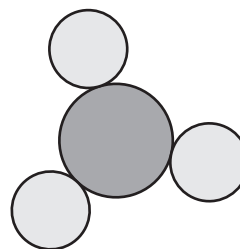
2 heat it

3 The compound is a different colour (white).

4 aluminium iodide

5 any two different properties: melting point; boiling points; hardness; etc.

6

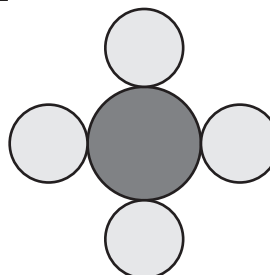


7 a sodium chloride b magnesium oxide c zinc sulfide d silver bromide

7Hd-6 Compounds and mixtures

1 a NH_3 b SO_2 c H_2O_2 d CO e Cl_2 f C_2H_6

2



3 a FeS

b There are equal numbers of iron and sulfur atoms joined together.

7Hd-7 Elements, mixtures and compounds 1

1 a pure and compound

b mixture and element

c mixture, element and compound

d mixture and compound

2 a Elements: lithium; chlorine. Compound: lithium chloride.

b Any sensible suggestions such as colour, state of matter.

c 'appears to burn and a white solid forms'

3 Mixture of elements – contains two or more kinds of elements that are not joined together and can be separated.

Compound – contains two or more kinds of atoms (elements) joined together.

4 copper and oxygen

7Hd-8 Elements, mixtures and compounds 2

1 Elements: **A** iron and oxygen **B** nitrogen, oxygen and argon **C** carbon, hydrogen and oxygen **E** sodium and chlorine.

Compounds: **A** rust and iron oxide **B** carbon dioxide and water **C** clay, stones and sand (all can also be mixtures) **D** sea water, rocks, salt and water **E** sea water, salt and sodium chloride.

Mixtures: **A** air **B** air **C** humus **E** rocks.

2 a coloured flames, sparks and solids and gases being produced

b carbon, zinc and oxygen

c carbon dioxide and zinc oxide

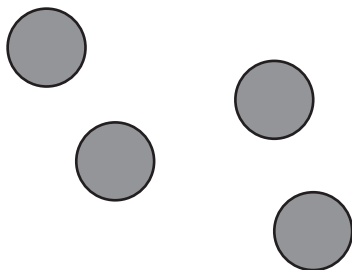
d carbon turns from a solid to a gas, zinc turns from a shiny metal to a white powder

3 correctly drawn diagrams of oxygen and carbon dioxide

7Hd-9 Elements, mixtures and compounds 3

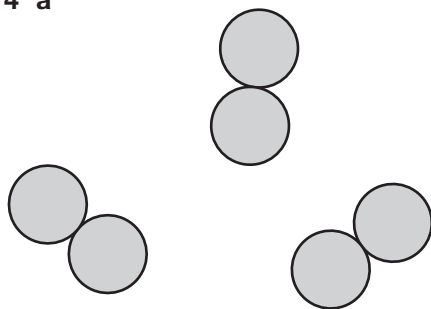
1 nitrogen – element, oxygen – element, argon – element, carbon dioxide – compound, water – compound

2 argon

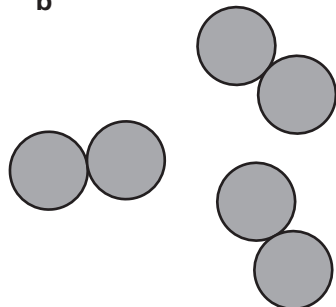


3 a O₂ **b** N₂

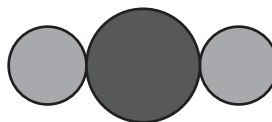
4 a



b



5



6 a 10 000 **b** 500

7 a magnesium oxide **b** MgO

7He Chemical reactions

Student Book

1: 7He Chemical reactions (Student Book)

1 One or more new substances are formed (or atoms are rearranged and joined in new ways).

2 a Cooking needs a constant supply of energy.

b Burning just needs energy to start it off.

c Rusting works without any energy input.

3 a copper + chlorine → copper chloride **b** carbon + oxygen → carbon dioxide

4 mercury and oxygen

5 a heat it in a test tube with a Bunsen burner

b silver oxide → silver + oxygen

6 a copper oxide and carbon dioxide

b Limewater turns milky/carbon dioxide gas is produced; the solid material changes colour from green to black.

c A physical change does not form any new substances but a chemical reaction does.

7 a sodium, phosphorus and oxygen **b** lead, nitrogen and oxygen

8 calcium carbonate → calcium oxide + carbon dioxide

2: 7He Problems with elements (Student Book)

1 a elements – lead, sulfur, arsenic, mercury; compounds – lead sulfide and lead oxide

b Elements contain only one kind of atom; compounds contain two or more kinds of atom joined together.

2 lead sulfide + oxygen → lead oxide + sulfur dioxide

3 thermal decomposition

4 It contains dangerous compounds (of lead, arsenic and mercury).

5

Benefits of lead production	Problems of lead production
income for the economy	air pollution with dust and smoke
work and training for the population	land pollution with toxic chemicals
introduces new technologies	creates unhealthy working conditions

Benefits of lead production	Problems of lead production
brings about improvements to transport systems	often exploits child labour
improves services like water and electricity supplies	contaminates environment for years

Activity Pack**7He-1 Chemical reactions**

1 substance

2 a colour b gas c solid d change

3 A chemical reaction – The change that always forms one or more new substances.

A carbonate – A metal compound that contains carbon and oxygen.

Thermal decomposition – A reaction involving breaking down a compound using heat.

Reactants – The substances you start with in a chemical reaction.

Product – The substances formed during a chemical reaction.

4 a sulfide b oxygen c silver oxide

7He-5 Matching Q & A

What happens in all chemical reactions – one or more new substances are formed

What is a substance containing only one kind of atom – an element

What do you call the new substances formed in a reaction – products

What is a substance that contains two kinds of atom joined together – a compound

What are starting substances in a chemical reaction called – reactants

What happens during a decomposition reaction – a compound breaks down into simpler substances

What would be formed if you decomposed mercury oxide – mercury and oxygen

Is sulfur an element or a compound – an element

What is the test for carbon dioxide – turns limewater milky

What kind of substance is found in the periodic table – an element

What is a compound of copper and oxygen called – copper oxide

What is needed to start many chemical reactions – heat energy put in

What are some signs that a chemical reaction has occurred – change of colour, solid or gas being formed

Is sulfur dioxide an element or a compound – a compound

How many elements are in magnesium oxide – two

What do you call a reaction that breaks down a compound with heat – thermal decomposition

What is the model that names all the chemicals in a reaction called – a word equation

What is a substance that contains different atoms not joined together – a mixture

Name the compound containing copper, carbon and oxygen – copper carbonate

How many elements are in calcium carbonate – three

When sulfur and iron react they glow. What does this tell you – heat energy is being given out

What is a molecule – a set group of atoms joined together

7He-6 Thinking about reactions

1 iron + oxygen → iron oxide

2 calcium + water → calcium hydroxide + hydrogen

3 gold + chlorine → gold chloride

4 lead carbonate → carbon dioxide + lead oxide

5 copper + carbon dioxide → copper carbonate

6 magnesium + oxygen → magnesium oxide

7 water + sodium → hydrogen + sodium hydroxide

8 zinc + water → zinc hydroxide + hydrogen

9 magnesium + water → magnesium hydroxide + hydrogen

10 aluminium + oxygen → aluminium oxide

11 Silver metal is heated with oxygen gas and reacts to form silver oxide.

12 Copper carbonate decomposes on heating to form copper oxide and carbon dioxide.

7He-8 Compound experiments

1 a iron and sulfur b iron sulfide c a magnet d The compound is a different colour e iron + sulfur → iron sulfide

2 a thermal decomposition

b copper oxide and carbon dioxide

c copper carbonate changes colour and lime water goes milky

d copper carbonate → copper oxide + carbon dioxide

7He-9 Compound properties

1 a copper carbonate

b iron sulfide, lead nitride and sodium chloride

2 a lead, nitrogen and oxygen b lead nitride

3 Heat is used to break down a substance (into simpler substances).

4 a copper carbonate → copper oxide + carbon dioxide

b Lime water turns milky (with carbon dioxide).

5 a calcium, carbon and oxygen

b calcium carbonate → calcium oxide + carbon dioxide

c heat it

- 6 a** thermal decomposition
b using heat
c mercury oxide → mercury + oxygen

7He-10 Planning an experiment

1 The aim of this investigation is to compare how easily different metal oxides decompose when heated.

2 Hypothesis: the less reactive a metal, the more readily the metal oxide will decompose on heating.

Prediction: silver oxide will decompose easiest.

3 Steps: A – Place 1 g of copper oxide in a test tube, stopper with a delivery tube and place it in a stand and clamp inside a fume cupboard.

B – Place the end of the delivery tube under a test tube full of water in a basin of water.

C – Start heating the test tube of copper oxide and start the stop watch.

D – Stop heating when the test tube is full of gas and note the time taken.

E – Repeat steps A to D with both silver oxide and mercury oxide.

4 wear eye protection and a lab coat; tie back long hair; remove the delivery tube before heating is stopped; place heat mat under Bunsen burner; conduct experiment inside a fume cupboard

5 You will change the type of metal oxide used. You will keep the same: the amount of metal oxide, the size of the test tubes and the heat from the Bunsen burner.

6 a colour change in the metal oxide and bubbles of gas in the basin of water

7 The metal oxide which fills the test tube with gas in the shortest time will be the one that breaks down the easiest.

- 8 a** silver oxide → silver + oxygen
b mercury oxide → mercury + oxygen

7I Energy

7Ia Energy from food

Student Book

1: 7Ia Energy and changes (Student Book)

1 possible responses for most energy – the large Ferris wheel (it is very large and very heavy, it is constantly moving and it works against gravity); the roller coaster (it uses gravity to power the ride but energy is needed to pull the carriages to the top and to stop them safely); the balloon ride (it is smaller, and less heavy than the Ferris wheel, but is constantly moving and working against gravity); possible responses for least energy – dodgem cars (move in two directions but not against gravity, energy needs to be transferred efficiently to many cars, cars travel fast); merry-go-round (it is moving

constantly but slowly and in limited directions, it is small)

2 a five reasonable examples such as: pulling carriages to top of rollercoaster, moving merry-go-round/Ferris wheel/balloon ride, moving dodgem cars, lighting, sounds/music, walking up stairs, stopping rollercoaster carriages

b answers may include: electricity, petrol, power stations (at this point students are not expected to know details of fuels or that electricity is not a source of energy)

3 a any five activities, ideally including use of machinery (such as getting a bus to school)

b Answers depend on students' responses to part A, but they should give acceptable responses with reasons.

2: 7Ia Energy from food (Student Book)

1 for growth and repair; to let you move and keep warm

2 a 1592 kJ **b** 5068 kJ

3 a because a teenager is bigger

b because a baby is growing inside her and it also needs energy

4 a baby, 11-year-old child, secretary, fire-fighter

b baby is smallest and so needs least energy; 11-year-old child is smaller than the secretary but bigger than the baby; fire-fighter is much more active at work than a secretary

5 a $6000 \text{ kJ} \div 544 \text{ kJ} = 11$ buns, or $6000 \text{ kJ} \div 837 \text{ kJ}/100 \text{ g} = 720 \text{ g}$

b $6000 \text{ kJ} \div 1990 \text{ kJ} = 3$ burgers, or $6000 \text{ kJ} \div 1592 \text{ kJ}/100 \text{ g} = 377 \text{ g}$

c Your body needs lots of different nutrients, which are found in different foods. A balanced diet is the healthiest way to eat.

6 A person takes in energy that is stored in their food. They need some of this energy to stay alive and to grow, and some for moving about/exercise. If they use up more energy for these things than they get from their food, they will have to use energy stored in their body (in fat or muscle) and they will lose weight/get thinner. If they take in more energy than they use, their body will store the extra energy as fat and they will gain weight.

7 They are not moving about while they are asleep, so they use less energy, which means they do not need to get as much energy from food as they would if they were awake for more of the day.

8 Our bodies need energy to stay alive, and active people such as mountaineers or explorers need more energy than most people. If they are in remote places they need to take all their food with them. It is important that they take enough food but not too much as food is heavy. If they know the amount of energy stored in different kinds of food they can work out exactly what foods and how much of each they should need during their expedition.

Energy

3: 71a Fair comparisons and ratios (Student Book)

1 a bread, crackers, cornflakes, cheese
b bread, cornflakes, cheese, crackers
c the temperature rise per gram of food, because the temperature rise depends on the type of food and on how much is burnt, so a fair comparison needs to look at the energy rise per gram

2 a 1:2 **b** 1:4

3 Yes, the ratio of energy stored in bread and cheese (represented by the temperature rises) is 1:2, so if twice the mass of bread is eaten as cheese, the same energy will be obtained.

4 pears:bananas = 175:350 = 1:2

Activity Pack**71a-1 Energy from food**

The order of the sentences may vary.

Our bodies need energy ... to grow, repair, move and keep warm.

Our bodies get energy ... from food.

Energy is measured ... in units called joules.

Energy used to be measured ... in units called calories.

The amount of energy stored in food ... is given on the food label.

The faster you are growing ... the more energy your body needs.

The more active you are ... the more energy your body needs.

A teenager needs more energy ... than an adult with an office job.

A teenager needs less energy ... than a very active adult.

71a-2 Energy in food 1

Labelling diagram, clockwise from bottom left: cork, boiling tube, thermometer, water, food, pin.

Missing words:

A – piece of food; **B** – same, distance; **C** – measuring cylinder; **D** – thermometer; **E** – repeat.

71a-3 Energy in food 2

6 The amount of energy released/temperature rise will depend on the size of the piece of food, as well as how much energy that kind of food stores.

7 No, some was transferred to the boiling tube itself, and some to the surrounding air. Some energy that was transferred to the water will also have been subsequently transferred to the boiling tube and surrounding air.

8 Suggestions could include using some kind of insulated container for the water, so that more of the energy released by the burning food stays in the water.

71a-4 Comparing foods

1

Food	Temperature rise per gram of food (°C/g)
salted peanuts	6.0
cashew nuts	6.0
sunflower seeds	6.0
raisins	3.0
dried apricots	1.8

2 dried apricots, raisins, (sunflower seeds, cashew nuts, salted peanuts – these in any order)

3 a It allows us to make a fair comparison between the amounts of energy stored in each gram of a food.

b It helps us to see which have the most and least energy per gram.

4 a apricots:sunflower seeds = 1.8:6.0 = 3:10

b raisins:cashew nuts = 3.0:6.0 = 1:2

5 Per gram of food burnt, cashew nuts raise the temperature of the water twice as much as raisins. Sunflower seeds raise the temperature of the water more than three times as much as dried apricots.

6 a Raisins contain a lot more energy per 100 g than dried apricots. Raisins contain 1.6 times as much energy per 100 g as dried apricots.

b They are about the same.

c Possible answers are: The energy per 100 g allows you to work out how much energy you are getting if you are not going to eat a standard/average-sized portion. The energy per portion allows you to easily work out how much energy you have taken in without having to find the mass of the food.

71a-5 Food cards

3 Check by finding out the energy per 100 g in each food, typical values are below.

Food	Energy in 100 g (kJ)
water	0
tea with milk	50
tomatoes	60
coffee with milk	65
lemonade	80
carrots	100
orange	150
orange juice	170
pear	175
apple	200
milk	250
peas	300
baked beans	350

Food	Energy in 100 g (kJ)
baked potato	350
banana	350
boiled potato	350
lentil dahl	450
boiled egg	650
chicken	750
wholemeal bread	900
beef	940
fried egg	950
white bread	950
chips	1000
falafel	1100
lamb	1100
poppadum	1150
pitta bread	1150
white toast	1250
chapattis	1400
cornflakes	1500
cheese	1670
margarine	3050

71a-6 Energy and you 1

1

Type of food	Energy value in 100 g (kJ per 100 g)	Energy value in one serving (kJ per serving)
cereal	1440	518
jam	1052	158
yoghurt	196	235
chicken	449	437
bread	956	330
butter	3046	243

2 butter

3 wholemeal breakfast cereal

4 a $330 + 243 + 158 = 731$ kJb $(2 \times 330) + (2 \times 243) + (2 \times 601) = 2348$ kJ (buttering both pieces of bread).**71a-7 Energy and you 2**

1 1000

2 to keep warm, to help us move, to grow, to keep our bodies working

3 a see 71a-6 Q1

b butter

4 a wholemeal breakfast cereal

b different-sized servings

5 Table from students' own labels. This should include the name of the food, and energy values per 100 g and per serving. A very good answer would also indicate the size of the serving for each food.

6 Answers could include various named fruits or vegetables.

71a-8 Climbing the Matterhorn1 a $4478 - 1620 = 2858$ mb $1000 \text{ N} \times 2858 \text{ m} = 2\,858\,000 \text{ J} = 2858 \text{ kJ}$ 2 a $10\,600 \text{ kJ} \times 2 = 21\,200 \text{ kJ}$

b 2120 kJ

c $3000 \text{ m}/500 \text{ m} = 6$, $6 \times 2120 = 12\,720 \text{ kJ}$ d $2 \times 2120 \text{ kJ} = 4240 \text{ kJ}$ (an extra 10% for cold weather, and an extra 10% for a heavy rucksack)e $21\,200 + 12\,720 + 4240 = 38\,160 \text{ kJ}$ 3 2 slices of bread, a portion of butter and a slice of ham: $(2 \times 400 \text{ kJ}) + 200 \text{ kJ} + 250 \text{ kJ} = 1250 \text{ kJ}$

4 a It is less than half.

b $2858/1250 \text{ kJ} = 2.3$ (accept $2\frac{1}{2}$ or 3 sandwiches)5 a It is significantly less. It is more than 30 times less ($38\,160/1250 = 30.5$).

b It doesn't seem likely, as he would need a lot more energy for the climbing he intended to do. He was also an experienced climber so would know from past climbs how much energy would be required.

71b Energy transfers and stores**Student Book****1: 71b Energy transfers and stores (Student Book)**

1 a three answers such as: light bulbs, fires, electric lights, candles

b three answers such as: musical instruments, radios, TVs

c any three electrical appliances

2 three of: food, cells/batteries, other named fuels such as petrol, coal

3 three answers such as: in a stretched spring, in a bow, in a stretched elastic band, bouncing on a diving board, flicking a ruler

4 energy stored in the stretched bungee/elastic; energy transferred by a force; energy stored in the moving passenger car5 a nuclear energy (stored in the fuel); energy transferred by electricity and heating; thermal energy (in room)

b 2000 J – energy cannot be created or destroyed, so all that goes in must come out again

c box with 'chemical energy stored in petrol/fuel', arrow with 'energy transferred by forces in the engine/car', box with 'kinetic energy stored in moving car'

Energy

Answer may also include an arrow from the chemical energy store labelled 'energy transferred by heating' and another box with 'thermal energy stored in the engine/surroundings'. Some students may also include sound as a further energy transfer, although at this level students would not be expected to know that energy transferred by sound also ends up as thermal energy in the surroundings.

Activity Pack

7Ib-1 Energy transfers and stores

- 1
 - a Chemical Energy
 - b Strain Energy
 - c Gravitational Potential Energy
 - d Thermal Energy
 - e Nuclear Energy
 - f Kinetic Energy
- 2
 - a force
 - b electricity, sound
 - c electricity, light, heating (last two in either order)

7Ib-2 Energy circus

The answers here are more detailed than would be expected from most students, but are included for completeness.

A Moving toy

- 1 chemical energy in the cell
- 2 The energy is transferred (via electricity and forces) by the motor.
- 3 The energy ends up stored in the moving toy (kinetic energy). Some energy is also transferred to the surroundings by heating and sound, and is stored in the surroundings as thermal energy.

B Electric fan

- 1 by electricity
- 2 In the moving air (kinetic energy). There will also be some energy transferred to the surroundings by heating, so the final energy store also includes thermal energy in the surroundings. The moving air will eventually slow down, so its store of kinetic energy will be transferred to more thermal energy in the surroundings.

C Hand fan

- 1 in the chemicals in the body/food (chemical energy)
- 2 in the moving air (kinetic energy) (details as for electric fan)
- 3 Muscles transfer stored chemical energy to kinetic energy by forces, and this kinetic energy is transferred to the air via the hand fan. The muscles also heat up, and the energy is transferred to the air as thermal energy.

D Electric bell or buzzer

- 1 Either in chemical energy in the cell or, if the bell/buzzer is being powered by a power pack plugged

into the mains, a store of chemical or nuclear energy (at the power station), with the energy being transferred to the bell by electricity.

- 2 by sound (and also by some thermal energy)

E Heater

- 1 A store of chemical or nuclear energy at the power station, transferred to the heater by electricity.
- 2 thermal energy in the heater and the air around it

7Ib-3 Energy sorting

1 Items that need energy transferred to them by electricity: E, F, H, I, J, K.

Items that mainly transfer energy by heating: B, (C), (D), (E), F, G, H, (I), (J), K (items in brackets if 'wasted' heat is considered).

Items that mainly transfer energy to kinetic energy: A, D, E, K, L.

Items that need a store of chemical energy: A, B, C, D, G, L.

7Ib-4 Match the energies

Energy to lift an apple by 1 metre.	1 J
Energy transferred when you walk up a flight of stairs.	5000 J
Energy stored in a AAA cell.	5000 J
Energy to boil a mugful of water.	110 000 J
Energy stored in the chemicals in an apple.	200 000 J
Energy stored in the movement of a family car travelling on the motorway.	650 000 J
Energy to play games on a computer for an hour.	750 000 J
Energy stored in the chemicals in one jam doughnut.	850 000 J
Energy your body needs just to keep alive for one day.	5 000 000 J
Energy stored in 1 kg of rocket fuel.	130 000 000 J

7Ib-5 Spotting the energies

1 Students may not get all the examples given, but should get one or two for each type of energy.

- a C on burger, coals, radio (assuming a battery inside it), ice-cream, stick
- b G on rollercoaster carriages, pirate ship ride, stick being thrown for dog
- c K on running dog, stick, rollercoaster carriages, roundabout
- d H on barbeque (the people, dog, radio, and even the theme park rides will all be transferring energy by heating as well, but students would not be expected to realise this at this stage)

- e S on dog, radio
 - f F on pirate ship, rollercoaster, roundabout, catapult
- 2 b** chemical, heating, thermal
c electricity, light, sound (last two in either order).

7Ib-6 Energy questions

1 a Chemical energy is stored in the fuel for the barbeque, the food/burgers, the ice cream, and batteries inside the radio. (Some students may also answer that our bodies and the stick store chemical energy.)

b The rollercoaster carriages and the pirate ship. The stick being thrown for the dog is above the ground, so it is also storing GPE.

c The dog, the stick, the roundabout and the rollercoaster carriages. (The pirate ship is shown at the top of its swing, so at this point it is not storing kinetic energy.)

d The burning coals are transferring energy by heating. (Some students may add that the people, the dog and the moving rides are also transferring energy to their surroundings by heating.)

e The dog and the radio. (Some students may add that the theme park rides will also be transferring some energy by sound.)

f The theme park rides, the children stretching the catapult. (Some students may add that the running dog is also transferring some energy using forces.)

2 a To the fire itself, and to the surroundings as thermal energy.

b Exactly the same amount of energy. The law of conservation of energy says that energy cannot be created or destroyed.

c Flowchart showing energy transferred to the TV by electricity, and from it by light and sound. Some students may also add an energy transfer by heating.

7Ib-7 Up and down

1 a gravitational potential energy

b by electricity

c No. Although energy cannot be created or destroyed, not all of the energy transferred to the motor by electricity will be converted to GPE in the people. Some will be transferred by heating from the hot motor, and will be stored in the surroundings as thermal energy.

2 gravitational potential energy and kinetic energy

3 The energy has been transferred to the air around them as thermal energy.

4 a The people start off with gravitational potential energy, and then this is converted to kinetic energy and back again. The energy is eventually transferred to their surroundings, which is why they come to a stop.

b The person bungee jumping climbed the tower instead of being pulled up; the bungee jump

involves changes between GPE, kinetic energy and strain energy, not just GPE and kinetic energy. (In the initial part of the jump, before the bungee cord has straightened, GPE is being transferred to kinetic energy. Once the bungee starts to stretch, GPE and KE are both being converted to strain energy. As the jumper bounces back, strain energy is being converted back to GPE and KE. Once the bungee cord has slackened, then it is only the remaining KE that is being converted to GPE. Students would not be expected to work out this sequence unassisted.)

c The energy has been transferred to the air around them as thermal energy.

7Ic Fuels

Student Book

1: 7Ic Fuels (Student Book)

1 a a store of chemical or nuclear energy

b three of: coal, oil, natural gas, uranium, hydrogen, wood, butane gas, ethanol, petrol, diesel

2 any three suitable suggestions such as: generating electricity, heating, cooking, running cars/buses

3 a oil

b for two reasons: we are not sure how much is left and we are not sure how fast we will continue to use them

4 a two of: they are made from fossils, they are squashed by layers above, they take millions of years to form

b one of: coal is made from plant remains, oil from animal and plant remains, coal was formed in swamps, oil formed beneath the sea

5 A fuel is a store of chemical or nuclear energy. Electricity is a way of transferring energy and it has to be generated using fuels (or other energy stores).

6 We are using them up faster than they are being formed. Renewable resources are those where the resource is replenished at about the same rate it is being used (as for biofuels), but we are using fossil fuels much faster than they are forming.

Activity Pack

7Ic-1 Fuels

1 chemical, oil, fossil, animals, rock, millions, nuclear, electricity, non-renewable, plants, renewable

2 plants, rot, rock, coal; sea, rot, rock, oil, gas

7Ic-2 Energy in fuels 1

Diagram (clockwise from bottom left): heatproof mat, clamp and stand, boiling tube, thermometer, water, solid fuels, tin lid

A heat, boiling

B same

Energy

C measuring cylinder

D Bunsen burner

E thermometer

F fuels, distance

6 B, C, E, F

7 students' own responses

7Ic-4 Using fuels

1 Matching fuels to pictures (note that there are several possible matches for some of the cards):

petrol and diesel – cards E, J

oil – cards G, H, I

butane – cards B, F

wood – cards C, G

hydrogen – cards A, L

uranium – card K

natural gas – cards D, G, I

animal wastes – card C

2 Possible groupings include: fuels used for generating electricity (oil, natural gas, and hydrogen if you count fuel cells); fuels used for cooking (butane, natural gas, wood, animal wastes); fuels used for transport (petrol and diesel, hydrogen).

7Ic-6 Fuels 1

1 True.

2 False. Natural gas, oil and coal are fossil fuels.

3 True.

4 False. Oil and natural gas take millions of years to form.

5 False. Fossil fuels are non-renewable fuels.

6 True.

7 True.

8 True.

9 False. Oil is called a fossil fuel because it is formed from fossils.

10 False. Most fuels are stores of chemical energy (or, All fuels are stores of chemical or nuclear energy).

7Ic-7 Fuels 2

1 Any three uses of energy such as heating, cooking, running cars.

2 Plants die and are buried and prevented from rotting. Pressure and heat turn them into coal over millions of years.

3 We are using them up faster than they are being formed, so they will run out one day.

4 **a** oil

b natural gas

c natural gas – does not produce smoke or soot

d natural gas

e coal = solid, oil = liquid, natural gas = gas

5 **a** it is easier to store in a tank than gas, easier to feed to the engine than coal, more energy per gram than coal

b It comes in pipes direct into the home instead of being delivered by lorry – more convenient. It burns cleanly and produces a high amount of energy – clean and efficient.

7Ic-8 Generating electricity

1 coal

2 natural gas

3 **a** natural gas, nuclear, imports, other

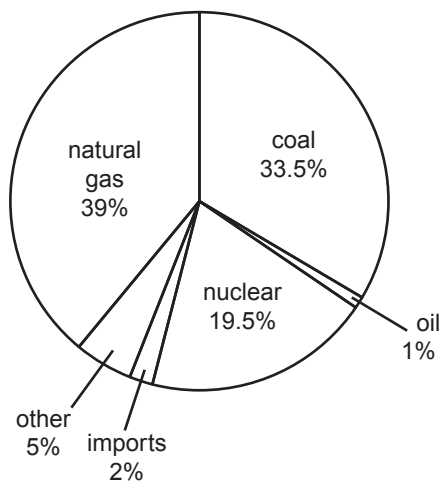
b coal, oil

4 Pie charts will vary: they could follow the trends shown, or add a slice for renewable energy.

5 **a** Total energy = 407 200 GWh

Fuel	Coal	Oil	Nuclear	Imports	Other	Natural gas
stored energy used (GWh)	136 400	4000	79 500	8100	20 400	158 800
percentage	33.5	1.0	19.5	2.0	5.0	39.0

b



6 **a** Line graphs should have suitable scales and points plotted correctly. Lines of best fit should NOT be drawn.

b Most students should consider that the line graph shows the changes more clearly.

7 Data here is from 2009, the latest available in the CIA World Factbook at the time of writing.

a In France just over half of electricity is generated in nuclear power stations with 20% fossil fuels, 18% hydroelectricity and the rest from renewable resources.

b Example include: In Kenya, around 43% of electricity is generated from hydroelectric plants, 43% from fossil fuels and the remainder from other renewable resources. In Ghana, hydroelectricity is also the most important at 60%, with the rest generated using fossil fuels.

c In India, fossil fuel power stations produce around 70% of the country's electricity, with hydroelectricity and other renewable resources making up most of the rest.

71c Transporting goods (STEM)

1 Answers will vary.

2 Any three from: the distances between the different shops by road, how fast the trucks travel, how long it would take one truck to visit all the shops, the mass/volume of goods to be transported each day, how much each truck can carry, how long it takes to load/unload each truck, how often deliveries have to be made.

3 Possible responses include:

If she has four, they can all be out delivering at once. If there was only one, some deliveries would not be made until late in the day.

If she has just one truck and it breaks down or crashes, she has no transport. If one of the vans breaks down or crashes she still has three others.

Some trucks may be too big to fit down narrow roads.

4 The locations to be visited, the speed limits/maximum speeds on different roads, where traffic jams might be likely, the maximum speed of the vehicle.

Activities

1 a Primary data advantages include:

- you can choose what data to collect
- you know how well the experiment went, which makes it easier to evaluate the data.

Primary data disadvantages include:

- you may not have the apparatus needed to carry out the experiment
- you may not have time to repeat the experiment to allow you to check your data.

Secondary data advantages include:

- it may be quicker and easier to find data on the internet or in books than it is to carry out experiments.

Secondary data disadvantages include:

- you may not get enough detail about how the experiment was carried out, so you may not be able to evaluate the data well.

b Students can choose either method, but should provide some justification for their answer. In this case, some of the fuels mentioned are too difficult and/or dangerous to handle in a school laboratory, so using secondary data is the preferred option.

2 Shortest route from A to D is A–B–E–D (14 km).

71d Other energy resources**Student Book****1: 71d Other energy resources (Student Book)**

1 more plants can be grown/waste materials used to make more fuel

2 to heat water in solar panels, to make electricity directly in solar cells, to generate electricity in a solar power station

3 tides, waves, hydroelectricity

4 Energy stored in chemicals in the corn came from the Sun. Energy in the milk came from the cow, which got it from grass, which grew using energy from the Sun.

5 from the Sun; energy from the Sun (transferred by light) was converted to the energy stored in plants, plants were buried and transformed to natural gas

6 a solar, wind, waves

b hydroelectricity, geothermal resources, biofuels

c solar, tides

Activity Pack**71d-1 Other energy resources**

1 a panels, heating; cells, electricity; mirrors

b wind (energy/power)

c hydroelectricity

d geothermal

e generate electricity

f generate electricity

2

Resource	Energy directly from the Sun	Energy from plants that used sunlight	Energy from the effect of the Sun on the air and water	Energy is not originally from the Sun
biofuels		✓		
fossil fuels		✓		
hydroelectric			✓	
geothermal				✓
wind			✓	
tides				✓
nuclear				✓
solar	✓			

71d-2 Energy answers

Possible questions are:

1 What kind of energy is stored in food/cells/fossil fuels? Name one kind of energy that fuels store.

2 What are the energy stores when a book falls off a table/you jump off a diving board/you cycle down a hill?

3 How is energy transferred to a radio/TV/any other electrical appliance? How is energy transferred from a power station/battery/generator?

4 What kind of energy is stored in a stretched catapult/bow/spring? What kind of energy is stored in a squashed/twisted spring?

5 Why is coal/oil/gas called a fossil fuel?

Energy

6 What kind of fuel is made from plants/plant waste/animal waste? What kind of fuel is renewable?

7Id-3 Advantages and disadvantages

1 biofuels: A/B/C, G

geothermal: A/B/C, D/E, H

hydroelectricity: A/B/C, M, P

solar: D/E, N, Q

tides: F, J/K, L

waves: J/K, O

wind: I, R, S, T

7Id-4 Charging mobile phones

1 any two from: there is no wiring for landline telephones; there are not enough phone masts for full coverage; it is difficult to recharge mobile phones

2 At level 4: a simple comment about allowing people to stay in touch, finding information etc.

At level 5: two or more reasons given, such as allowing people to find information, run businesses, get an education, etc.

3 They have to take the phone to somewhere with a generator.

4 a They will not have to go as far to find someone who can charge their phone.

b At level 4: a simple comment about using the time saved to earn money, or it being cheaper to charge the phone.

At level 5: two or more reasons given, including being able to find the cheapest place to buy goods, etc.

c At level 4: people who buy the chargers can make money from other people who need their phones charging.

At level 5: also, if it is easier to charge phones, people running businesses may be able to find the best place to buy/sell things to increase their profits.

5 Advantages of solar power – the person does not have to spend time pedalling the bicycle.

Disadvantages – the solar panels will only work when the Sun is shining, whereas the bicycle can be used at any time.

6 A wind turbine would have to be in a fixed place as it would be too big/heavy to move around, and the wind does not blow all the time.

7Id-5 Renewable resources

1 a solar

b hydroelectric, tides, waves

c wind

d geothermal

e biofuel

f hydroelectric

g biofuel, geothermal, hydroelectric

h solar

i tides, waves

j geothermal, tides

2 energy, food, sunlight

7Id-6 Solar fridges

1 To store vaccines/medicines, as vaccines do not work if they are not kept cold.

2 a mains electricity

b In some parts of the world there is no electricity supply.

3 a It needs to be recharged regularly, using diesel fuel. A very good answer might point out that there may be problems supplying diesel to remote areas, or it might be difficult to get the generator fixed if it breaks down.

b There will still be electricity to work the fridge at night, or it does not depend on the Sun shining.

4 a The Sun does not shine at night, so the ice is required to keep the fridge cool at night.

b They don't need to as electricity is always available.

5 If the weather is cloudy for a long period there may not be enough electricity from the solar cells.

6 The fridge will help countries to vaccinate children, to improve their health.

7Id-7 Choose your resource

1 Mr McCloud: wind turbines, because it is a windy place.

Mr and Mrs Singh: solar power, because the weather is sunny.

Mrs Williams: biomass, as she can use cow droppings to produce gas. Accept other sensible answers.

Mrs Jensen: hydroelectricity, because of the mountainous location of the factory and she can afford to build a dam to trap water to use.

7Ie Using resources**Student Book****1: 7Ie Using resources (Student Book)**

1 The fuel/resource will run out one day.

2 a two of: wind, solar, tide, wave

b Answers depend on the resources given in part A: wind – only works when there is enough wind (and not too much); solar – only works when the Sun is shining/when the skies are clear/in the daytime; tide – only works at certain times, depending on the times of the tides; waves – only works when the waves are big enough.

3 a any suitable suggestions, e.g. walk/cycle instead of using cars, insulate homes so we need to use less for heating in cold countries and less for cooling in hot countries, keep houses cooler so we use less for heating, buy more efficient appliances so that less energy is wasted

b to make them last longer/because they are non-renewable, because burning them adds carbon dioxide to the atmosphere/is causing climate change

4 a The solar panels will provide hot water, so he needs to burn less gas to do this.

b Burning less gas will put less carbon dioxide into the atmosphere.

5 Bulb A is the most efficient because it only wastes 2 J of energy every second, compared with wasting 16 J.

2: 7Ie Making changes (Student Book)

1 energy stored in people's bodies (chemical energy), in the warm air outside (thermal energy); energy is being transferred by forces (as people walk), by electricity (lights, air conditioning), by heating (people), by light (lights)

2 a Efficient appliances use less energy to do a particular job than inefficient or less efficient appliances.

b Electricity is a way of transferring energy, not a store. Using less energy uses up less of our fossil fuel/nuclear resources.

3 Non-renewable resources do not depend on the weather as many of the renewable resources do; power stations can be built almost anywhere and the power stations already exist; using the existing power stations and paying for the fossil fuels is still cheaper than investing in new generating systems that do not have fuel costs.

4 a Burning fossil fuels is leading to climate change; they are non-renewable, so using less will help them to last longer.

b any suitable ideas such as: buying electricity from companies who use renewable resources to generate electricity, using more efficient machines/cars, keeping their house cooler if in a cold country or warmer if in a hot country, insulating their house, walking/cycling instead of using a car, using public transport instead of using a car, turning off machines when not in use, driving a smaller car.

5 Answers may vary in detail and layout. Possible answers are shown below.

a flow chart showing sun → plants → coal → electricity → heat

b flow chart showing gravitational potential energy → electricity → heat

Activity Pack

7Ie-1 Using resources

Fossil fuels are non-renewable and release polluting gases when they burn.

Nuclear fuels are non-renewable but do not release polluting gases.

Renewable resources do not cause pollution, but they are not available all of the time.

Burning fossil fuels releases carbon dioxide into the atmosphere.

Extra carbon dioxide in the atmosphere is making the Earth warmer.

Cutting down the amount of fossil fuels we burn will make our supplies last longer.

Efficiency is a way of saying how much of the energy transferred by a machine is useful.

An efficient machine does not waste much energy.

If we use more efficient machines we will not need to burn as much fossil fuel.

7Ie-2 Where should we start?

1 a transport

b any two sensible suggestions, such as: using more efficient cars, walking or cycling instead of driving, using public transport more, etc.

2 There is more energy used in homes than in factories, so if everyone saved energy at home it could have more effect than factory owners making changes.

3 Reducing the amount of energy for heating rooms, as more energy is used for that purpose.

4 a They use most energy for heating rooms so would save more energy by insulating their homes.

b It is cheaper and easier to insulate a hot water tank.

5 Ms Goody. Heating rooms takes more than 20 times the energy used for cooking, so even if you didn't use any energy at all for cooking it would make a relatively small difference.

7Ie-4 Energy question loop

How is energy stored in a moving football? – kinetic energy

How is energy stored in a book on a shelf? – gravitational potential energy

Name three things that are stores of chemical energy. – food, fuel, batteries

How is energy stored in a stretched spring? – strain energy

Name two ways in which a light bulb transfers energy. – by light and by heating

How is the energy stored in a stretched elastic band transferred to it? – by forces

Why does a teenager need more energy than an adult? – the teenager is growing

What happens if your food contains less energy than you use? – you lose weight

What is the unit for measuring energy? – joule

Name a metal that stores nuclear energy. – uranium

Why do our bodies need energy? – to grow, move, and keep warm

Energy

Name an object that stores thermal energy. – a pan of hot water

Name an object that transfers energy by light and sound. – television

How is energy stored in food? – chemical energy

Name three fossil fuels. – coal, oil, natural gas

Why are fossil fuels referred to as non-renewable? – we are using them up faster than they are being formed

Name a renewable fuel. – biomass

Name an underground renewable energy resource that can be used at any time. – geothermal

Which renewable resource uses gravitational potential energy? – hydroelectricity

Name a renewable resource that uses a store of kinetic energy in the air. – wind

What gas is produced when fossil fuels burn? – carbon dioxide

What environmental problem is being caused by burning fossil fuels? – climate change

Name a way of storing energy that is only used in power stations. – nuclear energy

How is energy transferred to a light bulb? – by electricity

What is another name for strain energy? – elastic potential energy

Which fossil fuels were formed from sea plants and animals? – oil and natural gas

What is the name for the renewable energy resource used by roof panels for heating water? – solar

Which energy resources did not originally come from the Sun? – geothermal, tidal, nuclear

What process do plants use to obtain energy from sunlight? – photosynthesis

Which kind of power station does not produce polluting gases? – nuclear power station

7le-5 Energy questions 1

1 a A

b C, E

c B, C, D

d E

e all of them

2 a any three from: wind, waves, tides, hydroelectricity, solar, geothermal, biofuels

b carbon dioxide

c most are not available all the time

3 a nuclear, solar power

b nuclear, fossil fuels

c solar power

d nuclear

7le-6 Energy questions 2

1 a One of each from:

Advantages: cheap, convenient to use, available at any time.

Disadvantages: release polluting gases/carbon dioxide when they burn, non-renewable.

b One of each from:

Advantages: no polluting gases released, available at any time.

Disadvantages: expensive power stations, dangerous waste materials, non-renewable.

c One of each from:

Advantages: no fuel costs, no polluting gases, renewable.

Disadvantages: most not available all the time.

2 a wind, waves, tides, hydroelectricity (as GPE is converted to kinetic energy before entering the power station, or the power station might use water in a river)

b hydroelectricity

c biofuels, fossil fuels

d geothermal energy, solar

e solar

3 Petrol is a liquid. Petrol is a fossil fuel, formed from sea plants and animals, which originally got their energy from the Sun.

4 a How much of the energy transferred by a machine is useful.

b 3200 kJ

c An A energy rating is more efficient than a B rating, so the A machine will need less energy to do the same job because it wastes less of it.

5 a It will cost less to run.

b It will result in less carbon dioxide being put into the air (assuming it uses either fossil fuels or electricity generated using fossil fuels).

6 a It burns petrol or diesel in the engine.

b The battery in the car needs to be charged up. Most electricity in this country is generated using fossil fuels. So carbon dioxide is added to the atmosphere at the power station rather than directly from the car.

c It is making the Earth warmer/causing climate change.

7le-7 More on biofuels

1 a Most will come from fossil fuels (fuel for tractors etc. and fuel used for heating). If electricity is used for heating, this is transferring energy from a power station, so most of this will also come from fossil fuels.

b Energy is needed to make and distribute fertiliser, to run the tractors for sowing and harvesting, for transporting crops and the biodiesel, and for the process to make the biodiesel. Most of this energy will come from burning fossil fuels, either directly or in a power station.

c Energy is needed to survey for oil, to set up and use the drilling rig, to transport and refine the oil, and to transport the diesel. Most of this energy will come from burning fossil fuels, either directly or in a power station.

2 Although burning the fuel itself only puts back the amount of carbon into the atmosphere that the plants originally took out, extra carbon dioxide is put into the atmosphere because of the energy needed to grow the crops and make the biodiesel.

3 a Both processes add carbon dioxide to the atmosphere due to making the fuel, but the carbon dioxide directly resulting from burning the biofuel has only just come out of the atmosphere.

b Use only sources of renewable energy/ electricity from nuclear fuels to make the biodiesel.

4 a Fossil fuels were made from the remains of plants (or animals, which grew by eating plants), and the carbon in these came originally from the atmosphere.

b The carbon in them was taken out of the atmosphere millions of years ago.

5 Very. The carbon in the droppings is undigested plant material that has only just been eaten, and so when the droppings are burnt the carbon dioxide put into the atmosphere is only that which was taken out of it for the plants to grow. If droppings are collected by hand and dried in the Sun, there will be no additional carbon dioxide produced in 'making' the fuel. (Taking into account any extra carbon dioxide produced by people exerting themselves to do the collecting etc. is making the discussion rather too complex!)

7J Current electricity

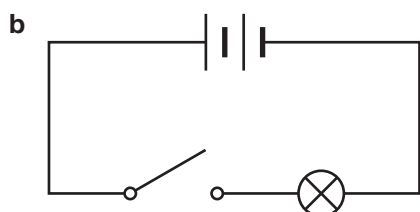
7Ja Switches and current

Student Book

1: 7Ja Discovering electricity (Student Book)

1 Metal is used for the wires because metals are good conductors of electricity. Plastic is used to cover the wires because plastic is an insulator. This stops the electricity causing harm if someone touches the wire.

2 a 2 cells, wires, switch, bulb



Students draw correct symbols for some or all of the components. Correct symbols are drawn and arranged correctly to match the circuit shown.

2: 7Ja Switches and current (Student Book)

1 When the switch is open there is a gap in the circuit so the current cannot flow. When the switch is closed there is a complete circuit so the current can flow and the bulb comes on.

2 The other bulb will not come on because the missing bulb has made a gap in the circuit.

3 A good answer will include a circuit diagram and explain that the circuit will be built with one bulb, then with two, with the brightness of the bulbs being noted each time. The apparatus list should include: cell/power pack, connecting wires, bulbs.

4 a The bulbs in circuit X will be brighter.

b They will get dimmer.

c It goes out, because now there is a gap in the circuit caused by the broken bulb.

5 a the size of the current **b** correct symbol for ammeter drawn

6 a 0.5 A **b** 0.5 A

7 answers may include: broken bulb, missing bulb, flat battery/cell, broken wire inside the torch, broken switch

Activity Pack

7Ja-1 Switches and current

1 a current
b ammeter
c cell
d filament
e switch
f battery

2 a true
b false
c false
d false

3 correct circuit symbols for cell, ammeter, bulb, switch

7Ja-2 Measuring current

A students' own observations

B students' own observations

C students' own observations

ammeter, circuit, circuit, same, circuit, used up

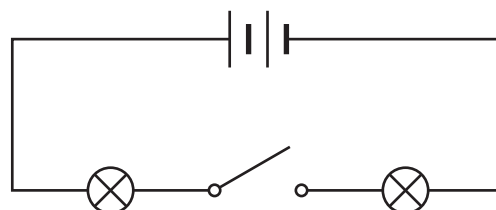
7Ja-3 Circuit diagrams 1

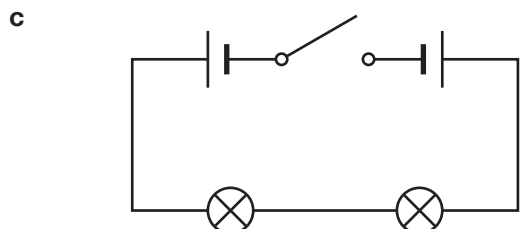
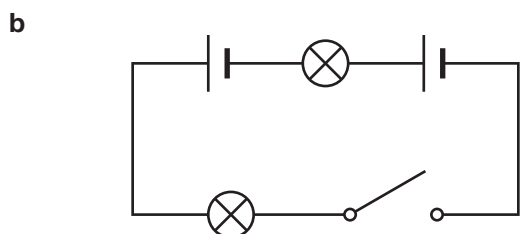
students' own answers

7Ja-4 Circuit diagrams 2

1 students' own circuit diagram – must be neat

2 a





3 One cell is the wrong way round (or similar answer).

7Ja-5 Investigating electricity

1 Observation, questions, hypothesis, prediction, investigation, data, does the data match the prediction?

2 Observation: Galvani – muscle twitched when a spark was made; Galvani – leg also twitched if he used copper hook and iron wire.

Questions: Galvani – is the twitch connected to the spark?

Hypothesis: Galvani – the spark caused the twitch; Volta – copper and iron made the electricity when they touched.

Prediction: Galvani – lightning should make the muscle twitch; Volta – electricity can be made without animal tissue.

Gathering data: Galvani – hung legs outside in thunderstorm; Volta – experiments with making cells.

Data: Galvani – leg twitched in thunderstorm; Volta – piles of zinc and copper produced electricity when connected by paper soaked in salty water.

Does the data match the prediction? Galvani – lightning *did* make the legs twitch; Volta – electricity can be made from zinc and copper.

3 possible answers include: so other scientists can find out what they have done, so other scientists can check on their work, so other scientists can test their own hypotheses, etc.

7Ja-6 Circuit questions

1 a battery

b 0.3 A

2 a cell; make the current flow/bulb light

b open; gap; close the switch

3 a both bulb X and bulb Y

b They will both be the same brightness.

c They will both be dimmer.

4 The other bulb will go off, because there is a gap in the circuit.

7Ja-7 Electricity reverseword

Sensible clues for the following words:

Across: insulator, amp, current, ammeter, battery, cell

Down: filament, conductor, switch, bulb

More able students will have written more than one clue for some of the words.

7Ja-8 Cells and batteries

1 They use two different metals, and they use a liquid that contains ions.

2 a They have two different metals, and these are in a jar that could have contained a liquid.

b Salty water or lemon juice. (These answers can be obtained from the information on the worksheet; other valid suggestions that may result from students' research include vinegar, acids, etc.)

3 Suggestions have been made that they could have been used for electroplating jewellery or statues. A BBC article speculates that they could have been installed inside religious idols (and controlled by priests) to give worshippers who touched them a slight shock!

4 Reasons include no evidence of wires found with the artefacts, or no evidence of other electrical equipment. There are some problems with the design (e.g. there is a bitumen seal not shown on the diagram on the worksheet that would have electrically insulated the copper).

7Jb Models for circuits

Student Book

1: 7Jb Models in science (Student Book)

1 a the pump **b** the water **c** the waterwheel

2 Answers may vary slightly. A possible answer is: the pump moves the water around the pipes and the cell makes the current flow around a circuit; the water moves around the pipes and electricity flows around a circuit; the water makes the waterwheel move and a current makes a bulb light up.

3 a It stays the same, because the funnel catches all the water that runs over the waterwheel.

b It gets less after it passes the hole in the track, because some of the balls fall through the hole.

4 a cell(s), connecting wires, bulb, ammeter(s) (optional: switch)

b The circuit diagram should show a cell/battery, a bulb and an ammeter either side of the bulb (or just one ammeter connected in series if the instructions mention moving the ammeter).

c The method should be described in a series of instructions, in a sensible order, e.g. build a circuit as shown in the diagram, measure the current, change the circuit so the ammeter is the other side of the bulb and measure the current again.

5 a All the ammeter readings should be the same.

b The current would be different at different places in the circuit/before and after the current flows through the bulb.

6 The current is the same everywhere in a circuit, so Sam's model is the best one.

7 This is a physical model because it is made of real objects that Dan can hold.

2: 7Jb Models for circuits (Student Book)

1 a flow of charges

2 because charges can flow round easily inside them

3 The charges are too small to see.

4 **a** It transfers energy and it pushes something around the circuit.

b They both transfer energy to their surroundings.

5 One possible answer is: if you make a gap in the pipe the water will leak out, while charges do not leak out of gaps in the circuit. There may be other valid answers.

6 **a** the cell

b the bulb or other component

c the charges

d the energy transferred by the charges

7 Any suitable answer, such as: the mine is only providing coal but a cell pushes the charges around as well as providing them with energy, or the factory is not obviously transferring useful energy to its surroundings.

8 *Students' own answers*, with reasons; of the models presented on the page, the central heating model probably has the fewest shortcomings.

Activity Pack

7Jb-1 Models for electricity

1 **a** charges

b metals

c insulating

2 pipes – wires; boiler and pump – cell; radiator – bulb; hot water – charges

7Jb-3 Speedy charges?

1 **a** the hosepipe

b the water

c the end of the hosepipe

d the tap

2 **a** The water had to travel down the length of the hosepipe.

b This time, the hosepipe was already full of water.

c The light comes on as soon as the switch is pressed as charges are always present in the wires. Pressing the switch simply starts to move them as a current.

7Jb-4 Electricity models 1

1 the coal mine – the cell; the wagons – the charges moving through the wires; the coal – the energy transferred by the current; the factory – a bulb or motor

2 **a** Yes, the empty wagons flow around the track back to the mine (or similar answer).

b No, there is no engine or other means of propulsion shown.

3 **a** They will stop.

b a switch

c A switch stops current flowing when it is open as it creates a gap in the circuit.

7Jb-5 Electricity models 2

1 **a** cell

b energy

c charges

d A bulb/motor or other component that transfers energy.

2 Yes, all the people carrying the burgers return to the burger bar for more.

3 No, the people appear to be moving themselves so there is nothing pushing the people around.

4 Put a gate or other barrier in the way of the people carrying the burgers.

5 **a** It shows that energy is transferred without current being used up.

b Weaknesses include: it does not show how charges are transferred around the circuit, or it does not show that the energy carriers/people are confined to a particular route (as charges are in wires).

7Jb-6 Electricity models 3

1 **a** The boiler gives the water energy and the pump pushes it around the pipes; a cell gives the current energy and pushes it around the circuit.

b Water flows through the pipes and the current flows through the wires.

c The radiators transfer energy to the room, and the bulb transfers electrical energy to light energy which goes into the room.

2 **b** **i** Extra radiators would mean that less water would get around the pipes because it is more difficult for it to flow.

ii adding extra bulbs (or other components)

iii The current would get smaller because it is harder for it to flow, so each bulb would get dimmer.

c **i** The value could be turned off to stop water flowing around the pipes.

ii adding a switch

iii The switch could be used to stop current flowing around the circuit.

3 Yes – if you broke a pipe, water would flow out, but charges do not fall out of a wire if the circuit is broken. Other sensible answers may be given.

4 a It helps us to understand what is happening when the things involved are too small to see.

b Models are not the same as the real thing, so they do not necessarily help us to understand all aspects of circuits. We need to remember that it is just a model, and NOT the real thing.

7Jc Series and parallel circuits

Student Book

1: 7Jc Series and parallel circuits (Student Book)

1 A series circuit has all its components on one loop; a parallel circuit has two or more branches.

2 parallel; each light can be switched on and off separately/they do not all go off if one breaks

3 The plan should include: the apparatus needed (cells/power supply, connecting wires, bulbs), a method that indicates that extra bulbs will be added in parallel to a simple circuit and the brightness noted each time, and ideally a circuit diagram.

4 a 1 only **b** A and C

5 a 0.2 A

b The brightness will stay the same.

6 A parallel circuit should be used, so that if one streetlight is broken the others will still work. The only argument for using a series circuit would be to switch them all on and off together but all the lights can be controlled at once in a parallel circuit if the switch is put into the main branch of the circuit. Note that, in practice, many streetlights are controlled by light-sensitive switches but the point about using a parallel circuit so that a broken lamp does not turn them all off still stands.

7 a on **b** off

8

Switch Y	Switch Z	Bulb
open	open	off
closed	open	on
open	closed	on
closed	closed	on

Activity Pack

7Jc-1 Series and parallel circuits

1 parallel; series

2 a True

b False; if you add more bulbs to a series circuit they get dimmer, or if you add more bulbs to a parallel circuit they stay the same brightness.

c True

d False; the current is not the same everywhere in a parallel circuit, or the current is the same everywhere in a series circuit.

e False; if you add more bulbs to a series circuit the current gets smaller.

f True

7Jc-2 Investigating parallel circuits

A bright, the same as, stay bright, dimmer

B goes off, stays on

C the same as

7Jc-3 Current in parallel circuits

1 same current

2 same current (assuming all bulbs are the same)

3 They give the same value as the current in A or D.

4 The current splits up when it comes to a junction, but the current in the branches adds up to the current in the main part of the circuit.

5 it increases

6 As each bulb is added in parallel, the current in the main part of the circuit increases.

7Jc-4 Spot the differences

1 Both bulbs are in one loop of wire in the series circuit, whereas in the parallel circuit each bulb is in its own piece of wire (or similar answer). Some students may also point out that there are more connecting wires in the parallel circuit.

2 a series circuits: D, E; parallel circuits: C, F

b i C is a parallel circuit so has two branches with bulbs on, whereas D is a series circuit so has all bulbs in the same loop.

ii The switch is in a different place. In both circuits, both bulbs will go out when the switch is open.

iii The switch is in a different place. In circuit C one bulb will remain on when the switch is open, whereas in circuit F both bulbs will go out when the switch is open.

c circuits D, E and F – no bulbs will be on; circuit C – the bottom bulb will be on

7Jc-6 Series and parallel 1

1 a series

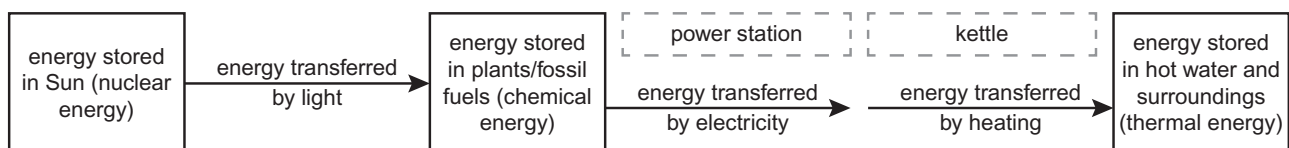
b parallel

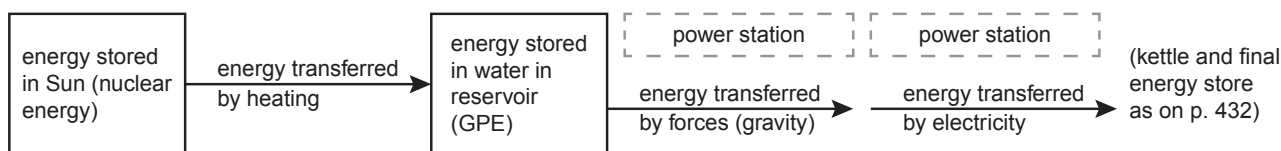
c parallel

d series

e parallel

f series





g series

h parallel

2 0.5 A, 0.5 A (bottom), 1 A (side)

3 switch drawn somewhere on the same branch of the circuit as bulb X

7Jc-7 Series and parallel 2

1 a The current is reduced for each extra bulb added to the circuit.

b The current is reduced as each bulb adds more resistance to the flow of current.

c The current increases for each extra bulb added to the circuit.

d The current is increased in the main part of the circuit as more loops are added to the circuit as the charges have more paths to follow, so it is easier for the current to flow.

2 a switches 1 and 2

b switches 1, 4 and 5

c Bulb A is on the main circuit so will be on whenever current flows.

d Bulb E is on whenever bulb D is on as there is no switch on the circuit loop for bulb E.

3 Bulb A will be brighter as the current is increased in the main part of the circuit as more bulbs in parallel are turned on.

7Jc-8 Combinations of switches

1 An extra switch should be in the main circuit before or after it splits for the manual and timer switches.

2 b He needs a light detector that closes a switch when there is no Sun, and a moisture detector that closes a switch when it is dry. The motor should pump water if it is dry AND there is no Sun. The circuit should show the switches and motor in series.

c She needs a switch on the door which is on when the door opens, another manual switch in the shop, and a bell. The bell should ring if the door is opened AND the switch is closed. The circuit should show the switches and bell in series.

d He needs a rainfall detector that closes a switch when it is wet, a wind speed detector that closes a switch when it is windy and a motor. The motor should close the windows if it is windy OR it is wet. The circuit should show the switches in parallel with the motor on the main circuit.

7Jd Changing the current

Student Book

1: 7Jd Changing the current (Student Book)

1 a voltage

b voltmeters are connected in parallel; ammeters are connected in series

2 It will get smaller (it will halve), as the size of the current depends on the voltage.

3 it decreases

4 a The football queue, as there are two entrances open, so two people can get through at a time.

b charges/the current

c a bulb (or motor/other component)

d The football entrance is like a parallel circuit, because the line of people splits up to go through the entrances. The fairground entrance is like a series circuit, because everyone has to go through the same entrance. It is easier for the people to get into the football ground, and it is easier for the current to flow when there are parallel wires in a circuit.

5 a Circuit F, because it is a parallel circuit and there is more than one path for the current to follow/the resistance is lower in a parallel circuit.

b The current will get less, because the resistance of the circuit is higher/it is harder for the current to flow when there are more bulbs.

c The current will increase, because the overall resistance of the circuit is lower as there is an extra alternative route for the current.

Activity Pack

7Jd-1 Changing the current

1 a voltmeter drawn across the cell

b voltmeter drawn across the bulb

2 a volt

b voltmeter

c resistance

d resistor

3 *students' drawing* of the correct symbol for variable resistor

4 high, low, decreases

7Jd-2 Current in wires

1 *students' own readings*

2 *students' own graph*

3 longer; smaller; more difficult; longer

Current electricity

5 comments could relate to measuring lengths more accurately

6 comments could relate to repeating readings

7Jd-3 Resistance of wires

7 The longest wire had the highest resistance, because the current was the smallest.

8 It is harder for the current to get through long wires than short wires.

9 The longer the wire, the higher the resistance.

7Jd-4 Investigation planning

1 a The current, as the higher the resistance, the lower the current. (A very good answer will also comment on the greater accuracy of measuring current rather than assessing the brightness of a bulb in the circuit.)

b an ammeter

c *Students' own diagrams* showing ammeter connected in series with the wire being tested.

d power pack, connecting wires, crocodile clips, ammeter, wire to be tested, metre rule (accept ruler or tape measure)

2 a Which one has the least resistance (or which has the highest resistance – either interpretation is valid!).

b The length of a wire affects its resistance.

3 Answers may vary, but should include: set up the circuit; get it checked by the teacher; measure the length of wire between the crocodile clips; switch on and measure the current; switch off; measure out a bigger (or smaller) distance between the crocodile clips; switch on and measure the current. A very good answer will also specify five different lengths of wire to be used and give the measurements.

4 a the length of the wire

b the type of wire (i.e. the metal from which it is made), the thickness of wire, the voltage setting on the power pack

5 The shorter the wire, the higher the current, because it should be easier for the current to flow through a short wire than a long one (or expressed as the longer wire having the lowest current).

6 Suggestions such as having the circuit checked by the teacher before switching on, not touching the wires when the circuit is on, and switching off while adjusting the circuit.

7Jd-5 A model for parallel circuits

1 circuit A

2 Half the people would enter at this entrance, so more people would get in.

3 12

4 B

5 There are two ways for the current to flow, so it is easier (the resistance is lower) and so more current flows.

6 Everyone would go through that entrance and no-one would pay to go through the first entrance.

7 It is easiest for the current to go through the top circuit wire because nothing is resisting it.

8 Nearly all of the current flows through the top circuit wire, so little or no current flows through the bulb.

9 It does not help to explain cells or energy transfers.

7Jd-6 Lorry model

1 a The road, as it allows things to move along it.

b The lorries, as they are the objects moving in the model.

c The factory, as this is where the boxes are being transferred.

d The person counting the number of lorries going past, as this is similar to measuring the number of charges that go past.

e The people comparing the loads in the lorries before and after the factory, because this is similar to measuring how much energy has been transferred as the current goes through a component.

f The difference in the number of boxes in the lorries as they go into and come out of the factory.

2 An ammeter is connected in series, so if it had a high resistance it would affect the current it is supposed to be measuring. A voltmeter is connected in parallel, so it needs a high resistance so that hardly any current from the circuit flows through it (if a voltmeter had a low resistance it could effectively cause a short circuit).

3 Answers may vary, but could include: an ammeter does not actually count charges; a voltmeter is a single instrument rather than two instruments whose readings must be compared.

7Jd-7 Voltage and resistance 1

1 a cell, bulb, resistor

b voltmeter drawn across (parallel to) resistor

c voltmeter drawn across (parallel to) cell

d ammeter drawn in series anywhere in the circuit (other than on the voltmeter connections)

2 a amps

b volts

3 The resistance of a resistor is fixed so it stays the same. The resistance of a variable resistor can be changed.

4 B; lowest

5 The ammeter in circuit D, because a parallel circuit has a lower resistance than a series circuit with the same number of bulbs. This makes it easier for the current to flow through a parallel circuit.

7Jd-8 Voltage and resistance 2

1 a B, C, A, D

b D, because it has the highest resistance.

2 a Position A, because the current has to go through almost all of the coil of resistance wire when the slider is in this position.

b 0.25 A – because moving the slider from the middle to the right reduced the current by 0.1 A, so moving it the other way should increase it by a similar amount (or similar explanation).

c any two from: increase the voltage of the supply, reduce the number of bulbs, make sure the bulbs are in parallel instead of series

3 a *Students' own graph* drawn with an additional straight line (labelled 'wire C') that passes through the origin and lies below the original line (labelled 'wire B').

b Wire C has a higher resistance than wire B (as it is thinner) so less current will pass through wire C at the same voltages.

7Jd-9 Resistance in circuits

1 Similarities: both have two bulbs; both have all bulbs controlled by just one switch.

Differences: the first circuit has the bulbs in series, the second circuit has the bulbs in parallel; the parallel circuit will have brighter bulbs; if one of the bulbs in the series circuit breaks the other will go off but if one of the bulbs in the parallel circuit breaks the other will stay on.

2 a Bulb A will be the brightest, as the current in the main part of the circuit is the sum of the currents in the branches, so A must have the highest current through it.

b Bulbs B and C should be the same brightness, as they have the same current flowing through them.

c The resistance of the branch with bulbs B and C in it is greater than the resistance of the branch with only bulb D, so the current flowing through B and C will be smaller, and they will not be as bright as bulb D.

3 a This could model two resistors/bulbs in series.

b The equivalent model for a pair of bulbs in parallel would be to put two ropes on the beam so each person can choose between two ropes and two people can cross at once. This would model the doubling in current produced by putting two bulbs in parallel.

c The rope breaking would be equivalent to a bulb breaking. In the 'series circuit' model, once the rope breaks no more runners can get past. In the double rope model, all the runners can still use the other rope, but not as many will get through in a given time.

Tying up or removing the rope would be equivalent to opening a switch. In the parallel model, either rope could be removed independently of the other.

7Jd Building robots (STEM)

1 a Any sensible suggestion, such as vacuum cleaning, carrying things, controlling the temperature of the house. Future possibilities could include cooking, child care, etc.

b Any sensible suggestion, such as street sweeping, cleaning drains, controlling traffic. Future possibilities could include law enforcement, driving buses, cars or trams.

2 Any sensible suggestions, such as the Arctic/Antarctic, underground caves, the deep oceans, inside volcanic craters.

3 a 1 – eyes, 2 – brain, 3 – hands/feet, or muscles

b 1 – camera or infra-red sensors, 2 – computer

4 Sensor – camera / Deciding on colour – computer program to analyse image / Communication – radio

Activity

Any sensible answers that break the task down into three or four parts.

7Je Using electricity

Student Book

1: 7Je Using electricity (Student Book)

1 It can cause fire, can cause skin burns, can stop your heart/kill you.

2 The electricity may flow through you/you will get an electric shock.

3 a

Wire	Colour
live	brown
neutral	blue
earth	green and yellow

b So they can be connected to the correct places in plugs/sockets.

4 It could cause a fire.

5 The 10 A one; the 5 A fuse would melt/blow if a 6 A current flowed through it and the 13 A fuse might let too much current flow.

6 The apparatus listed should include: power supply/cells, ammeter, variable resistor, connecting wires, fuse wire, heatproof mat. The answer should include: a suitable circuit diagram, and a description of steadily increasing the current until the fuse melts.

7 a If bare wires are showing, someone touching them could get an electric shock or the damage might cause the wires to overheat and cause a fire.

b Cables have two layers of plastic covering the wires. Plugs are fitted with fuses that should melt and cut off the current if it is too high.

2: 7Je A world without electricity (Student Book)

1 a Advantages: we use electric kettles which automatically switch off when they have boiled and toasters which pop the toast up when it is done; without electricity we would have to put a kettle on

Current electricity

the cooker/stove to boil and watch it to remove it from the heat; toast would have to be made under a gas grill/by an open fire and watched to make sure it did not burn.

Disadvantages: the need to take care when using electrical appliances in a kitchen with water about; things may get stuck in the toaster so care must be taken to switch off the toaster before poking around inside it.

b Advantages: we can use automatic washing machines and tumble dryers so the person doing the laundry does not have to be there all the time; without electricity the hot water for washing would have to be produced over a fire or by a gas boiler and the person doing the laundry would have to wash it, rinse it and wring it out; clothes would have to be dried outside on a dry day or indoors on a wet day which could cause condensation inside the house.

Disadvantages: it costs money to buy automatic washers and/or dryers and for the electricity to run them (although heating water for washing would also cost money); if students have done any work on climate change they may also comment that the energy used by the machines is contributing to climate change.

2 The answer will mention lights being on or off together, or a broken bulb resulting in all other bulbs going off. The answer may also include the following: the brightness of bulbs in a house would change as other people switched bulbs on or off; the change in brightness would be linked to changing resistance and changing current.

Activity Pack**7Je-1 Using electricity**

- 1**
- cable grip
 - neutral
 - shock
 - ring main
 - fuse
 - live

2 rings placed around: pool of water beneath kettle; frayed cable on kettle; screwdriver being poked into socket; multiple plugs overloading the socket

7Je-2 Testing fuses

- students' own readings*
- thin; thick
- students' own answers*
- students' own answers*

7Je-3 Ring mains

- 1**
- 3
 - live, neutral, earth
 - live and neutral
 - for safety

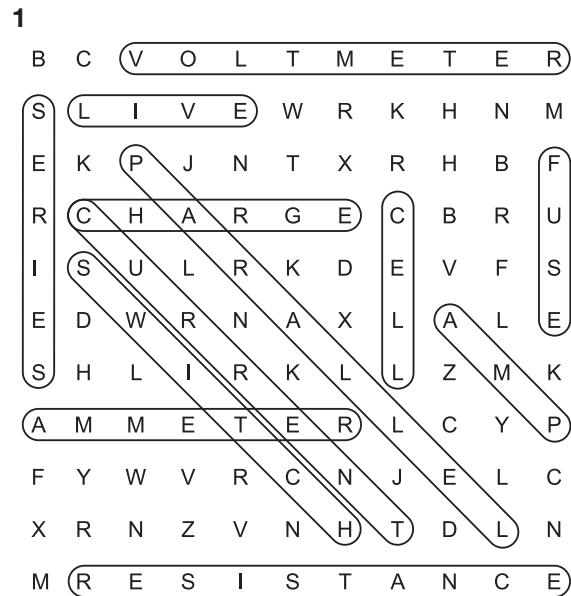
2 Examples could include: cooker; immersion heater; shower; sockets; upstairs lights; downstairs lights (in practice, there may also be separate circuits for sockets in different parts of the house, particularly if a house has been extended, but this information is not given on the sheet) etc.

3

- cooker and immersion heater
- sockets
- lights

b The thickest cable is used for the things that need the highest current, and the thinnest for the things that take the lowest current.

4 so if one breaks the others do not go off; so they can be switched on and off separately; so they do not get dimmer if more are switched on

7Je-4 Electricity wordsearch

2 any sensible clues for the following words: ammeter, amp, cell, charge, current, fuse, live, parallel, resistance, series, switch, voltmeter

7Je-5 Using electricity safely

- clockwise, from top: earth wire, live wire, fuse, cable grip, (blue)
- fuse, earth wire
- So they can be identified and then connected to the correct places.
- The fuse will melt and stop the current flowing.
- Any two sensible rules, such as: never touch the bare metal parts of plugs; never poke things into sockets; keep electricity away from water; don't use switches with wet hands; do not plug too many things into one socket; never use something that has a damaged wire.

7Je-6 Electricity at home

1

- The earth wire (green and yellow) should be connected to (i). The neutral wire (blue) should be connected to (ii). The live wire (brown) should be connected to (iv).

- b** (v) is the fuse. It melts if the current is too high.
c (iii) is the cable grip. It stops the wires being pulled out of the pins if someone pulls on the cable.
- 2 a** The fuse will melt and stop the current flowing.
b If it had a 13 A fuse the current could get as high as 13 A without the fuse melting, which could cause a fire.
- 3 a** a parallel circuit
b So that each socket can be switched on or off independently, and so that the current does not go down when lots of things are plugged in.
- 4** The covers stop young children/people poking things into the socket, which could give them an electric shock.
- 5** If there are wires buried in the wall, drilling into the wires could give him an electric shock. Detecting the wires first helps him to make sure he does not drill into one. (Students may also answer in terms of water pipes, but preventing electric shocks is more relevant to this unit.)

7Je-7 Shocking!

- 1** It causes burns and can affect nerves. It can lead to death.
- 2** A high voltage will give a high flow of current.
- 3** Rubber is a good insulator, so he would have had a higher resistance and so only a very small current may have flowed through him.
- 4** The current could flow through you as well, and give you a shock.
- 5** The boy. The voltage is almost the same at both feet of the bird, so no current will flow through it. The voltage is high at the wire and low at the ground that the boy is standing on, so a high current could flow down his kite string if it touches the wires and then flow through him to the ground.

7K Forces

7Ka Different forces

Student Book

1: 7Ka Forces (Student Book)

1 a answers may include: running events, jumping events (e.g. long jump, high jump), throwing events (e.g. shot, javelin), ball games (e.g. football, cricket, tennis), swimming

b answers may include: rock climbing, mountain biking, skiing, snowboarding, kayaking

2 a gravity **b** friction

3 a one of: friction, air resistance, water resistance, upthrust

b two of: gravity, magnetism, static electricity

4 equipment is better – more friction from shoes, better safety equipment and techniques

2: 7Ka Different forces (Student Book)

1 make it change speed, direction or shape

2 a three of: friction, air resistance, water resistance, upthrust

- b** gravity, magnetism, static electricity
- 3** newtons (N)
- 4 a** the motorbike
b It has a bigger force arrow.
c They will start to move/speed up; the motorbike will accelerate/speed up faster than the bicycle.
- 5 a** the force of gravity pulling on something
b newtons (N)
c the amount of matter in something
d kilograms (or grams) (kg or g)
- 6** Gravity is not as strong on the Moon as it is on the Earth.
- 7** So that they all mean the same thing when they talk about a kilogram; this would be important in replicating experiments (accept similar explanations).

Activity Pack

7Ka-1 Different forces

- 1** change the shape of something, change the speed of something, change the direction of something (in any order)
- 2 a** contact force
b friction
c water resistance
d upthrust
e gravity
f magnetism
g newton
h mass
- 3** any three from: friction, water resistance, air resistance, upthrust
- 4** gravity, magnetism and static electricity

7Ka-2 Forces in action

- 1** attracting, close together, magnetism, they will repel
- 2** friction, easier, wet
- 3** harder, smooth, friction
- 4** bigger, pulling
- 5** First answer depends on the mass of the object; gravity.
- 6** less time, less

7Ka-3 Ideas about forces

- 1** above air (or at the top of everything)
- 2 a** Its natural place is above the Earth but below the air.
b Its natural place is below water.
- 3** Air and water, as it floats between the two.
- 4 a** The force of gravity pulls on it, and there is nothing to stop it falling.
b Upthrust from the water.

7Ka-4 Hazards and risks

- 1 a** To make sure they do not fall very far if they slip off the rock.

b To protect their heads from falling stones. The helmets will also protect their heads if they do fall off and the rope makes them swing into the rock face.

c To spread the force, so the rope does not hurt them if they fall off.

2 a Hang heavy weights on it to find out how much weight it could hold (dynamic testing is needed as well, but students would not be expected to give this response).

b Drop weights on it to find out what kind/weight/speed of object it could withstand without breaking.

c Suspend various weights using the harness, or pull on parts of the harness.

3 A hazard is something harmful that may happen. The risk includes how likely this is to happen and how much harm it would do if it did happen.

4 Some possible answers are:

a Hazards: falling off the bike and getting injured; getting lost; getting too cold/hypothermia.

Reducing risks: avoid very difficult or steep ground where you are more likely to fall off; carry a mobile phone to summon help; carry a map and know how to use it; wear the correct layers of clothing.

b Hazards: capsizing and drowning; getting lost; getting too cold.

Reducing risks: going in suitable sea/weather conditions; wearing buoyancy aids; carry the means to summon help, i.e. flares.

7Ka-5 Forces and mass 1

1 a upwards arrow above either of the people with parachutes open

b Arrow beneath the feet of the person climbing up to the cliff. The arrow should be pointing backwards along the ground (allow either direction – at this level, students are more likely to think of friction acting to oppose the motion of the whole person rather than acting forwards to prevent their feet slipping backwards).

c downwards arrow beneath any of the people or the boat

d arrow from the boat, pointing against its direction of travel

e upwards arrow above the boat

2 a gravity

b magnetism, static electricity

3 a mass

b weight

c weight

d mass

e mass

f weight

g mass and weight

h mass and weight

7Ka-6 Forces and mass 2

1 a Air resistance is acting upwards on both the people falling under their parachutes.

b At level 5: Friction is acting beneath the shoes of the person walking up the cliff.

At level 6: It is acting to stop their feet slipping backwards as they walk, so it is acting forwards along the ground.

c Gravity is acting downwards on everything in the picture.

d Water resistance is acting on the boat, in a direction opposite to the direction of travel.

e Upthrust is acting upwards on the boat.

2 a gravity

b magnetism, static electricity

3 Change the shape of something, e.g. stretching a spring, sculpting using modelling clay.

Change the speed of something, e.g. gravity making something fall, a car accelerating away from traffic lights, brakes slowing down a bicycle.

Change the direction of something, e.g. a car or bicycle going around a bend.

4 Mass is the amount of matter in something, and does not change unless something is added to or taken away from the object. Weight is the force with which gravity pulls on an object, and it depends on the mass of the object and on the strength of gravity.

5 a Eating breakfast is the most likely answer, or carrying your school bag.

b Example answers are going to the toilet, or having your hair cut.

c Increasing mass increased weight, decreasing mass decreased weight.

d Take it to a place with a different force of gravity.

7Ka-7 Measuring masses

1 a The units for weight are newtons, whereas kilograms are the units for mass.

b As gravity is constant, a certain mass will always have the same weight on the Earth. Therefore, even though the scales work by measuring the weight, this will relate to the correct mass.

Alternatively, the fruit/vegetables will be priced per kilogram and recipes will be given in grams, so the information given is still useful and relevant to the customer.

1 a mass

b Food is put in the pan, and different masses are added to the other side until the scales balance. The total of the masses on the right is the same as the mass of the food.

c They compare the weight of the standard masses with the weight of the food in the pan.

3 The scales from question 2. The different gravity on the Moon will have the same effect on the object

being measured and on the standard masses. For the scales in question 1, the weight of the object being measured will be less due to the lower gravity so the pointer will show a smaller mass.

4 a $10 \text{ stone} = 10 \times 14 \text{ lb} = 140 \text{ lb}$

mass in kg = $140 \times 0.454 = 63.56 \text{ kg}$

b $1 \text{ cwt} = 8 \text{ st} = 8 \times 14 \text{ lb} = 112 \text{ lb}$

mass in kg = $112 \times 0.454 = 50.85 \text{ kg}$

c $4 \text{ oz} = 4/16 = 0.25 \text{ lb}$, so $5 \text{ lb } 4 \text{ oz} = 5.25 \text{ lb} = 5.25 \times 0.454 = 2.38 \text{ kg}$

d Standard units allow scientists to have a common understanding, meaning they can share and compare results of their experiments.

7Kb Springs

Student Book

1: 7Kb Springs (Student Book)

1 Something that changes shape when a force is applied and returns to its original size/shape when the force is removed.

2 Y; it is showing the difference between the original length and the stretched length

3 e.g. Set up the apparatus so that the zero on the ruler is next to the bottom of the unstretched spring; add a mass to the spring and measure the extension; add further masses, measuring the extension each time.

4 4 cm

5 a Both materials change shape when a force is applied; an elastic material returns to its original shape when the force is removed but a plastic material does not.

b Any plastic material such as: clay, modelling clay, adhesive tack.

6 a A

b A and C; the graphs are straight lines/the extension is proportional to the force

c A, as it stretches the most for a small weight. This would make the scale easier to read/make it possible to detect small differences in force.

7 The spring in each meter must stretch almost the full length of the meter for the maximum force it is designed to measure. The spring in A must stretch with a force up to 10 N; the spring in B must be stiffer and only stretch that far when a 50 N force is on it.

Activity Pack

7Kb-1 Springs

1 compress

2 stretch

3 a original length

b stretched length

c extension

4 original length, elastic

5 a proportional

b elastic limit

7Kb-2 Investigating stretching 1

3 a a straight line with the extension of the spring increasing with weight applied

b a curved line or S-shaped curve

c They both get longer when more weight is added. The spring stretches equal amounts for each extra weight, while the elastic band does not stretch evenly.

4 a yes

b Springs and elastic bands both stretch when a force is applied to them, but they do not stretch by the same amounts. The spring produces a linear or proportional graph and the elastic band does not.

7Kb-3 Investigating stretching 2

1 *Students' own hypotheses* that make a prediction based on the materials chosen for testing.

2 Method should include: a list of apparatus and a diagram; a description of how it is to be used; the materials to be tested; safety suggestions such as using a box beneath the weights to stop them falling on feet; suggestions that measurements should be repeated to improve accuracy.

6 b Springs and wires should give a linear graph up to the limit of proportionality (eventually snapping when the load was too heavy).

Elastic bands or rubber strips produce S-shaped curves.

Other materials such as nylon rods will produce more complex graphs, often showing straight lines up to the elastic limit.

7 Conclusions should describe the different shapes of graph obtained, and state which materials have been stretched past their limits of proportionality/elastic limits.

7Kb-4 Make a force meter

2 Suggestions could include: repeating the measurements to check there are no errors; using a weaker spring that stretches further for each addition of force; ensuring that any bouncing of the weights has stopped before measurements are taken.

3 a The extensions will be incorrect if the spring has been permanently stretched beyond its elastic limit.

b The spring will be permanently stretched and it will not be possible to make any more measurements with it.

7Kb-7 Stretching springs 1

1 missing units for weight, N

2 correctly plotted graph showing a linear relationship

3 The larger the weight, the longer the spring.

4 The missing values are (going down the table): 2, 6, 3, 9.

7Kb-8 Stretching springs 2

1 The missing extensions are: 4, 8, 12, 16, 20.

2 correctly plotted graph – the graph should show a straight line

3 0–10 N. Some students might point out that, as a limit of proportionality has not been reached, the range could be greater than this.

4 A – 1 N; B – 9.5 N; C – 2.25 N; D – 3.25 N

5 200 g is a mass, not a force; they added masses, not weights.

7Kb-9 More than one spring

1 They will all have twice the extension as before (A = 10 cm, B = 5 cm, C = 20 cm), as the extension is proportional to the force and the force has doubled.

2 The bottom spring will have an extension of 5 cm and the top pair will have an extension of 2.5 cm, so the total extension will be 7.5 cm.

3 10 cm – it will act in the same way as two springs arranged as in C.

4 a E will extend by 5 cm. The 30 N is shared between the three springs, so each effectively has only 10 N on it.

F will extend by 45 cm. Each spring has 30 N on it, and so each one will extend by $3 \times 5 \text{ cm} = 15 \text{ cm}$.

b That the limit of proportionality/elastic limit has not been exceeded.

5 a To make the ride more comfortable by preventing bumps in the road from jolting the rider.

b The single spring would have to be mounted in the middle. The spring would also have to be stiffer. With the current arrangement each spring is subject to half the force/the force is spread out between two springs. A single spring would have to cope with all the force, and if it were of the same stiffness it would compress by twice as much as the current arrangement.

7Kc Friction

Student Book

1: 7Kc Friction (Student Book)

1 *Students' own answers*, e.g. a car parked on a hill with its handbrake on.

2 They increase friction between your feet and the bath, so they stop you slipping.

3 a To reduce friction and make the bicycle go faster.

b Oil reduces the friction between the brake blocks and the wheel so the brakes would not work.

c Rain acts like a lubricant and reduces the friction between the brake blocks and the wheel.

4 Cars need high friction between the tyres and the road to allow the tyres to grip the road for moving the car, steering and braking. Water can act as a lubricant between the tyre and the road, reducing the friction and allowing the wheels to spin or to skid.

5 a Rubber tyres wear away due to friction between them and the road.

b They are used at faster speeds, so wear away faster. They also tend to be made from stickier compounds, which wear away faster (students are not expected to know this).

6 oil it

7 three of: slow down the movement, produce heat, make noise, wear the objects away

8 Examples of suitable answers are: friction between soles of shoes and the ground allows you to walk; friction between pencil lead and paper rubs off some of the lead and allows you to write; friction between your hand and a glass allows you to lift it; friction between you and a chair allows you to lean back in a chair without sliding off.

9 The stories should include descriptions of three different effects of the absence of friction, such as: what would happen when your feet could not grip the floor, your hands could not grip food containers to let you eat, tyres could not grip the road to steer or to slow down.

Activity Pack

7Kc-1 Friction

1 a useful

b useful

c not useful

d not useful

e useful

2 lubricants

3 a increase friction

b decrease friction

c decrease friction

d decrease friction

e decrease friction

4 heat, noise (either order), wear

7Kc-2 Investigating friction 1

4 500 g, 0 g

5 greater, greater, greater, greater, or smaller, smaller, smaller, smaller

7Kc-4 Friction – true or false?

True statements: C, D, E, F, H, J (you could use a straw).

False statements: B (if there were no friction at all, the car would keep moving without needing the tyres to push on the road); K, M, N.

Partly true statements: A – the friction from moving air (wind) or water can start things moving.

G – Water resistance is not useful for moving a ship, but there will be some parts of the machinery in a ship that would not work without friction.

I – You could pick up the cup if you hooked a finger through the handle, but you would probably spill a lot of the tea!

L – It is useful in some places but not in others.

7Kc-5 Hovercraft

1 The hovercraft would sink down onto the surface, because all the air would leak out from under the skirt.

2 When the lift fans are off the hovercraft is touching the ground so there is a lot of friction. When they are on, there is air between the hovercraft and the ground so the friction is much less.

3 At level 4: The grease reduces the friction and allows the propellers to spin freely.

At level 5: Without grease the axle would rub against its mounting, and this would increase wear, reduce the speed at which the propellers spin, and cause the axle to heat up.

4 a The hovercraft does not touch the surface, so driven wheels would not work on land. A propeller sticking down into the water might be possible, but this would then remove the advantage of being able to move over lots of different surfaces.

b Friction between a car's tyres and the road stop the car from skidding sideways while it is turning (unless on an icy road!). There is nothing under the hovercraft in contact with the surface to stop it skidding sideways, so its turning circle is quite big (especially if it has been going fast).

5 a So it can go over bumps and adjust to different surfaces.

b The air inside it might leak out and the hovercraft would not hover.

6 Aeroplanes land and take off on runways. People are kept away from runways, and normally only a few people are around parts of airports where they may come into contact with aeroplanes with their engines running. Hovercraft can operate over any flat surface, so there must be safety measures to stop people putting hands (or themselves) into the path of the blades.

7 The hovercraft can be used when the tide is in or out. If they did not have a hovercraft the RNLI would have to use a boat when the tide was in, and might not be able to rescue people from the mud at all when the tide was out, as even vehicles with tracks might sink in the quicksand.

7Kc-6 Useful or not?

A Useful friction: between tyres and floor; between hands and wheel rims; between hands and ball.

Not useful: in axles of wheelchairs.

Increase useful friction by: using stickier rubber for tyres; making the floor rougher; making the wheel rims rougher; wearing gloves with a rubber surface; making the surface of the ball rougher.

Decrease friction in axles by oiling/lubricating them.

B Useful friction: between the dog's feet and the snow; between the man's boots and the sled runners he is standing on; between the man's hands and the sled.

Not useful: between the sled runners and the snow.

Increase useful friction by: giving the dogs little 'boots' with rough treads; the man wearing boots with soles made from stickier rubber; making the tops of the runners/the sled handle rougher; wearing gloves with a 'sticky' surface.

Decrease friction: make sure the runners are smooth; wax the runners.

C Useful friction: between the man's skis and the snow; between the man's hands and the poles.

Not useful: between the sled's runners and the snow.

Increase useful friction by: having rough surfaces on the bottom of the skis (although this will then be a disadvantage when he goes downhill); making the grips on the poles or the man's gloves from a fabric with a rubbery or 'sticky' surface.

Decrease friction: make sure the runners are smooth; wax the runners.

D Useful friction: between the climber's shoes and the rock; between surfaces of the rope where it is knotted; between the rope and the belaying device/belayer's hands (the belayer is the person at the bottom controlling the rope).

Not useful: between the rope and the ring (actually called a carabiner) that it runs through at the top of the drawing.

Increase useful friction by: making the shoes out of a stickier rubber; giving the rope a rougher surface; belayer could wear gloves with a 'sticky' surface.

Decrease friction: giving the rope a smoother surface; making sure the ring at the top has a smooth surface.

7Kc-7 Friction and sport

1 Low, so he can go faster. High friction would slow him down.

2 Between her hands and feet and the cliff-face, to help them to grip the rock.

3 a Circles around: the points where the wheels touch the ground; the rider's feet are on the pedals; where he contacts the seat and handlebars; and where the brake pads meet the rim of the wheels. Friction is needed to provide grip.

b Squares around wheel hubs and axles. Low friction is needed to allow the wheels to turn easily.

c oil or grease them

7Kc-8 Mountain bikes

1 a So the rider's feet can easily touch the ground – more likely to be needed when riding over rough ground than on a road bike. Saves injury to delicate parts!

b To smooth out the bumps from riding on rough ground.

c Going over bumps is more likely to create forces that damage the bike, so it needs to be stronger.

d More grip in muddy conditions.

2 It has things such as suspension that ordinary bikes do not, and the stronger frame is likely to be made of thicker tubes, so will be heavier.

3 They are heavier (which makes them slower and harder to ride, particularly uphill). Other reasons that students would not be expected to give include the fact that rougher tyres increase resistance to motion, and smaller wheels make it harder to ride fast.

4 One from: Rims are more likely than the centres to get wet/muddy, which would reduce the friction. They are also more likely to get damaged, which would reduce braking force.

5 a New materials and technology made it possible to make strong enough bikes that could cope with rough terrain. There are likely to be sociological reasons too, such as the increasing emphasis on leisure activities, but students would not be expected to know this.

b The chain needs to bend around the gears and then straighten out again during use, so the links in the chain need to be able to move freely. 'Wet lube' stays wet after it is applied. It stays on better in wet conditions (i.e. it is not washed off by rain or by riding through puddles), but as it stays wet it also allows dirt and grit to stick to it, which can get into the moving parts of the chain and make them stiffer/make them wear out faster. 'Dry lube' goes on wet but then dries, so it does not let dirt stick to it. The disadvantage of dry lube is that it is easily washed off by rain/puddles.

7Kc-9 A curling question

1

Weight of stone (N)	Force needed to move stone at steady speed (N)
20	0.40
40	0.80
60	1.20
80	1.60
100	2.00

2 correctly plotted graph

3 1.4 N

4 To make the results more accurate and so they could spot any mistakes.

5 The 20-N stone – it needs the smallest force to keep it moving, so it must have the least friction beneath it.

6 It acts as a lubricant.

7 The sweeping makes sure the ice is smooth, so friction is less. If the sweeping is hard/fast enough, friction makes some of the ice melt, which acts as a lubricant.

7Kd Pressure**Student Book****1: 7Kd Pressure (Student Book)**

1 It should have wide tyres. The greater area of the tyres makes the pressure lower, so the car is less likely to sink into the sand.

2 It will get less, because the same force with a larger area gives a lower pressure. (A higher-level answer might point out that the person's weight is likely to increase slightly with a larger pair of snowshoes, but the effect of this should be less than the effect of the increased area, so the pressure will be reduced.)

3 a The sharper the point, the smaller its area and the greater the pressure. This means that with a sharper point a smaller force is needed to achieve the same pressure so it is easier to push the pin into the wall.

b The force on your finger/thumb is the same as the force pushing the pin into the wall, so the area needs to be much larger than the point of the pin so that the pressure on your finger is small enough not to damage the skin.

4 Apparatus – scales, squared paper; draw around your shoes and count squares to work out the area; measure your weight and calculate pressure by dividing weight by total area of both shoes.

5 $\text{pressure} = \text{force} \div \text{area} = 800 \text{ N} \div 2400 \text{ cm}^2 = 0.33 \text{ N/cm}^2$

6 The tracks have a large area, so the pressure under them is low; this stops the snowmobile from sinking into the snow. The area of the spikes is small, so the pressure under them is high. The spikes will sink a little way (until the main part of the tracks comes into contact with the snow) but the high pressure will also allow the spikes to grip if the snowmobile is moving over ice.

2: 7Kd SI units (Student Book)

1 a metres **b** metres squared **c** seconds

2 a millimetres or micrometres **b** kilojoules
c kilometres

3 a *Students' own answers*, such as: science is carried out in different countries and it is important that scientists can reproduce/replicate/understand what other scientists have done.

b If everyone in a particular place is using the same set of units, there will be no problems. Using

a common/understandable set of units is more important when people in different places buy and sell goods or exchange information.

Activity Pack

7Kd-1 Pressure

- large, low
 - small, high
 - small high
 - large, low
 - bigger, smaller
 - smaller, bigger
- 360, 600, area, 600 N, 360 cm², 1.67 N/cm²

7Kd-2 Pressure on your body

- doubled
 - bigger

7Kd-3 Different units

- height of a double-decker bus
 - volume of an Olympic swimming pool
 - length of a football field
 - area of Wales
- the first caption (28 000 km²)
 - the second caption as it is easier to visualise/ imagine
- $304/4.5 = 67.6$ double-decker buses (or 'nearly as high as 68 double-decker buses')
 - $500/(90-120) =$ between 4 and 5 football pitches
 - $100\ 000/2500 = 40$ Olympic swimming pools
- It helps to give people an idea of the size of the measurement given. People may not know how big 20 000 km² is, but they do know that Wales is a large area.
 - The things that the unusual units are based on are not always of a standard size. For example, not all football pitches are the same length. They are also not very useful for scientists or engineers, who need to be sure they are using the same standard set of units.
 - It is a standard set of units that everyone uses, so there is no confusion.

7Kd-4 Wintry calculations

- pressure = force/area = $500\text{ N}/170\text{ cm}^2 = 2.94\text{ N/cm}^2$
 - $500\text{ N}/(2 \times 170\text{ cm}^2) = 500/340 = 1.47\text{ N/cm}^2$ (or just pressure = $2.94/2 = 1.47\text{ N/cm}^2$)
 - The pressure under one foot, as you do not have both feet fully on the ground at the same time when you are walking.
- $500\text{ N} = 50 \times 10\text{ N}$, so the area of each snowshoe should be $50 \times 14\text{ cm}^2 = 700\text{ cm}^2$
 - pressure = force/area = $500\text{ N}/700\text{ cm}^2 = 0.71\text{ N/cm}^2$

c snowshoes C as their area is closest to the ideal area

d She doesn't need a bigger area to stop her sinking, and they will be heavier/more awkward to use.

3 a pressure = $500\text{ N}/1.5\text{ cm}^2 = 333.3\text{ N/cm}^2$

b The points will sink into ice/snow and stop her slipping.

4 She has the same weight and as the crampon points have a smaller area, the pressure under them will be higher.

7Kd-5 A winter walk 1

1 a The following are underlined: they are big things we strap to our boots and they stop us sinking in the snow; skiing down the hill; put a ladder down on the ice and crawled out along it.

b The following with boxes drawn: the snowshoes have little spikes underneath; spikes strapped to their boots; ice axes that they dug into the ice; knife to cut the chocolate.

2 a area bigger

b area smaller

3 spikes circled

4 It has a thin edge, so the pressure under it is high (or it concentrates the force).

5 It spread out his weight so the pressure under him was less and did not break the ice.

7Kd-6 A winter walk 2

1 a The pressure needs to be low if someone is walking on soft snow, to stop them sinking in. The pressure needs to be high on ice for grip, so spikes stick into the ice.

b They reduce the pressure by having a large area. They increase the pressure by having spikes with small areas beneath them. On ice, only the spikes will make much contact with the surface, so there is high pressure beneath the walker. In soft snow, the spikes will just sink into the snow until the main large area of the snowshoe touches it, so the pressure will be low.

2 Spikes and ice axes both have sharp points, which produce high pressure (by concentrating the force of the climber's foot kicking into the ice or the axe digging into ice) so the points go into the ice and give them a grip.

3 They were on very hard snow and needed something sharp to put a lot of pressure onto the snow so it would dig into the snow and act like a brake.

4 The boy fell through the ice because the pressure beneath him was too great for the ice to support. Although the man was heavier, his weight was spread out a lot more by the ladder, so the pressure under him and the ladder was small enough not to go through the ice.

5 Pressure being decreased: sledges and skis.

Pressure being increased: people not wearing snowshoes; knife cutting chocolate.

6 They have a large area so reducing the pressure on the snow and they are smooth underneath so reducing the friction.

7Kd-7 Tyres and pressures

1 a $\text{area} = \text{force}/\text{pressure} = (700 \text{ N} + 90 \text{ N})/760\,000 \text{ Pa} = 0.00104 \text{ m}^2$ (or 10.4 cm^2)

b $\text{area} = (700 \text{ N} + 130 \text{ N})/170\,000 \text{ Pa} = 0.00488 \text{ m}^2$ (or 48.8 cm^2)

2 The mountain bike needs a lower pressure to stop it sinking into mud or soft ground, so the tyre pressure is lower. (The high pressures typically used for road bikes reduce the energy wasted in flexing the tyre, but students are not expected to know this.)

3 $\text{force} = \text{pressure} \times \text{area} = 550\,000 \text{ Pa} \times 0.0015 \text{ m}^2 = 825 \text{ N}$

4 $\text{pressure under the tyres of the quad bike} = 4000 \text{ N}/0.083 \text{ m}^2 = 48.2 \text{ kPa}$

$\text{pressure under off-road vehicle tyres} = 26\,000 \text{ N}/0.113 \text{ m}^2 = 230.1 \text{ kPa}$

The off-road vehicle is more likely to sink into mud, as there is a higher pressure under its tyres.

7Ke Balanced and unbalanced

Student Book

1: 7Ke Balanced and unbalanced (Student Book)

1 a The pulling force from the man is the same size as the force from the mule.

b It will start to move (backwards).

2 a apply the brakes

b It will make her slow down.

3 The friction forces will then be bigger than the pulling force, so the sled will begin to slow down.

4 The weight will be stronger than the force from the spring, so the mass will move downwards. When the spring has stretched further, the forces will be balanced again and the force meter will show the new weight.

5 a The forces are balanced.

b The weight of the man will be less, so the tightrope will not stretch as much and will push up with a smaller force.

6 If the object speeds up as you drag it, the force you are putting on it must be bigger than the friction force, so the reading on the force meter will be bigger than the amount of friction. If the object is slowing down, the reading on the force meter will be less than the amount of friction.

7Ke Designing structures (STEM)

1 a Answers could include classrooms, toilets/washrooms for students and for staff, assembly hall, gymnasium or sports hall, changing rooms,

dining rooms, kitchens, staff rooms, storerooms, science prep room, offices for teachers, offices for head teacher and other staff, corridors, staircases.

b Possible answers include: Does the bigger school need twice as many rooms of all sorts? How will all the extra rooms be arranged? Will the corridors/stairs be wide enough when twice as many students are moving around? Will the distances between different classrooms be too long for students to get from one to another on time? Will twice the number of people be able to leave the building safely if there is a fire?

2 a Possible answers include: How wide is the gap the bridge has to cross? What is the ground like under the bridge? How far above the solid ground/water does the bridge have to be? How many people/cars/lorries will cross the bridge? How wide must it be?

b Possible answers include: How many shops will there be? How big do the shops need to be? Do they need storerooms as well as the parts where customers view the goods? Are cafes and restaurants needed? How many people will use the mall? How many washrooms should there be? Do all the shops need to be under cover? How many car parking spaces should there be? How many fire exits are needed, and where should they be?

3 Large buildings and bridges are complicated objects, and a lot of work is needed. It would take too long for a single person to do it. Also, having a team of people means that a greater range of skills can be brought together to work on the design.

4 a If members of a team use different units, different parts of the building/structure may not fit together, or may not be strong enough. They may order/buy the wrong quantities of materials.

b Using a convention for symbols makes sure everyone working on the project can understand which units are being used.

3: 7Ke Safety standards (Student Book)

1 a The stretchiness will stop them being jolted when the rope takes their weight.

b It might stretch so much that they hit the ground anyway.

2 a So they can go faster – friction and air resistance both act to slow down the skier, so if the friction can be made smaller, they will be able to go faster.

b Any three examples, such as: between climbing shoes and rock, between mountain bike tyres and the track, between brake blocks and wheel rims.

3 If a climbing rope were not made to the correct standard, someone relying on it could be hurt or killed. If ski wax is not made to the right standard, skiers may not go quite so fast but they will not be harmed.

4 a If they were going to ski on very soft snow, they might want bigger skis to make sure they did not

sink in. The bigger area of the skis means there will be a lower pressure underneath them.

b *Students' own answers*, such as: beneath crampon points in mountaineering to grip on the ice, under the end of a ski pole used by a slalom skier

5 a There is an upwards force from the rope and a downwards force from gravity/weight. The two forces are balanced, so the climber does not start to move.

b Gravity is pulling the climber downwards. He will start to move down. When the rope becomes tight it will start to stretch. As it stretches it will exert an upwards force on the climber. The more it stretches the greater this force will become, until eventually it is the same size as his weight. At this point the two forces will be balanced. Students may also state that when the forces become balanced the climber is already moving downwards, so his speed will not immediately change. Further movement will stretch the rope further and increase the upwards force, so that the climber begins to fall more slowly. Eventually the force from the rope will be big enough to make him stop falling and start to move upwards. Eventually he will become stationary at the point where the force from the stretched rope balances his weight.

Activity Pack

7Ke-1 Balanced and unbalanced forces

1 An object has balanced forces on it ... when there are two forces of the same size in opposite directions.

Unbalanced forces on an object ... can make it speed up/can make it slow down/can change the direction it is moving in.

Balanced forces on a stationary object ... will not make it move.

Balanced forces on a moving object ... will not change its speed or direction.

2 a A forward arrow labelled 'force from dogs', the same size as the rearward arrow.

b The rearward arrow labelled 'friction'.

c Arrows labelled 'friction' (rearward) and 'force from dogs' (forward), with the friction arrow larger than the forward arrow.

7Ke-2 What will happen?

1 A – No vertical movement, horizontal speed will continue at 5 m/s.

B – No vertical movement, diver will start to move forwards.

C – Diver will start to move downwards, no horizontal movement.

D – No vertical movement, diver will slow down.

E – No vertical movement, diver will continue to move at 2 m/s.

F – Diver will start to move up, diver will continue to move horizontally at 2 m/s.

2 *Students' own situations*. Check that the description of the movement matches the forces shown.

7Ke-3 Forces and movement

1 a He thought that a force was needed to keep moving objects moving.

b He thought that things would keep moving if there were balanced forces on them (or no forces).

2 a He made some observations and thought about them.

b He carried out experiments.

c Galileo's

3 a Any moving thing needs a force to keep it moving.

b You need to keep pedalling to balance the friction forces that act to slow you down.

4 a It will slow down.

b Answers may vary. One would be no, because the forward force has been removed but the bicycle is still moving (even though it is slowing down).

c Yes, the friction forces are making the bicycle slow down.

7Ke-4 Modelling forces

1 the names of the forces and the fact that there are two different forces acting backwards

2 the speed at which the cyclist is already moving

3 where the friction occurs; forces acting on the bike in a vertical direction

4 Answers may vary, but should be accompanied by explanations. Possible answers are:

a A (as you only need to know the total force in each direction) or C (as A, but it may also be useful to know the speed of the bike)

b B (if you are only thinking about the horizontal movement of the bike, this shows the three types of force involved) or D (this also shows forces in a vertical direction)

c D (as this shows the origins of the friction forces)

5 Answers may vary.

a A or C are fine for this use.

b Diagram similar to D, but with all the friction forces combined into just one arrow might be more use. The arrow on D representing the speed is not necessary.

c Diagram showing only the locations of the friction and air resistance forces would be more useful similar to B; D has too much information on it.

7Ke-5 Springs and bungee jumps

Force meter:

B, F, G, with a down arrow and the smallest up arrow

A, D, I, with a down arrow and the medium up arrow

C, E, H, with equal-sized up and down arrows

Sound

Bungee jump:

c, g, q, l, with a down arrow

b, h, k, n, with a down arrow

e, j, r, s, with a down arrow

d, f, t, m, with a down arrow

a, i, p, o, with a down arrow

7Ke-6 Changing speed 1

1 a Dinesh

b Al

2 The forces are balanced.

3 Nothing. There are no forces acting to move him forwards or backwards.

4 He will speed up. The forwards force is bigger than the backwards force.

5 He will slow down. There is only a backwards force.

6 It will stay the same. The forces are balanced.

7 Friction and air resistance.

7Ke-7 Changing speed 2

1 Al will stay still. There are no forces shown.

Bev will continue to move at 7 m/s, as the forces are balanced.

Charlie will speed up, as the forwards force is bigger than the backwards force.

Dinesh will slow down, as there is no forwards force at all.

Ellie will continue to move at 6 m/s, as the forces are balanced.

2 Charlie. He will carry on speeding up, whereas all the others are at a constant speed, slowing down or not moving.

3 a gravity

b No – she has the same mass in each drawing and therefore the same weight.

c friction

4 A – balanced – she is not moving. B – unbalanced – she is speeding up. C – balanced – she is moving at a steady speed.

5 a Any two examples of stationary objects with balanced forces, such as: a mass hanging from a force meter (weight and force from spring); a boat floating on a pond (weight and upthrust); a dog pulling against a stationary lead (force from dog, force on lead).

b Any two examples of an object moving at constant speed, such as: a car moving at a constant/stated speed (force from engine, forces of friction/air resistance); downhill skier (weight, friction and air resistance forces).

7Ke-8 Climbing ropes

1 Gravity and some air resistance.

2 a Gravity and a force from the rope.

b unbalanced

c She will still accelerate downwards, but not as much as before.

3 balanced

4 a Yes. She is still moving at D, and the balanced forces will not change her speed.

b It will get bigger.

c It will slow her down.

5 a further

b She might hit the ground before the rope stopped her.

6 a She would stop suddenly. She might be injured by the sudden stop.

b It would probably hurt!

7L Sound**7La Making sounds****Student Book****1: 7La Animal sounds (Student Book)**

1 a answers may include: talking, beeps at pedestrian crossings

b answers may include: car horns, reversing alarms

2 hummingbird is quieter; hummingbird makes noise with wings, not voice; hummingbird is not making the noise deliberately

3 two of: talking/singing/humming; whistling; clapping; belching, passing wind

4 a make the strings vibrate

b use different strings/make the strings different lengths

c pluck the strings harder for louder notes

5 elephant – low notes are made when large objects vibrate; as an elephant is larger than a mouse, it should be able to make the lowest noises

2: 7La Making sounds (Student Book)

1 any four animals, such as: whales, lions, elephants, dogs

2 movements backwards and forwards

3 a 500 Hz b The sound will have a higher pitch.

4 The noise made by the bee hummingbird will have a higher pitch than the noise made by the giant hummingbird because the bee hummingbird's wings move at a higher frequency.

5 a Lower sounds are made when larger objects vibrate, so the one making the lowest sound is likely to be bigger than the other one.

b It can hit its chest harder.

6 Listen to/find recordings of the sounds made by different animals and find the size of the animals. See if there is a link between the size of the animal and the pitch of the sound it makes.

Activity Pack**7La-1 Making sounds**

1 a Vibrations

b Volume

- c Pitch
- d Frequency
- e Hertz
- f Amplitude

- 2 a louder, amplitude, bigger
b lower, longer
c slowly, lower, lower

7La-2 Changing the pitch

- 1 air
2 The more water, the higher the sound (as there is less air to vibrate).
3 The same shape bottle, and blow the same way each time.
4 Longer nails should give lower sounds.
5 Longer chimes should give lower sounds.
6 Drop all from the same height onto the same surface.
7 Longer pieces of wood should make lower sounds.
8 Thicker bands should give lower sounds (although this depends on the tension being the same).
9 When the part of the ruler vibrating is longer, the sound is lower.
10 The longer the object vibrating, the lower the frequency and the lower the sound.

7La-3 Bird calls

1 a Either mass or length would be appropriate. Wingspan does depend on the 'size' of the bird to some extent, but some birds have long, thin wings whereas a different bird of similar mass might have shorter, deeper wings. So, wingspan does not necessarily indicate the overall size of the bird.

b Length – bigger objects make lower sounds when they vibrate, so the length of the bird might indicate the possible length of the vocal folds (birds do not have quite the same mechanism as mammals, but students are not expected to know the details).

Mass – the larger the bird, the heavier it is likely to be, so mass is also a reasonably good indicator of overall size.

c Suggestions are likely to include taking the mid-point or finding an average.

2 a If pitch depends on size, there should be no birds in the top left and bottom right parts of the table. However, this may depend on where students decide to draw the line between large and small birds, and between high and low pitch.

b If pitch depends on size, the birds in the two columns will be in the same (or very similar) order.

3 *Students' own answers.* Suggest looking at birds of different sizes, and several birds for each size category.

4 Sample results based on the list of birds given on the worksheet. Note that in A results may vary depending on how the birds are divided into large and small, whereas in B rank order may vary as ranking the pitch of the calls is subjective, and may also depend on which recording is used.

A

	Large birds	Small birds
High pitch	heron, red kite, buzzard	wren, robin, swift, blackbird
Low pitch	raven, tawny owl	jackdaw

B

In order of size	In order of pitch
wren	red kite
robin	robin
swift	swift
blackbird	wren
jackdaw	buzzard
tawny owl	heron
raven	blackbird
red kite	jackdaw
heron	raven
buzzard	tawny owl

5 Students are likely to find that the hypothesis is not correct – most small birds do have high-pitched calls, but larger birds can have high or low-pitched calls. (In particular, birds of prey often have high-pitched calls.)

6 Answers may depend on the particular birds investigated, but students should conclude that generally small birds have high-pitched calls, but larger birds can have high or low-pitched calls. Explanations for this could include that the vocal apparatus of a bird needs to be of a certain size to make low notes, but even a large bird can have smaller vocal apparatus/make higher sounds. Thus the lowest sound made by a bird is limited by its size, but not the highest sound.

7 Looking at the correlation between the head size (or throat size) of a bird rather than its overall size/mass would be more relevant.

7La-4 Octaves and frequency

1 High-pitched sounds are produced by objects that vibrate with a high frequency. Low-pitched sounds are produced by objects that vibrate with a low frequency. Examples of high-pitched sounds are those produced by a piccolo or a squeaking mouse. Examples of low-pitched sounds include thunder and the double bass.

2 The higher the frequency of the vibrations, the higher the pitch of the sound.

3 a 256 Hz and 1024 Hz

b 880 Hz and 220 Hz, respectively

Sound

- 4 a** any two instruments with overlapping frequencies such as flute and violin
b examples include bass voice and soprano voice, piccolo and sitar
c the harp
- 5 a** two octaves
b 15 notes
c air (and the wood)

7La-5 Cut out the cards

- 1** lion, gorilla
2 gorilla
3 grasshopper
4 lion, gorilla, grasshopper, canary
5 grasshopper, canary
6 lion, gorilla
7 pitch, frequency
8 amplitude, loudness, intensity, volume
9 frequency
10 amplitude
11 loudness, volume
12 frequency

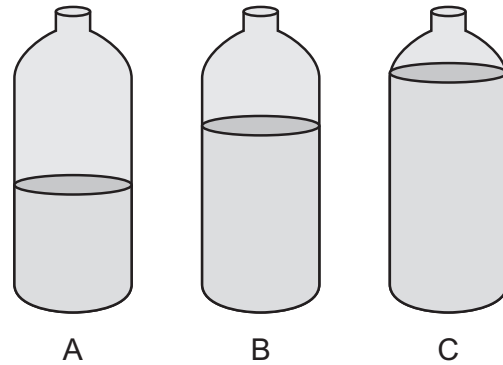
7La-6 Describing sounds

- 1** Across: 3 – low; 5 – high; 6 – amplitude.
 Down: 1 – volume; 2 – frequency; 4 – pitch;
 5 – hertz.
- 2 a** hit it harder
b The amplitude is larger.
- 3 a** X will have a lower pitch.
b Y
c Shorter objects vibrate with higher frequencies.

7La-7 Different sounds

- 1 a** A, C and E
b A, D and F
c B, C and G
- 2** Each test needs to be a fair test, so the variable being investigated must be the only thing that is different between the tubes. So for **1 a**, the tubes are all the same material and same diameter, they only have different lengths.
- 3 a** The longer the tube, the lower the frequency (or the shorter the tube, the higher the frequency).
b The diameter of the tube does not affect the frequency of the sound it makes.
c The material of the tube does not affect the frequency of the sound it makes.
- 4** High frequencies make high-pitched notes, so the shortest tubes (A, D and F) will make the highest-pitched note.
- 5** Bottle X will make the highest note, because the length of air that can vibrate is shorter.

- 6** The exact levels of the water shown do not matter, as long as the relative amounts are correct. Order of notes: A, A, B, B, C, C, B

**7La-8 Concert pitch**

- 1** a group of musicians who play music together
- 2** The air inside the oboe makes 440 complete vibrations in one second. That is, the frequency of vibration is 440 Hz.
- 3** So that the instruments are playing the correct notes as written by the composer. Failure to do this would lead to the wrong notes being played and an incorrect reproduction of the intended music. It is also important that all the instruments are playing to the same standard, otherwise the music will sound discordant/unharmonic (accept 'not right!').
- 4** The oboe is the instrument that holds its pitch most consistently.
a stringed instruments, woodwind, brass and percussion
b Stringed instruments – vibrations of the strings, e.g. violins; woodwind – vibrations of air or a reed e.g. flute; brass – vibration of air, e.g. trombone; percussion – vibration of drum skin or vibration of metal, e.g. kettle drum.
c percussion
- 6 a** *Students' own responses*, e.g. tuba, bassoon, double bass.
b All the instruments produce low-frequency sounds.
- 7 a** French concert pitch in 1859
b the audience's favourite concert pitch in 1859
c the concert pitch used by Mozart and Handel
d the London Philharmonic Orchestra concert pitch in 1896
e concert pitch today
- 8** *Students' own responses*, e.g. No, because they used science to work it out. Yes, because they were only trying to change it because existing pitch had been set by the French!

7Lb Moving sounds**Student Book****1: 7Lb Moving sounds (Student Book)**

1 In solids the particles are close together and held in a fixed arrangement by strong forces. In liquids the particles are close together and held by fairly strong forces but they can move around within the liquid. In gases the particles are a long way apart and can move around freely.

2 The sound passes through the air in one helmet then through the solid helmets to the air in the second helmet.

3 X, because the amplitude is greater/the particles are moving further as the wave passes.

4 The particles are closer together so it is easier for the vibrations to be passed on.

5 a There is just one metal in the table and only two other solids. There are not enough examples here to be able to tell whether or not this statement is correct.

b Find out the speed of sound in a lot of different metals and in a lot of different non-metallic solids.

6 Your hands/the cone make all the sound waves move in one direction, so they do not spread out as much and the sound will still be loud enough to hear at a greater distance. This means the energy is concentrated compared with shouting without the cone/hands, so the sound is louder at a given distance.

7 a The disturbance passes along it without the slinky itself moving as a whole, just as vibrations pass through materials without the medium as a whole moving; the vibrations are in the same direction as the wave is travelling, as for sound waves.

b Answers may include: it is much larger than the particles that move as sound waves pass; the vibrations/disturbance moves much more slowly than in sound waves; the vibrations are bigger than the vibrations that form sound waves; particles are not rigidly connected to each other like the coils of the slinky.

2: 7Lb Line graphs and scatter graphs (Student Book)

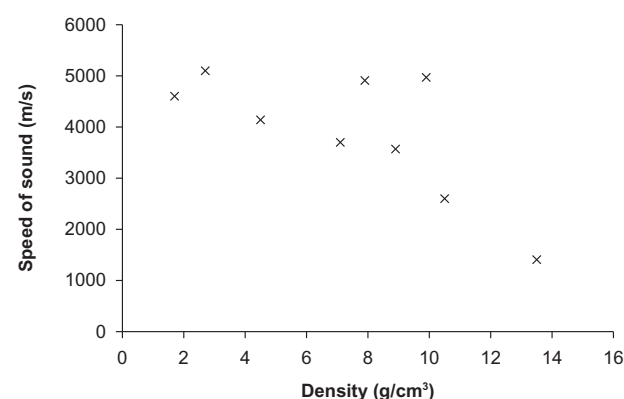
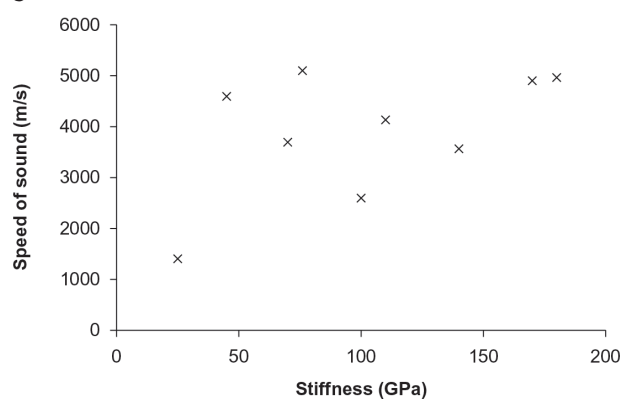
1 a The coil is in its original position. **b** 3 cm

2 The peaks and troughs would be at the same times but would be closer to the horizontal axis (i.e. have a smaller amplitude).

3 The speed increases as the temperature increases.

4 A sketch with points scattered in a generally upwards direction and a sketch with the points scattered in a generally downwards directions - like

the two plots for question 5. Students may have attempted to draw lines of best fit through the points.

5

a The graph of speed against stiffness shows that there is not a direct relationship (as there was with speed of sound in air and temperature), but that in general the speed of sound increases when the stiffness increases. The graph of speed against density also shows no direct relationship, although in general the greater the density the slower the speed.

b Dave was correct, although it is not a simple relationship.

c The graphs make it easier to see how the speed changes when the other variables change (or similar answers).

Activity Pack**7Lb-1 Moving sound**

1 C where particles are closer together, F where particles are more spread out.

2 sound wave – vibrations passing through a solid, liquid or gas

medium – a substance (a solid, liquid or gas)

amplitude – the distance that particles move when a sound wave passes

frequency – the number of waves per second

3 energy

4 C, A

Sound

7Lb-2 Travelling sound 1

Fill the gaps: wood, stethoscope, hear, gases
Conclusion: solid, gas, solids, gases

7Lb-3 Travelling sound 2

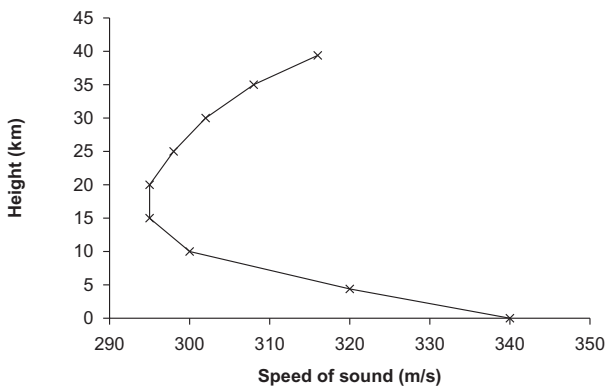
8 The results do not say anything about the speed of sound, only about how loudly students can hear sounds transmitted through the different materials.

7Lb-4 Particle revision

Solid: B, E, H, L
Liquid: A, G, I, K
Gas: C, D, F, J

7Lb-5 Speed of sound in the atmosphere

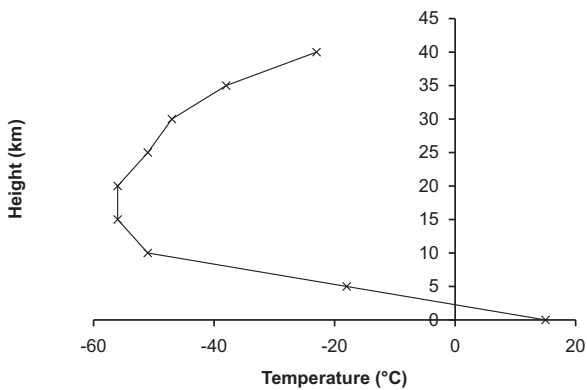
1 a



b The speed of sound decreases as you go up to 15 km, then it stays the same to 20 km, and then it starts increasing again as you get higher.

2 The graphs are different shapes, so there probably is no link between density and the speed of sound.

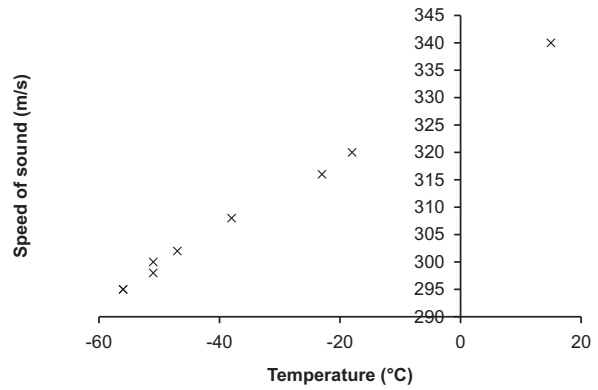
3



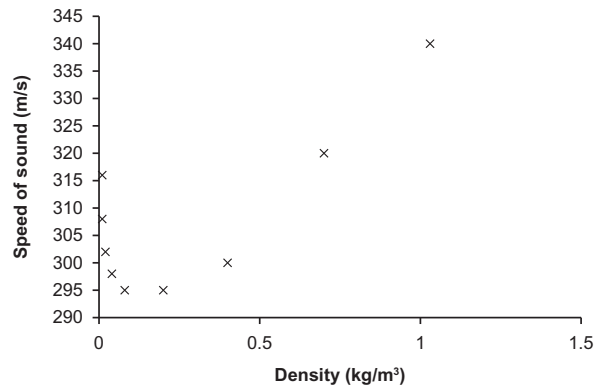
4 a The shapes are similar.

b There may be a link between temperature and speed of sound.

5 a



b



6 a Yes, as the points on the scatter graph are a straight line.

b No, the points do not form a straight line.

7Lb-6 Sound on the move

1 Sound cannot travel in empty space/sound needs a medium to travel through.

2 The number of sound waves per second.

3 double-headed arrow showing particles vibrating in the same direction as wave motion

4 a C

b They are closest to the starting gun.

c C

d Sound spreads out as it travels, so it will be quieter further away (or similar answer).

5 Flipper. Sound travels faster in water than in air.

7Lb-7 Measuring the speed of sound

1 The sound has to go from you to the wall and back again.

2 a the second result, as it is an outlier

b 0.3025 s

c $100 \text{ m} / 0.3025 \text{ s} = 330.6 \text{ m/s}$

3 any two reasons from: they may have had more (or less) accurate timing devices; sea water is denser than fresh water; sea water contains

dissolved salts; the water in the sea and the lake might have been at different temperatures

4 time = $16\,000\text{ m}/1435\text{ m/s} = 11.15\text{ s}$

5 a time = distance/speed = $16\,000\text{ km}/1500\text{ m/s} = 10.67\text{ m/s}$

b distance = $1500\text{ m/s} \times 5\text{ s} = 7500\text{ m}$ (or 7.5 km)

7Lb-8 Mach number

1 subsonic – less than the speed of sound

supersonic – greater than the speed of sound

shock wave – a sudden change in the properties of the air

Mach number – the ratio between an object's speed relative to the air and the local speed of sound

2 It is calculated by dividing one speed by another speed, so the units cancel out.

3 a From the graph, speed of sound at $10\,000\text{ m} = 300\text{ m/s}$. Mach number = $247/300 = 0.82$

b At 5000 m the speed of sound is higher. Dividing 247 m/s by a higher speed will give a smaller Mach number (or similar explanation).

4 a The speed of sound changes with altitude, so it is important to use the speed at the same altitude as the aircraft.

b The speed of an aircraft over the ground will depend on the speed of the wind as well as the speed of the aircraft through the air. As Mach number is used when considering how air flows around the aircraft, the speed relative to the air is the important value.

5 from graph, speed of sound at $20\,000\text{ m} = 295\text{ m/s}$; at $5000\text{ m} = 325\text{ m/s}$

A: Mach 2 = speed of aircraft A/295 m/s so speed of aircraft A = $2 \times 295 = 590\text{ m/s}$

B: Mach 1.5 = speed of aircraft B/325 m/s, so speed of aircraft B = $1.5 \times 325\text{ m/s} = 487.5\text{ m/s}$

A is flying fastest relative to the air around it.

7Lc Detecting sounds

Student Book

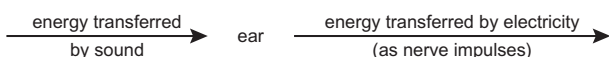
1: 7Lc Detecting sounds (Student Book)

1 eardrum, bones, cochlea

2 a electrical signals that travel along nerves

b auditory nerve

3



4 Loud sounds can damage hearing.

5 Put an object such as a bell inside a box. Measure the sound intensity outside the box with different materials wrapped around the box/stuffed inside the box. Students may also explain how to make fair comparisons or suggest repeating the measurements.

6 a elephant

b all except owl and elephant

7 Owls can hear much quieter sounds than humans/their hearing is more sensitive; humans can hear a greater frequency range than owls/humans can hear higher sounds than owls.

8 a Sound waves enter the ear canal and make the eardrum vibrate. These vibrations are amplified by the ear bones and passed to the cochlea. Tiny hairs in the cochlea detect the vibrations and create impulses which travel to the cat's brain along the auditory nerve.

b any suggestion between $21\,000\text{ Hz}$ (21 kHz) and $45\,000\text{ Hz}$ (45 kHz)

Activity Pack

7Lc-1 Detecting sound

Labels on the ear, clockwise from top left: ear bones, auditory nerve, cochlea, eardrum, ear canal.

Microphone labels, clockwise from top right: wires, electronics, diaphragm.

7Lc-4 Hearing – true or false?

1 True.

2 True.

3 False. The large ear flaps are mainly for cooling. You cannot tell how well an animal hears by the size of its ears.

4 False. It vibrates when sound waves reach it.

5 False. Soft/floppy/fluffy materials are good at absorbing sound.

6 True.

7 True.

8 False. The higher the number, the louder the sound.

7Lc-5 Decibel scale

whisper – 10 dB, leaves rustling – 20 dB, bird singing – 40 dB, normal conversation – 50 dB, traffic – 70 dB, vacuum cleaner – 80 dB, motorcycle – 100 dB, front row at rock concert – 110 dB, military jet take-off – 130 dB

7Lc-6 Hearing loss

1 Temporary: A (wax can be removed); B (may go away on its own, or can be cured by draining the fluid); D (eardrum may repair itself); E (antibiotics can be used to cure infection).

Permanent: C (cochlea will not heal itself); D (eardrum may not repair itself); F and G (age-related deterioration is not going to fix itself).

2 A affects detection.

C affects conversion to electrical signals.

F affects amplification.

G affects transmission of signals to brain.

3 The liquid in glue ear replaces air in the space around the ear bones. Water resistance is greater than air resistance, and so it is harder for the bones to vibrate when surrounded by the liquid. This reduces the amplification of the vibrations.

4 As the aircraft ascends the pressure in the cabin falls. This means the air outside the eardrum is at lower pressure than the air behind the eardrum, so the eardrum is pushed out of shape.

There is a tube (the Eustachian tube) that connects the back of the nose to the space behind the eardrum, and allows air to pass through it to equalise the pressure each side of the eardrum. Swallowing or sucking a sweet helps this process. When you have a cold the Eustachian tube may become blocked, which will prevent any changes of air pressure being equalised.

7Lc-7 Ears and noise

1 ear canal, eardrum, bones, cochlea

2 a eardrum

b cochlea

c bones

3 a Both contain a membrane that vibrates; or the eardrum is like the diaphragm; or both convert sound into electrical signals.

b The ear produces nerve impulses; or the microphone produces current in a wire.

4 a elephant

b dog, mouse

5 a any frequency between 67 and 1000 Hz

b any frequency between 45 000 and 91 000 Hz

6 soft, fluffy materials

7Lc-8 Gardiner's frogs

1 They responded to recorded calls, so they must have been able to hear the recordings.

2 a Answers could include: to attract mates, to mark a territory, to distract predators.

b Territorial or predator-distracting calls are not aimed at animals of the same species.

3 a tympanum

b ear canal, eardrum, ear bones

4 a Within the middle ear the eardrum converts sound waves into vibrations and the bones amplify the vibrations.

b Their skin will reflect most of the sound; or they do not have anything to amplify the sound.

c They have thinner tissue between the inside of their mouth and their inner ear than other frog species; and their mouth helps to amplify the sound.

5 a Protects them from damage.

b They help to direct sound into the ear canal.

7Lc-9 Owls and ears

1 Sound arrives at one ear before the other, and is also louder in that ear.

2 If their head is very small, the difference in arrival time and intensity between the two ears will also be very small, and may be too small to detect.

3 Part of locating a sound depends on a difference of arrival time. This is only detectable at the beginning of a sound. If the sound is continuous, such as humming, our direction-finding has to rely on intensity differences alone.

4 a The sound is coming from below and right. It is louder in its left ear than its right, the sound is coming from somewhere below the owl. If the sound arrives at its right ear first, then it is to the right of the owl.

b The sound will still arrive at the right ear first. It will also be louder in the right ear than the left ear.

5 Pointing the external ears in different directions allows the animal to detect prey/predators without moving their heads.

6 The face acts a bit like a satellite dish, to guide the sound into the ear openings.

7Ld Using sound

Student Book

1: 7Ld Using sound (Student Book)

1 *Students' own answers*, e.g. asking for breakfast, talking to bus driver, talking to friends, asking teacher a question.

2 warning calls, mating calls, territorial calls

3 makes tiny bubbles, which loosen dirt when they burst

4 so they only use their own sounds to help them to navigate/find prey; if they detected another bat's calls by mistake, they could not use it to locate objects

5 It has detected two objects at different depths (either two groups of fish or fish and the sea bed). The equipment can work out how deep each object is.

6 a Detecting ultrasound lets them know when bats are hunting nearby. It is believed that producing ultrasound can lead to 'jamming' of the bat's sounds, making it more difficult for bats to find them.

b You could check the production of ultrasound by using equipment that can detect ultrasounds and listening while the moths are active. You could check detection by seeing if their behaviour changes when recordings of bats' ultrasounds are produced.

Activity Pack

7Ld-1 Using sound

Humans and animals use sound ... for communication.

Sound waves can be transmitted ... through materials.

Some materials reflect ... or absorb sound.

Energy transferred by sound waves ... can be used to clean delicate objects.

Physiotherapists use energy transmitted by sound waves ... to relieve pain.

Reflected sound is called ... an echo.

Bats and dolphins find prey ... using echolocation.

Sonar uses ultrasound ... to find the depth of the sea.

7Ld-2 Investigating bats

1 They conducted experiments that showed that the bats could find their way around in total darkness and when their eyes had been removed or covered. However, when their ears were covered, the bats could no longer navigate, proving that it was their ears they used to find their way around.

2 a Jurine concluded that bats used their ears to navigate.

b The bats could find their way around only when their ears were not blocked.

3 a By letter to their Society.

b email, Internet, journals, conferences, telephone, etc.

c So they can learn about new findings, check each others' results and plan their own investigations.

4 From a scientific point of view, Spallanzani's work was useful (although Jurine seems to have managed similar discoveries using hoods instead of blinding the animals). From an ethical perspective, students may state that it is wrong to harm bats by removing their eyes. (It is now against the law to harm bats in the UK.)

5 Equipment that could detect ultrasounds was not available until then.

6 Fruit bats (also called flying foxes) eat fruit or nectar and use a good sense of smell to help them to find food, so they do not need echolocation.

7 Many echolocating bats have specially shaped noses to help focus the sound; they have a muscle that separates their ear bones while they are emitting their ultrasounds which stops them being deafened by their own calls; they have specially shaped ears to help them to locate the direction of the echo.

7Ld-3 Dolphins and sound

1 The dolphins could still find their way around once their eyes had been covered.

2 nasal sacs

3 Dolphins can use ultrasound to find fish that are buried in sand without being able to see them.

4 If dolphins can see inside a shark's stomach, then they know if the shark will be hungry or not, based on whether the stomach is empty or full.

Sharks eat dolphins, so if the reflected sound

waves indicate that the stomach is empty, then the dolphins need to swim away.

5 Dolphins can use ultrasound to find objects in murky water or objects that are buried in mud. These objects would not be easily seen by humans.

6 *Students' own answers*, but they should be accompanied by reasoning.

7Ld-5 Uses of sound 1

2 absorbs – takes sound energy in and does not let it out again

transmits – lets energy pass through it

reflects – when waves bounce off something

echo – a sound that has reflected from something

3 A, because it transmits the least energy (accept absorbs the most energy).

4 echolocation, B, it reflects the most sound

5 dolphins

6 a Bats use ultrasounds, which we cannot hear.

b So they can hunt in the dark.

7Ld-6 Uses of sound 2

1 a absorb – takes in energy and does not let it out again

transmit – allows energy to pass through it

reflect – energy bounces off it

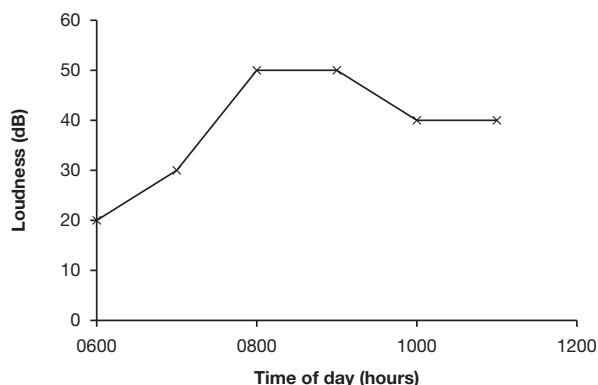
b an echo

2 Material C absorbs 60%; Material A transmits 20%; Material B transmits 10%

3 a correctly drawn bar chart, with bars for the different materials clearly labelled, vertical axis labelled and bars correct lengths

b It is easier to make comparisons (or similar sensible answer).

4 a



b Material C, as it transmits the smallest amount of energy.

c Any line with all points below the ones shown in part a.

5 a Bats use ultrasounds that we cannot hear.

b so they can hunt in the dark

c Material B, as it reflects the most energy.

6 It is used to find the depth of water or detect things in the water. Ultrasound pulses are sent out

and the equipment detects the echoes. It works out the distance to the reflecting object using the time and the speed of sound in the medium.

7 for cleaning delicate items and in physiotherapy

7Ld-7 Mapping the deep

1 a If the weight continues to be lowered after it has touched the bottom, too much rope will be let out and the measurement will be deeper than the true value.

b If the person lowering the weight thinks it has touched the bottom before it really has reached the bottom, then not enough line will have been let out and the measurement will be less than the true value.

2 If the ship is blown away, the rope will not be going vertically downwards, so there will be more rope let out than there should be and the measurement will be deeper than the true value.

3 a percentage = $\frac{3}{300} \times 100\% = 1\%$

b percentage = $\frac{3}{5000} \times 100\% = 0.06\%$

4 The time for the echo will be shorter than for the true depth, and so the measured depth will be less than the true value.

5 a distance = speed \times time = $1500 \text{ m/s} \times 0.4 \text{ s} = 600 \text{ m}$, water depth = 300 m

(or time for half the journey = 0.2 s , depth = $1500 \text{ m/s} \times 0.2 \text{ s} = 300 \text{ m}$)

b The sound will have travelled further in the measured time, so the real depth will be greater than the measured depth.

c actual distance travelled = $1550 \times 0.4 \text{ s} = 620 \text{ m}$, actual depth = 310 m

percentage error = $\frac{10}{300} \times 100\% = 3.3\%$

6 Speed of sound – for 300 m depth the percentage error from waves is much smaller than that from possible errors in the speed of sound.

7 Some points that could be included in the answer: measurements at the surface will not necessarily provide information about the speed of sound at depth; measurements could be taken at various depths, but this could take a long time.

7Ld Working with sound (STEM)

1 a Any sensible suggestions, such as students talking, bells, doors banging, footsteps, traffic noise from outside.

b Any sensible mitigation ideas related to the original suggestions, such as not talking/talking more quietly, making the bells quieter, walking instead of running, etc.

2 a Any sensible suggestions such as near roads, railways or airports, inside or outside factories, roadworks, in concerts, in houses with music playing/noisy neighbours.

b Any sensible mitigation idea related to the original suggestions, such as noise barriers, using softer/absorbent materials in walls/ceilings, wearing ear defenders, turning music players down, etc.

3 Metal – Advantages: strong, long lasting/will not rot. Disadvantage: will reflect sounds back to the road, so noise may be worse for drivers.

Wood – Advantage: will absorb some of the noise, so making the road itself quieter than with a metal barrier. Disadvantage: will not last as long/may rot.

4 a The company will want to record only the music being played, and not any echoes or other sounds. Acoustic engineers can design a soundproof room to stop sounds coming in from outside, with materials that reduce or stop echoes from the music being played.

b Engineers will try to reduce the noise inside the railway station buildings, and also make sure that people can hear loudspeakers used for making announcements about trains.

Student Book

1: 7Le Comparing waves (Student Book)

1 In a transverse wave the particles vibrate/move at right angles to the direction in which the wave is travelling. In a longitudinal wave the motion of the particles is along the same direction as the wave is travelling.

2 up and down

3 a Some of it is transferred to the water and it spreads out across the surface as waves.

b Drop a heavier stone (as it will have more energy).

4 The duck furthest from the centre of the ripples; as the ripples spread out there is less energy in each section of wave, so the amplitude will get less.

5 Students can choose either type as the best model but should provide reasons for their choice. These could be: slinky is better as it can model a longitudinal wave; water waves are better as they spread out from a source but the wave in a slinky only travels along the slinky.

6 Waves can be reflected by the cliffs, so they could be coming from the direction of the sea and from the direction of the cliffs. Some of the waves may be bigger because if the peaks of a wave from the sea and from the cliff occur together their effect will add up and make a bigger wave.

7 Sound waves get smaller faster. Sound waves spread out all around the source, but water waves only spread out along the surface of the water. The expanding sound waves form the surface of a sphere and the area of this surface depends on the radius squared. Expanding water waves form the circumference of a circle, whose length depends on the radius. So if the distance from a source is doubled, the intensity of a sound wave will be a quarter and the intensity of a water wave will be half.

2: 7Le Animals and noise (Student Book)

1 Noise makes it harder for birds to hear mating calls, so if some birds do not manage to find mates, then there will be fewer baby birds.

2 a Bats use ultrasound to locate their prey. Noise may make it difficult for them to hear the echoes, or may mean they can only detect echoes from closer objects. This will make it more difficult for the bats to find food.

b If they cannot find as much food, some bats may die or they may not be able to raise as many young.

3 a The sonar sounds are made by a vibrating object. The vibrations spread out through the water as longitudinal waves.

b Sonar uses ultrasound. This is sound that is too high for humans to hear/above the auditory range of humans. Dolphins can hear a wider range of sounds than humans.

c Dolphins use ultrasound for finding prey. The sonar noises may affect their ability to find prey, may be uncomfortably loud, or may frighten the dolphins so they leave the area. If they have to move away, this means they may have less time for feeding or may have to move to an area with less food.

Activity Pack**7Le-1 Comparing waves**

1 Left-hand wave (from top): crest, amplitude, trough, transverse

Right-hand wave (from top): amplitude, longitudinal

2 transverse, at right angles, longitudinal, same energy, water amplitude, spreading bigger, no

7Le-2 Spot the mistakes

Sound is made by vibrating things. High notes have a high **frequency**, and low notes have a low **frequency**. The frequency is the number of waves per **second** and is measured in hertz. The higher the **amplitude**, the more energy the wave is transferring.

Sound waves travel fastest through **solids** and slowest through **gases**. They do not travel at all in space, because space is a **vacuum**.

We hear using our ears. Sound waves make the **eardrum** vibrate, and these vibrations are passed on to the **ear bones** and then to the **cochlea**. Nerve impulses are sent to the brain.

Loud noises can damage our ears. The best materials for sound proofing are **soft, fluffy** materials.

Sounds that are too high for humans to hear are called **ultrasound**. Sounds that are too low for us to hear are called **infrasound**. Dolphins and bats can hear **ultrasound**, and they use this to find prey.

We can use the energy transferred by **ultrasound** in physiotherapy and for cleaning things. Sonar systems use echoes from the sea bed to work out the depth of the sea.

7Le-3 What kind of wave?

1 Because the particles move up and down (or backwards and forwards) from their initial position.

2 The graph does not say whether the movement is along the direction of travel of the wave (in which case it would be longitudinal) or at right angles to the direction of travel (in which case it would be transverse).

3 new line added with same frequency but larger amplitude

4 new line added with longer wavelength

5 Longitudinal – it is representing a sound wave, which is a longitudinal wave.

6 a The amplitude would be smaller.

b The frequency would be less, or the wavelength would be greater.

7 It shows that the amplitude of the wave gets less as it travels away from its source.

8 The wave spreads out all around the source, so the energy is spread out more. Amplitude depends on energy, so the amplitude gets less.

7Le-4 Water and sound waves

1 a water

b both

c sound

d sound

e water

f both

g both

h neither

i sound

2 a another line drawn showing higher amplitude waves

b The amplitude gets smaller.

3 a They make a bigger wave.

b There is no wave.

7Le-5 Earthquakes and tsunamis 1

1 The P-wave. Sound waves are longitudinal waves, and so are P-waves.

2 a The S-wave is a transverse wave, and so are waves on the surface of water.

b It is not like a water wave in that S-waves can travel through rocks in all directions, but the water waves only travel along the surface.

3 Up and down. P-waves travel faster than S-waves, so they will reach the building first. The particles in P-waves move along the same direction as the wave is travelling, so the building will move up and down/in the same direction as the wave is moving.

4 Sound waves travel much faster through solids than they do through air. The shaking is effectively a sound wave travelling through the rocks.

5 In Sumatra, because it was the closest place to the location of the earthquake.

6 Waves spread out as they travel away from their source, so the energy they carry is also spread out. The amplitude of a wave depends on the energy it is transferring, so the heights of the waves also get less as they get further from the source.

7Le-6 Earthquakes and tsunamis 2

1 The P-wave. Sound waves are longitudinal waves, and so are P-waves.

2 a The S-wave is a transverse wave, and so are waves on the surface of water.

b It is not like a water wave in that S-waves can travel through rocks in all directions, but the water waves only travel along the surface.

3 a She heard the bang at the same time as she felt the shaking. If the vibrations causing the bang had come through the air from the location of the earthquake they would have arrived after the shaking, because sound waves travel much faster through solids/rock than they do through the air.

b The vibrations travelled through the ground, and the vibrating ground made the air in the house vibrate, which was what Mrs Jones heard as the bang.

4 a $300 \text{ J}/2 = 150 \text{ J/m}$

b $300 \text{ J}/3 = 100 \text{ J/m}$

5 In Sumatra, as that is the closest place.

6 The energy per metre of wave gets less as the wave gets further from the source, because the energy is spread out over a larger circumference. The amplitude of the wave depends on the energy, so the amplitude also gets less as the wave gets further away.

7 Answers may vary, but should include some of the following points: they are not spreading out freely; in this case, the waves started very close to a string of islands, so some energy might have been reflected; waves also occur on the oceans because of the wind, and this may have affected the size of the tsunami waves; waves may get channelled between islands; the shape of the sea bed might affect the way the waves travel.

8 a $5000 \text{ MJ}/(2 \times 2) = 1250 \text{ MJ}$

b $5000 \text{ MJ}/(3 \times 3) = 555 \text{ MJ}$

9 The energy transfer by the earthquake waves reduces as the square of the distance away from the source.