Workbook answers

Unit 1 Respiration

Topic 1.1 The human respiratory system

Exercise 1.1 The human respiratory system

1

Letter	Name
A	diaphragm
B	intercostal muscle
C	rib
D	lung
E	air sacs
F	bronchus
G	bronchiole
H	trachea (windpipe)
J	larynx (voicebox)

2

Letter	Function
C	protects the lungs
D	where oxygen gets into the body
E	where oxygen goes into the blood and carbon dioxide comes out
F	delivers air to the lungs
G	carries air from the bronchus, deep into each lung
H	carries air from the bronchioles to each air sac
J	makes sounds

3 Look for an answer that:

- is written entirely in the learner's own words, rather than copied from the text in the Learner's Book or elsewhere
- mentions each part in the correct sequence
- gives a brief description of each part.

Topic 1.2 Gas exchange

Exercise 1.2 Gas exchange

1 The entries should be arranged in order of either decreasing or increasing body mass. For example:

Mammal	Body mass in g	Total surface area of air sacs in m^2
human	80 000	70
sheep	68 000	60
fox	20 000	40
rabbit	1000	2
rat	300	0.8
mouse	20	0.1

2 The larger the body mass, the larger the total surface area of the air sacs. Learners might also add that the relationship is not proportional.

3 The larger an animal is, the more oxygen it will need, because it will contain more cells that are all respiring and using up oxygen. Having a larger surface area of air sacs enables more oxygen to diffuse into the body at the same time, which helps to supply the demands of the respiring cells. A similar argument could be put forward relating to the need to get rid of carbon dioxide produced by the respiring cells.

Topic 1.3 Breathing

Exercise 1.3A Measuring lung volumes

1 Use the measuring cylinder to measure a known volume of water – say 50 cm^3. Pour the water into the bottle and mark its level as representing 50 cm^3. Repeat with another known volume – say another 50 cm^3 – and mark its level as 100 cm^3. Keep doing this until they reach the top.

2

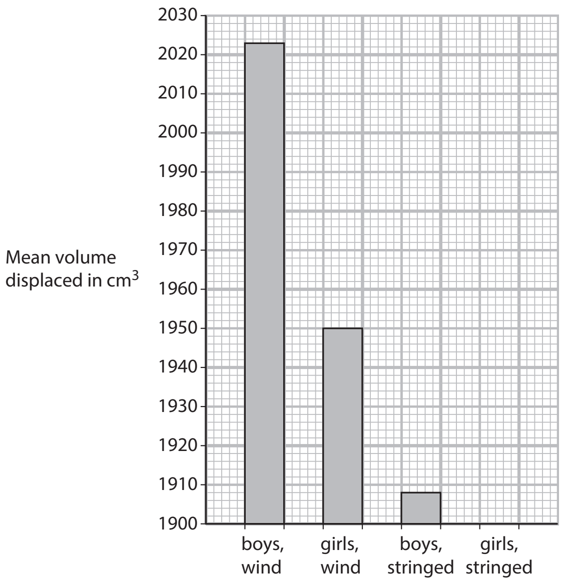
Person	Boy or girl	Wind or string player	Volume displaced in cm^3
1	boy	wind	2100
2	boy	wind	1965
3	boy	wind	2005
4	girl	wind	1950
5	boy	string	1865
6	boy	string	1950
7	girl	string	1905
8	girl	string	1910
9	girl	string	1885

3 (2100 + 1965 + 2005) ÷ 3 = 2023 cm^3

4 (1865 + 1950) ÷ 2 = 1908 cm^3

5 (1905 + 1910 + 1885) ÷ 3 = 1900 cm^3

6



Exercise 1.3B Looking at data on lung volumes

1 Yes. Boys who play wind instruments displace an average of 2023 cm^3, which is greater than the one girl who plays a wind instrument with a displacement of 1950 cm^3. Boys who play stringed instruments have an average of 1908 cm^3 while for girl string players this is 1900 cm^3.

2 Yes. Boys who play wind instruments have an average of 2023 cm^3, which is greater than for boys who play stringed instruments with a value of 1908 cm^3. Similarly, the girl who plays a wind instrument displaces 1950 cm^3, compared with the girl string players with an average of 1900 cm^3.

3 Collecting more results from more people in the orchestra; making three measurements for each person.

Exercise 1.3C Lung volume at different ages

1 Look for the idea that there will be a lot of variation in the lung volumes of individual people of the same age.

Measuring many samples and calculating a mean takes account of this variation.

2 3.9 dm^3

3 5.0 dm^3 (men) – 3.8 dm^3 (women) = 1.2 dm^3

4 The average volume of air pushed out with one breath of women increases steadily over time until it peaks at the age-group 30–39. Then it steadily decreases.

5 An answer of 3.3 dm^3 to 3.5 dm^3 would be acceptable.

Topic 1.4 Respiration

Exercise 1.4 Respiration by yeast

1 A measuring cylinder, to measure out the yeast and sugar solutions.

2 Make sure that her eyes are level with the meniscus in the thermometer to read the temperature.

3 The temperature will increase, because respiration releases energy. Some of this energy is given off as heat.

4 She needs to have another cup where there is no respiration. For example, she could have a cup containing just yeast and water with no sugar, or a cup with just sugar solution and no yeast. She can then compare the temperature in the two cups.

5 Use at least three different cups, each with a different concentration of sugar solution. The sugar could be measured by mass, or Sofia could put different numbers of spoonsful of sugar into each cup.

Add the same volume of water to each cup, and the same volume of the yeast and water mixture. The initial temperature should be the same for each one.

Sofia could take the temperature of the liquid in each cup at set time intervals (for example every two minutes). She could plot a graph showing temperature against time, with different lines for each cup.

Alternatively, she can leave all the cups for the same length of time and measure the temperature after this set time interval. She can then plot temperature against concentration of sugar.

Topic 1.5 Blood

Exercise 1.5A The components of blood

1 plasma

2 white blood cells

3 a red blood cells

b white blood cells

c plasma

Exercise 1.5B Functions of blood components

Blood contains a pale yellow liquid, called plasma. This liquid carries red blood cells and white blood cells around the body. It also transports several different substances in solution, including **nutrients** and **carbon dioxide**.

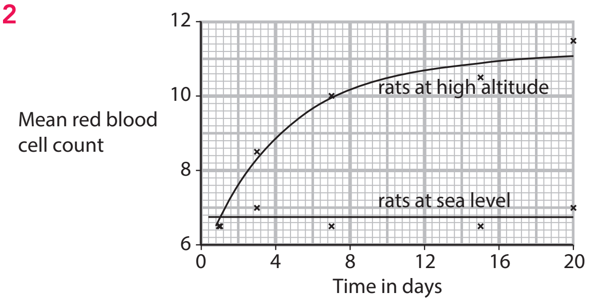
Red blood cells are the **most** abundant cells in the blood. Their function is to transport **oxygen** from the lungs to all the cells in the body that are respiring. To help them to do this, they contain a red pigment called **haemoglobin**.

White blood cells, **unlike** red blood cells, contain a nucleus. Their function is to destroy pathogens, such as **bacteria**, that get into the body. Some of them do this by producing chemicals called **antibodies**, which attach themselves to the pathogens and kill them. Other white blood cells kill pathogens by taking them into their **cytoplasm** and digesting them.

Exercise 1.5C Rats at altitude

1 The number of red blood cells might increase. As there is less oxygen in the air, having more red blood cells could help to get enough oxygen to the body cells.

2



3 The height above sea level (altitude).

4 The mean red blood cell count.

5 Two variables should be given. For example: the age of the rats, the food and water provided, how much exercise the rats did, the volume of the rats' blood that was tested.

6 11.5 − 6.5 = 5.0

7 5.0 ÷ 19 = 0.26 per day (Accept 5.0 ÷ 20 = 0.25)

8 Their red blood cell count would return to normal, about 6.5 or 7.0 They would no longer need the extra red blood cells, because now they would be surrounded by air with a normal concentration of oxygen.

Unit 2 Properties of materials

Topic 2.1 Dissolving

Exercise 2.1A Using the correct scientific term

A mixture

B filtrate

C solute or accept solid

D solvent

E solution

Exercise 2.1B What is the difference between these terms?

1 If something is transparent, you can see through it. For example: clear plastic or a solution of copper sulfate is transparent and you can see what is inside or behind it. Something that is opaque does not allow light through it, for example, milk or a container made of ceramic or metal does not allow you to see what is inside.

2 When something dissolves, such as sugar in tea, there are two substances involved: the sugar that dissolves and the tea that it dissolves into. When something melts, only that one substance is involved: ice cream on a hot day, for example.

3 A solute is something that dissolves in a solvent to form a solution.

Exercise 2.1C Explaining observations

1 120 g

2 When the salt dissolves in the water, it does not disappear, but is still in the water, although you can't see it any more. You have added 20 g of salt to 100 g of water so there will be 120 g of solution.

Topic 2.2 Solutions and solubility

Exercise 2.2A Using the correct scientific term

1 insoluble

2 concentrated

3 saturated solution

4 soluble

5 diluted

Exercise 2.2B Looking at the solubility of three solutes

1 Solute A

2 Solute B

3 Yes, Arun's results do agree with Zara's: he has the solubility of the solutes in the same order as her.

4 Arun used more water than Zara in his investigation, so he was able to dissolve more solute.

5 Marcus has not used the same volume of water for each of his tests. He used about the same volume of water for solute A as Zara did and he got the same result as she did. For solute B, he used more water than Zara and about the same volume as Arun and got the same result as him. For solute C, Marcus used more water than Zara but less than Arun and his result was different from both of theirs. Marcus should have used the same volume of water when he tested each of the solutes. He cannot compare the solubility of the three solutes because he did not make his test fair. He changed two things, the solute he was using and the volume of water.

Exercise 2.2C Making up a solution

1 **a** Arun should add 50 cm^3 of solution X to 50 cm^3 water.

b Arun should add 25 cm^3 of solution X to 75 cm^3 water. (Accept Arun should add 50 cm^3 of the solution produced in answer **a** to 50 cm^3 water.)

c Arun should add 50 cm^3 of the solution produced in answer **b** to 50 cm^3 water.

2 Credit any sensible suggestion, including accurate measurements using a suitable measuring cylinder (indicate which size) and care taken to fill and read accurately (details needed).

Topic 2.3 Planning a solubility investigation

Exercise 2.3A Dissolving salt

1 Sofia predicted that the more water they used, the more salt would dissolve in it.

2 The reading taken for 20 cm³ water has been plotted incorrectly on the graph (on the 25 cm³ line). This should be circled in red.

3 The reading taken for 60 cm³ water, 26 g, looks too high and is the same as the reading for 70 cm³ water. This should be circled in blue on the graph and in the results table.

4 The line of best fit should pass through or close to all of the plotted points, after the two errors highlighted in question **2** has been corrected and that in question **3** has been ignored.

5 The graph shows that the larger the volume of water used, the larger the mass of salt that can be dissolved.

6 Yes, Sofia's prediction was correct.

Exercise 2.3B Comparing the solubility of two salts 1

1 The type of salt.

2 How much of the salt dissolves

3 The volume of water used and the temperature of the water.

4 The account should cover all the points here and it should be possible to follow the plan to complete the investigation.

Measure a fixed volume of water in two test tubes or beakers.

Check the temperature is the same in both.

Add salt X to one of the test tubes or beakers until no more can be dissolved. Mention measuring the quantity of salt added (either counting the number of spatulas added or using the top pan balance to measure the mass).

Repeat using salt Y.

If learners have drawn a diagram, credit the use of appropriate apparatus, such as a beaker with thermometer, water at the same level, spatula of salt being added. The diagram should be drawn in pencil, using a ruler where appropriate, and should be fully labelled.

Exercise 2.3C Comparing the solubility of two salts 2

5 80 °C

6 salt Y

7 The solubility of salt X at 0 °C is about 55 g/100 g water. The solubility rises slowly as the temperature increases to about 70 °C, then the graph levels off. This shows that any increase in temperature over 70 °C makes no difference to the quantity of salt X that can dissolve.

8 Salt Y has a solubility of about 30 g/100 g water at 0 °C. The solubility of salt Y then rises steadily up to a temperature of 100 °C, at the same rate.

Topic 2.4 Paper chromatography

Exercise 2.4A Wordsearch

M	O	L	E	N	R	O	C	E	L	O	J	F	L
B	S	O	L	U	T	E	T	S	C	G	W	T	X
S	O	L	A	Y	A	L	K	A	S	L	P	I	E
N	L	C	H	R	O	M	A	T	O	G	R	A	M
I	U	T	I	O	N	G	I	U	L	R	K	C	K
E	T	U	D	E	R	M	O	R	P	A	I	M	T
D	I	L	U	T	E	B	R	A	E	P	A	T	E
S	O	L	V	E	N	T	A	T	M	H	S	E	A
U	N	P	R	Y	R	N	X	E	L	F	K	S	K
V	D	E	M	S	A	W	C	D	S	J	A	S	H
D	I	K	D	I	S	S	O	L	V	E	T	M	T
F	L	O	D	B	I	B	C	A	C	L	H	I	X

Exercise 2.4B Paper chromatography

1 So that it will be carried up as the water moves upwards and does not move into the water at the bottom of the beaker.

2 six

3 The third patch from the top should be circled.

4 The scientist needs to check that she gets the same result if she repeats the test. She also needs to find out what the colouring is, so that if it is harmful, the company making the drink can be advised to stop using it.

Exercise 2.4C Paper chromatography with plant material

1 This happened because the dried liquid was not soluble in water.

2 Sofia should now try using a different solvent such as ethanol.

3 A – glass rod or any sensible item, such as a pencil or spill to support the chromatography paper).
B – solvent front place where solvent reached.
C – beaker
D – chromatography paper
E – spot where liquid was placed at start
F – solvent

4 So that a small spot of liquid would be more concentrated.

5 It is a mixture because there are several spots of different substances.

6 The liquid dissolved in the solvent. The different substances have different solubility. As the solvent moved up the chromatography paper, the solutes were carried up with it. The particles of the more soluble substances are carried further up than the particles of the less soluble substances.

Unit 3 Forces and energy

Topic 3.1 Forces and motion

Exercise 3.1A Balanced forces

1

Statement	Needed for forces to be balanced?
Two forces must be the same size.	✓
Two forces must be different sizes.	
Two forces must be in the same direction.	
Two forces must be in opposite directions.	✓

2 a false

b true

c false

3 Forward arrow and backward arrow of approximately the same length; forward arrow labelled driving force; backward arrow labelled friction. Weight and contact force need not be shown as they were not asked for.

Exercise 3.1B Unbalanced forces

1 Ticks by 'a boat will slow down', and 'a football will change direction'.

2 a contact force and weight

b driving force and friction

c start to move forward/get faster/speed will increase

Exercise 3.1C Changing direction

1 a Bird is flying at a constant speed and at a constant height.

b Force **A** increases (credit can be given to force **C** decreasing, although it can be pointed out that this is less likely).

c Force **D** increases; force **B** decreases.

2 arrow pointing to the right of the page

3 a Arrow on the string pointing toward the pole labelled F.

b Arrow at a tangent to the circle from the ball in the same direction as the rotation of the ball labelled D.

Topic 3.2 Speed

Exercise 3.2A Units of speed

1 a metre

b second

c m/s

2 It travels a distance of 60 km every hour.

3 distance = speed × time
= 260 000 × 2
= 520 000 km

Exercise 3.2B Calculating speed

1 **a** $\text{speed} = \frac{\text{distance}}{\text{time}}$ (or correct arrangement)

b m/s or metres per second

2 **a** $\text{speed} = \frac{\text{distance}}{\text{time}}$

$= \frac{70}{2}$

$= 35\ \text{m/s}$

b $\text{speed} = \frac{\text{distance}}{\text{time}}$

$= \frac{30}{2}$

$= 15\ \text{m/s}$

3 **a** $\text{speed} = \frac{\text{distance}}{\text{time}}$

$= \frac{450}{300}$

$= 1.5\ \text{m/s}$

b His walking speed may not be constant.

4 $\text{speed} = \frac{\text{distance}}{\text{time}}$

$= \frac{5400}{6}$

$= 900\ \text{km/h}$

Exercise 3.2C Calculating distance and time

1 **a** distance = speed × time

b $\text{time} = \frac{\text{distance}}{\text{speed}}$

2 **a** distance = speed × time
= 45 × 30
= 1350 m

b 2 minutes = 60 × 2
= 120 s
distance = speed × time
= 45 × 120
= 5400 m

3 **a** $\text{time} = \frac{\text{distance}}{\text{time}}$

$= \frac{120}{4}$

$= 30\ \text{s}$

b distance travelled by Sofia = speed × time
= 6 × 60
= 360 m
distance travelled by Zara = speed × time
= 4 × 60
= 240 m
difference = 360 − 240
= 120 m

4 **a** $\text{speed} = \frac{\text{distance}}{\text{time}}$

$= \frac{50}{2}$

$= 25\ \text{km/h}$

b The car is likely to be travelling slower than this or be stopped for some of the time, so to make the average work out at 25 km/h, there need to be some higher speeds.

Topic 3.3 Describing movement

Exercise 3.3A Distance/time graphs 1

1 the speed of an object

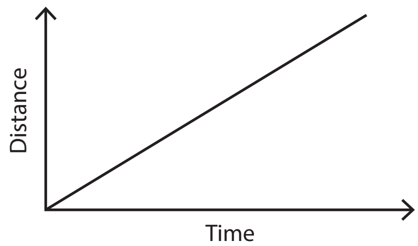
2 **a** C

b B

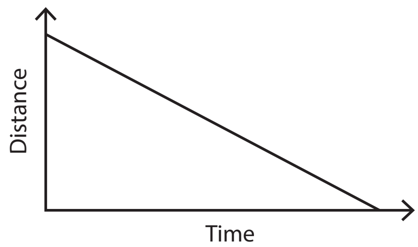
Exercise 3.3B Distance/time graphs 2

1 **a**

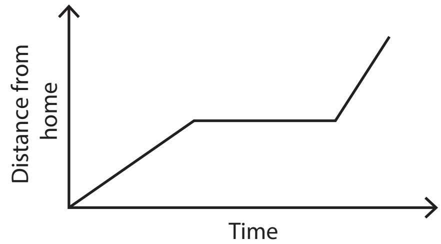
b



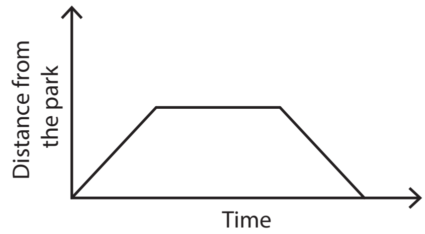
c



2



3



Exercise 3.3C Distance/time graphs 3

1 a

b i 10 hours

i $\text{speed} = \frac{\text{distance}}{\text{time}}$

$= \frac{3600}{4.5}$

$= 800\text{ km/h}$

ii $\text{speed} = \frac{\text{distance}}{\text{time}}$

$= \frac{3600}{4}$

$= 900\text{ km/h}$

Topic 3.4 Turning forces

Exercise 3.4A Identifying turning forces

1 Ticks next to: pushing a door open, twisting the top off a bottle, and pushing the hands of a clock around.

2 Ticks next to the tap, gate and door handle.

3 moment

Exercise 3.4B Calculating moments

1 moment = force × distance (from pivot)

2 a moment = force × distance
= 15 000 × 5
= 75 000 (N m)

b i will increase the moment

ii will decrease the moment

3 pounds foot / pounds feet / foot pounds

Exercise 3.4C Moments, force and distance

1 a moment = force × distance

$\text{force} = \frac{\text{moment}}{\text{distance}}$

$= \frac{40}{0.2}$

$= 200\text{ N}$

b Increasing distance will increase the moment using the same force.

2 $\text{force} = \frac{\text{moment}}{\text{distance}}$

$= \frac{350}{0.35}$

$= 1000\text{ N}$

3 a moment = force × distance
= 500 × 2
= 1000 Nm

b moment = force × distance

$\text{force} = \frac{\text{moment}}{\text{distance}}$

$= \frac{1000}{400}$

$= 2.5\text{ m}$

Topic 3.5 Pressure between solids

Exercise 3.5A Describing pressure

1 $\text{pressure} = \frac{\text{force}}{\text{area}}$

2 tick in the box under shoes with high, sharp heel

3 a C

b $\text{pressure} = \frac{\text{force}}{\text{area}}$

It has the largest area but the force (or weight) is the same, so the pressure is smaller.

Exercise 3.5B Calculating pressure

1 A force of **20 N** acts on each (1) **cm²** of area.

2 $\text{pressure} = \frac{\text{force}}{\text{area}}$

$= \frac{15}{60}$

$= 0.25\ (\text{N/cm}^2)$

3 $\text{pressure} = \frac{\text{force}}{\text{area}}$

$\text{force} = \text{pressure} \times \text{area}$

$= 60 \times 0.5$

$= 30\ \text{N}$

4 pounds per square inch

Exercise 3.5C Variables affecting pressure

1 area (at end of thorn) is very small; pressure on skin will be large; pressure = $\frac{\text{force}}{\text{area}}$; other parts of stem would have larger area, so smaller pressure on skin

2 area in contact with ground is larger; so pressure is smaller; pressure = $\frac{\text{force}}{\text{area}}$

3 with sharp knife, area in contact with bread is smaller; so pressure is larger; pressure = $\frac{\text{force}}{\text{area}}$

4 End A has large area to decrease pressure on thumb when pushing, so less likely to be painful.

End B has small area to increase pressure on the surface, so more likely to go into surface.

Topic 3.6 Pressure in liquids and gases

Exercise 3.6A Trends in pressure 1

1 pressure increases

2 at sea level

3 pressure increases

4 pressure increases

Exercise 3.6B Trends in pressure 2

1 The pressure is equal in all directions.

2 Pressure increases with depth in a liquid.

3 **a** pressure decreases

b Particles move slower at lower temperature; collisions of particles with the inside wall of the balloon become less frequent and occur with less force.

Exercise 3.6C Trends in pressure 3

1 Pressure inside the balloon decreases; particles move slower at lower temperature; collisions of particles with the inside wall of the balloon become less frequent and occur with less force; pressure of the air on the outside stays the same, so the forces are not balanced and the balloon is compressed by atmospheric pressure.

2 **a** line starting from above the origin and sloping up (in any manner)

b line starting from above the origin and sloping up (in any manner)

Topic 3.7 Particles on the move

Exercise 3.7A Diffusion in gases and liquids

1 Black circles and hollow circles randomly, and roughly evenly spread throughout the whole container; same number (10) of each type of particle.

2 Black circles randomly, and roughly evenly spread throughout the whole container; same number (10) of black circles.

Exercise 3.7B Diffusion

1 The random movement of particles from an area of higher concentration to an area of lower concentration.

2 **a** the particles/the ink diffuse(s); the particles start at high concentration and spread out randomly to areas of lower concentration

b diffusion occurs faster at higher temperature; because particles move faster at higher temperature

3 Close to the container the particles/brown gas is at high concentration; higher concentration means the particles are closer together/there are more particles in the space; the particles/brown gas diffuse; further away from the container, the particles are further apart.

4 When the green colour fills the bottle, the movement of particles has stopped; **false**.

When the green colour fills the bottle, diffusion has stopped; **true**.

Exercise 3.7C Variables affecting diffusion

1 a The particles are closer together when the crystal first dissolves; the particles are in high concentration; the particles have not yet started to diffuse; particles randomly spread out to areas of lower concentration; when fully spread out, the particles are further apart.

b Any two from: increasing the temperature; using more purple crystals; using a smaller volume of water.

2 Diffusion happens faster at higher temperature; particles move faster at higher temperature; the particles from the hot coffee will change from being a liquid to being a gas faster/will evaporate faster; there will be a higher concentration of coffee particles in the air just above the hot coffee than the cold; particles from the hot coffee will take less time to travel from the cups to Zara's nose.

3 The concentration of particles causing the smell will be higher closer to the food; if the animal moves closer to the food, the smell will get stronger; if the animal moves away from the food, the smell will get less/weaker.

Unit 4 Ecosystems

Topic 4.1 The Sonoran Desert

Exercise 4.1 The Sonoran Desert ecosystem

1 The Sonoran Desert, which is very dry, and the temperature never goes below 0 °C

2 It has wide-spreading, shallow roots to absorb water when it rains. It has no leaves to reduce water loss by evaporation. It has spines to stop animals eating it.

3 It is too cold. They die if the temperature falls below 0 °C, because their cells are killed if they freeze.

4 If all the Gila woodpeckers and gilded flickers died out, there would be no holes made in the saguaro cacti, so other animals that use these holes would not be able to use them. This could mean that the population of birds such as elf owls might decrease.

If all the saguaro cacti died out, all the birds that use them for nesting (Gila woodpeckers, gilded flickers, elf owls, Harris hawks) would not be able to breed, so their populations would decrease. Bats would not have a source of pollen and nectar from the cacti, so, unless they could switch to feeding on other plants, their population might also decrease. Animals that eat the cactus fruits could also die out.

5 The cacti are probably unable to compete with other plants that are specifically adapted to survive in wetter places. For example, other plants are likely to be able to grow faster than saguaro cacti, and produce a lot of leaves. They would overshadow the cacti, reducing the light falling onto them, so that they would not be able to photosynthesise.

Topic 4.2 Different ecosystems

Exercise 4.2A A tropical rainforest ecosystem

Tropical rainforests grow where the temperature is always high and there is plenty of rainfall. Many different species of plant grow in the rainforest.

The rainforest provides **habitats** and food for many different species of animal.

On the forest floor, fungi break down dead leaves and waste from the animals. These fungi are **decomposers**.

The fungi release **nutrients** from the dead leaves and waste, which help the plants to grow.

All of the plants, animals and fungi interact with one another. They also interact with the non-living parts of their **environment**.

This network of interactions makes up the tropical rainforest **ecosystem**.

Exercise 4.2B Hydrothermal vents

1 There is no light, so they cannot photosynthesise.

2 For example: bacteria ➔ zooplankton ➔ sea anemones ➔ crabs

3 bacteria

4 From chemicals dissolved in the hot water that comes out of the vent.

5 For example: inside a tube worm; in the hot water around the vent; on the sea floor.

Exercise 4.2C Mangroves and fish

1 habitat – the place where an organism lives

ecosystem – a network of interactions between living and non-living things

predator – an animal that kills and eats other animals

2 yellowtail

3 The masses for all species are lower where there are no mangroves. The biggest difference is for yellowtail, where the mass is less than half of that where there are mangroves on the shore.

4 When no mangroves are present, there is no habitat for the baby fish to develop safely from predators, so fewer baby fish grow to become adults, and there are fewer adult fish on the coral reef.

Topic 4.3 Intruders in an ecosystem

Exercise 4.3A Beavers in South America

1 streams and rivers in North America

2 They make dams, which cause deep pools to form. They cut down trees.

3 The bears would almost certainly harm other native species (including humans) as well as killing beavers.

Exercise 4.3B Water hyacinth

1 herbivore: an animal that eats (only) plants

invasive species: a species that has been introduced into an ecosystem where it is not native, and that has spread widely and in large numbers

aquatic: living in water

2 Water hyacinths are native to South America, and there are several herbivores in the ecosystems there that eat water hyacinth and keep its numbers under control.

3 The water hyacinths stop oxygen getting into the water, so native plants and fish are killed. They make it difficult for fishermen to make a living, because the boats cannot move easily through the water hyacinth and the nets cannot catch fish.

Exercise 4.3C Cane toads in Australia

1 There will be other species in their native country that keep cane toad numbers under control – for example, predators that can eat them without being poisoned. In Australia, no species can eat them safely.

2 The researchers should obtain a large number of quolls, and keep them all in the same conditions. They should feed cane toad sausages to half of them, and sausages that do

not contain cane toad to the other half. (This is the independent variable.)

They should then give each quoll the chance to eat a cane toad, and record whether or not the quoll tries to eat it. (This is the dependent variable.)

If the hypothesis is correct, the results should show that the quolls that have eaten cane toad sausages try to eat fewer cane toads, than the quolls that have only eaten sausages that do not contain cane toad.

Topic 4.4 Bioaccumulation

Exercise 4.4A Microplastics

1 tiny pieces of plastic less than 5 mm long

2 Some come from large pieces of plastic that break up into small pieces. Others are manufactured as microplastics, used in products such as face creams and toothpaste.

3 Some sink to the bottom because they are denser than water. Some go into the bodies of animals and may be carried to the bottom when the animal dies.

4 a 54

b 156 − 54 = 102

5 As they feed, they take in microplastics that are floating in the water. There may also be some microplastics in the bodies of the zooplankton that they eat.

6 Bioaccumulation is the build-up of substances in an organism's body over its lifetime, because the substance does not break down in its body.

7 Seals eat many fish in their lifetimes, and all of the microplastics in the fish that they eat gradually build up in their bodies.

Exercise 4.4B Bias

1 The company wants to make money by selling its product, so it might try to make the risk posed by using the spray seem less important than it really is.

2 Yes. Once again, the company that sells the predators wants to make money, so it might play down the risk (represent it as lower than it really is) to other species posed by using the predators.

3 No damage is done to organisms that live in the area.

4 This could reduce the populations of other insects and, in some cases, could make them become extinct. Some of these could be useful: they could be pollinators, for example. This could, in turn, affect the populations of plants that rely on pollinators.

5 The chemicals in the spray build up in each organism that is exposed to it. The further up the food chain an animal is, the more of the chemicals it will take in over its lifetime, as it eats many animals that contain the chemicals.

6 No, they cannot be absolutely sure, but they can certainly trust this information more than the information from the companies.

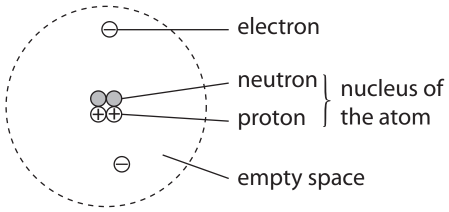
7 Checking for bias is difficult, but it could involve looking at the results of any tests that have been done, so that they can see for themselves whether the results match the statements made by the agriculture department.

Unit 5 Materials and cycles on Earth

Topic 5.1 The structure of the atom

Exercise 5.1A Labelling the structure of the atom

1 and **2**



3 The following statements should be ticked

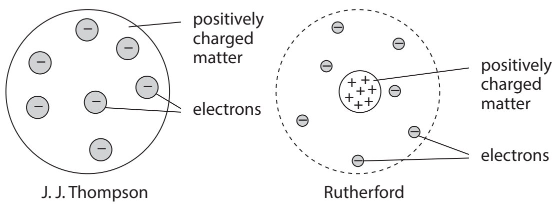
Electrons have less mass than protons.

Electrons have a negative electrical charge.

Neutrons have more mass than electrons.

Exercise 5.1B Models of the structure of the atom

1



2 In J. J. Thompson's model, the particles he knew about, electrons and positively charged particles, are scattered randomly throughout the atom and there is no nucleus. In Rutherford's model, there is a nucleus and the electrons are randomly scattered throughout the rest of the space in the atom.

3 Credit any of the scientists named, such as James Chadwick or Niels Bohr.

Exercise 5.1C Rutherford's gold foil experiment

1 The diagram should be completed by drawing most particle pathways passing straight through the foil. A few should be shown being reflected back or deflected from the gold foil.

2 The results of Rutherford's experiment told him that the atom was mostly empty space, but with a dense/solid nucleus.

Topic 5.2 Purity

Exercise 5.2 Purity

1 It means that all the atoms in the element are the same. So pure silver has only silver atoms.

2 Diamonds are made of **carbon** atoms. When diamonds are coloured, they have **atoms** of different **elements** mixed in with the carbon atoms. When they have **boron** atoms the diamonds will be a blue colour. If diamonds have nitrogen atoms mixed with the carbon atoms, the diamond will be a **yellow** colour. The **rarest** colour of diamond is green. Green diamonds have nitrogen, **nickel** or hydrogen mixed in with the carbon atoms.

3 92.5%

4 **a** 37.5%

b 91.7%

c 58.3%

5

Purity of gold alloy in carats	Purity of gold alloy in percentage	Hardness in arbitrary units
9	37.5	80
14	58.3	90
18	75.0	120
22	91.7	40
24	100.0	30

6 Credit: a suitable scale on the horizontal axis; the points plotted accurately and neatly; a best-fit line drawn.

7 The assistant gave an opinion. The science shows that 18 carat gold is much harder than pure gold. Although the other samples are harder than pure gold, they are not harder than 18 carat gold, so it is mostly not in line with the science.

8 The description should state that the hardness of the gold increases up to 18 carat gold and then decreases at values greater than 18 carat.

9 This may be due to the fact that the other metal used in the alloys is not the same.

Both silver or copper can be used. The data do not say which is used in each case.

Topic 5.3 Weather and climate

Exercise 5.3A Words and meanings

temperature ➔ how hot it is

humidity ➔ how much water vapour there is in the atmosphere

precipitation ➔ rain, hail or snow which falls from clouds

visibility ➔ how far you can see; it depends on the atmospheric conditions or darkness

atmosphere ➔ the layer of gases around the Earth

meteorology ➔ the study of weather

Exercise 5.3B Weather or climate?

1 The weather is the atmospheric conditions over the short term, from minute to minute, hour to hour or day to day.
Climate is the average weather of an area over a much longer time, usually at least 30 years.

2 Credit approximate areas, such as Antarctica, northern Canada, Greenland and northern Russia, but both Poles must be included and labelled.

3 The climate in the polar zone is very cold and dry all year.

4 Credit approximate areas, such as central America, south America (east of the Andes) central Africa, south-east Asia, the north-east tip and south-east coastal strip of Australia, but tropical zone in more than one continent must be shown and labelled.

5 The climate in the tropical zone is hot and wet all year.

6 Meteorologists record the weather in so much detail because they are looking for patterns to see if they can predict what will happen in the future. Knowing what the weather will be like has a big effect on the agriculture, transport, health and other industries.

Exercise 5.3C Weather data

1 Data should be plotted as instructed with the date and time along the horizontal axis and the temperature up the vertical axis. Credit a suitable scale, labelled axes, accurately plotted points and the points joined 'temperature style', that is point-to-point.

2 It is difficult to see any pattern in these results but learners may spot that generally the temperature at 00:00 is lower than that for the rest of the day. The temperature often rises during the day and falls a little over night. They should give examples. They may be able to link the small fall in temperature to the fact that Iceland has a very long day length. If they fail to see a pattern, give them credit if they give examples.

3 The only 'pattern' in the week is that the temperatures are fairly constant.

4 The temperature on this day remained constant from 06.00 to 18.00 and that was not typical of other days during the week.

5 The description of this climate zone is cold and dry.

6 This week the weather in Iceland was not very cold and there was rain, which is not typical of this climate zone.

7 Credit ideas about Iceland being an island in the middle of an ocean and a long way from any other land. They may also realise or find out that the winds and weather systems move quickly in this area and are influenced by the Gulf Stream.

Topic 5.4 Climate and ice ages

Exercise 5.4A Wordsearch

B	O	I	C	V	W	A	H	O	R	D	E	S	D
K	I	C	Y	G	A	B	O	U	L	D	E	R	V
M	L	E	X	B	S	L	S	E	A	G	A	I	C
G	L	A	C	I	E	R	K	I	F	H	O	C	P
N	H	G	L	A	C	I	A	L	M	A	D	E	O
O	U	E	S	Q	G	R	U	H	Y	G	O	S	P
S	D	U	F	B	L	O	P	G	U	E	S	H	E
I	N	T	E	R	G	L	A	C	I	A	L	E	A
P	R	O	D	F	W	O	R	S	H	C	Y	E	T
L	I	E	X	V	U	R	P	N	M	E	Z	T	B
A	M	A	Y	G	O	H	P	D	Y	E	A	O	O
M	A	L	O	C	M	L	A	H	A	B	Z	E	G

Exercise 5.4B Soil cores

1 a The oldest peat is from the bottom of the bog.

b The plant material has not rotted because the conditions in the bog slow down decay. There is not enough oxygen and the conditions are acidic.

c Scientists hope to find out which plants were growing in that area thousands of years ago. If they can identify the plants from their pollen, they can then work out what the climate was like at that time.

2 a These periods are the glacial periods.

b These periods are called interglacial periods.

Exercise 5.4C Climate cycles

1 The graph should be labelled with the peaks as interglacial periods and the troughs as glacial periods.

2 About 75 000 years ago. It lasted from about 75 000 years ago until about 25 000 years ago, so it lasted about 50 000 years.

3 In an interglacial period the average temperatures are generally above freezing reaching as high as 20 °C.

4 When the temperatures are well below freezing for a long time, most living organisms cannot survive.

5 There have been four glacial and five interglacial periods over the past 450 000 years.

The first interglacial period was 85 000 years long and was followed by 25 000 years of a glacial period. The second glacial period lasted 70 000 years the second interglacial period was warmer and lasted longer than the first.

The third glacial period lasted 20 000 years so the glacial periods seem to be getting shorter. During the third interglacial period (about 225 000 years ago) there was a short, sharp dip in the average temperatures. The next glacial period was longer and the next interglacial period had very high average temperatures, the highest of all the interglacial periods in this time span, and lasted until about 75 000 years ago. The most recent glacial period lasted about 50 000 years and we have been in the current interglacial period for about 25 000 years.

6 The evidence we have comes from core soil samples from peat bogs and from the evidence in the landscape from the effect of glaciers.

Topic 5.5 Atmosphere and climate

Exercise 5.5A

In the first billion years after the Earth formed there were lots of **volcanoes**. These produced **gases**, which made up the atmosphere. The **water vapour** that was produced condensed, to form lakes and **oceans**. The early atmosphere was mainly made up of **carbon dioxide** gas. There was little or no **oxygen** gas. This is like the atmosphere of the planet **Venus** today.

As plants began to grow on Earth, they used up the carbon dioxide gas and produced food by the process of **photosynthesis**. Over billions of years the **carbon** in the carbon dioxide gas became **locked up** as **fossil fuels**, such as oil and coal and as **carbonates** in sedimentary rocks such as **limestone**. This caused the levels of carbon dioxide in the atmosphere to **fall**.

Exercise 5.5B

1 80%

2 10%

3 0.038%

4 It decreased very quickly at the start and then continued to decrease, but at a much slower rate.

5 The level of carbon dioxide has increased quite dramatically over the past 200 years. This is because, as industry developed, more fossil fuels were burnt to provide energy for factories and transport. More forests have been cut down to use the wood and make room for people, crops and farm animals, so this means less carbon dioxide from the atmosphere is being used up.

Exercise 5.5C

1 The answers will depend on what learners have found out, but as a minimum should include the following:

There is evidence that iron oxide was formed in rocks after the period 2.1 to 2.0 billion years ago, not before. There is evidence from the pockets of air trapped in the ice cores from Greenland and Antarctica. We have measurements of the percentage of gases in the atmosphere over the past 100 or so years.

2 The answers will depend on what learners have found out, but as a minimum should include the following:

There is evidence from the ice cores about the way the ice was formed over time.

There is evidence of an increase in the rate at which the polar ice caps and glaciers are melting. There is evidence of the sea levels increasing.

3 The evidence from a long time ago is not direct evidence, but has been inferred from other things, whereas the records over the past 100 years were taken directly and there are lots of records. However, even with the more recent records we cannot be sure of the way in which they were taken unless they were taken and recorded by professionals that we can trust.

Unit 6 Light

Topic 6.1 Reflection

Exercise 6.1A Making reflections

1 flat mirror

2 bouncing

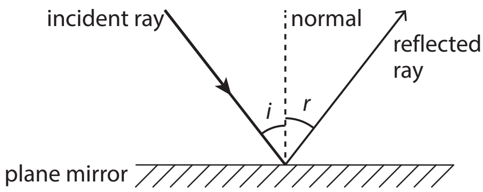
3 a incident ray

b reflected ray

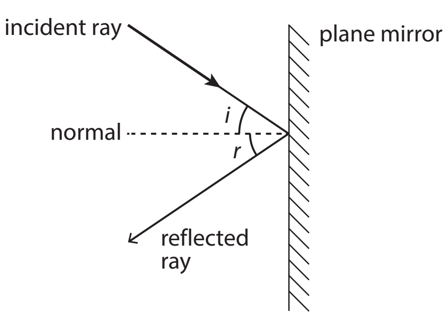
c normal

Exercise 6.1B Ray diagrams

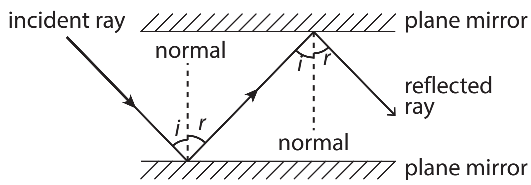
1 a



b



c

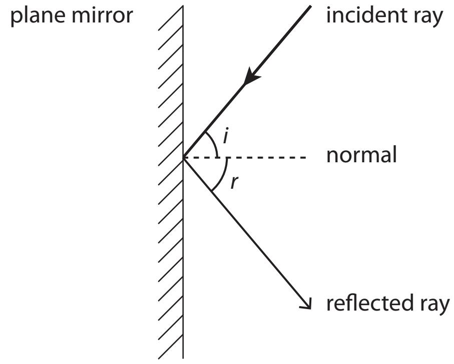


2 a line drawn at 90° to the mirror surface at the point where the light ray meets the surface; line can be dashed or solid and may pass through the mirror surface

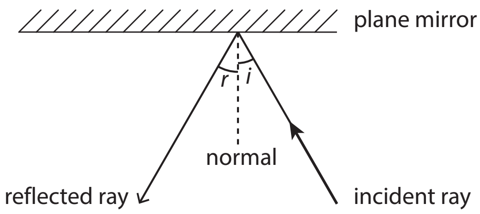
b angle of incidence = 50°

Exercise 6.1C Accurate ray diagrams

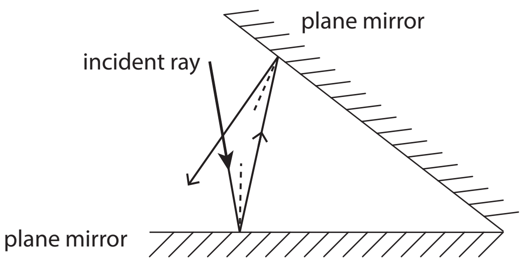
1 **a**



b



2 First angle of incidence in range 20–23°. First angle of reflection should be equal to this. Second angle of incidence should be smaller than first. Second angle of reflection should be equal to second angle of incidence.



Topic 6.2 Refraction

Exercise 6.2A Causes of refraction

1 medium

2 **a** When light passes from air into water, the light **slows down**.

b When light passes from glass into air, the light **speeds up**.

c When light passes from water into glass, the light **slows down**.

3 When light changes direction, the change in direction can be caused by a change in **speed**.

When light changes direction passing from air into glass, this is called **refraction**.

Exercise 6.2B Predicting refraction

1 When light changes speed (caused by) passing from one transparent substance/medium to another.

2 **a** diamond

b air and diamond

c corn oil and glycerol

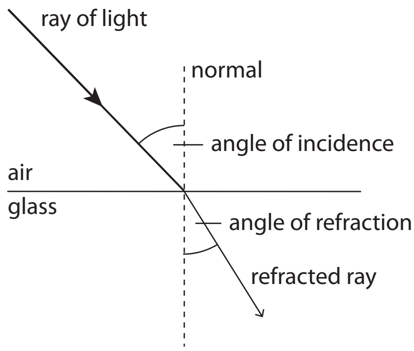
3 When light passes into a medium where it slows down, the light bends **towards** the normal.

When light passes into a medium where it speeds up, the light bends **away from** the normal.

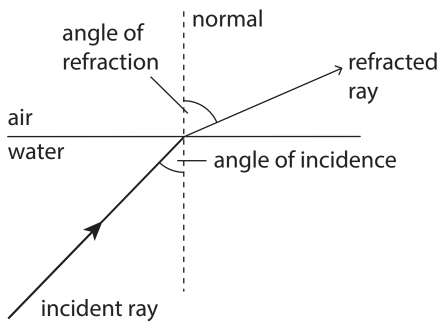
4 Raindrops refract light; raindrops are curved; raindrops refract light in different directions.

Exercise 6.2C Refraction ray diagrams

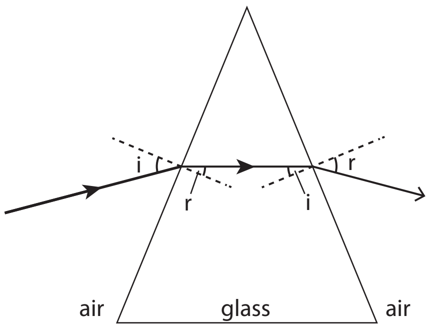
1 **a**



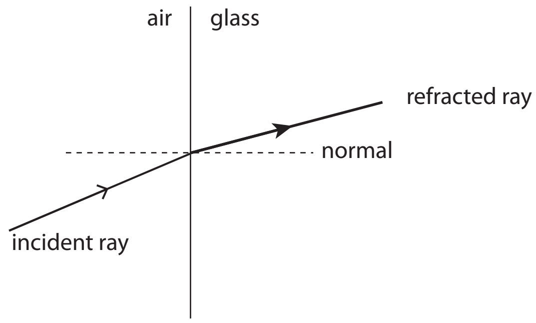
b



c



2



Topic 6.3 Making rainbows

Exercise 6.3A Colours of the rainbow

1 spectrum

2 red, **orange**, yellow, green, **blue**, indigo, **violet**

3 **a** white

b dispersion

c Each colour merges into the next one with no space.

Exercise 6.3B Making a spectrum 1

1 **a** triangular prism

b violet; because violet bends through the largest angle

c **i** Move the screen closer to the prism.

ii The colours get closer together / merge together more.

Exercise 6.3C Making a spectrum 2

1 Violet light slows the most when passing from air into plastic; violet is refracted the most; violet travels slowest in plastic; red light travels fastest in plastic and is refracted the least; other 5 colours listed in order of speed, either increasing or decreasing (increasing speed starts with violet, decreasing speed starts with red).

Topic 6.4 Colours of light

Exercise 6.4A Adding primary colours

1 Colours of light that cannot be made by adding other colours.

2 **a** Adding red light and green light makes **yellow** light.

b Adding green light and blue light makes **cyan** light.

c Adding red light, green light and blue light makes **white** light.

3 All seven colours are given out together; all seven colours are of (approximately) equal brightness; all seven colours mix to give white light.

Exercise 6.4B Subtracting colours of light

1 **a** any one from orange, yellow, blue, indigo, violet

b The green light has been **absorbed** by the red filter. Red light passes through the filter because red light is **transmitted** by the filter.

2 **a** blue
All other colours except blue are subtracted/absorbed/removed from the white light, so only blue remains.

b The remaining blue light will be absorbed by the green filter.

3 A yellow filter is used; all other colours except yellow are subtracted/absorbed/removed from the white light, so only yellow is transmitted.

Exercise 6.4C Seeing colours

1 **a** The green T-shirt **reflects** only green light.
The green T-shirt **absorbs** all the other colours of light.

b black

2 **a** red or white

b blue

c red or blue

3 **a** Black does not reflect light of any colour / black is the absence of light.

b White reflects all colours equally / white light contains all colours.

Topic 6.5 Galaxies

Exercise 6.5A Our own galaxy

1 a Milky Way

b tick under first picture (spiral)

2 a the Sun

b more than 1 000 000

3 There is a small quantity of dust between the stars in our galaxy; **true**.

There is a small quantity of gas between the stars in our galaxy; **true**.

Exercise 6.5B Galaxies in space 1

1 a Universe

b They contain stars; stars give out their own light.

2 spiral, elliptical, irregular

3 Scientists have made an <u>estimate</u> of how many galaxies there are in total. This number may not be <u>accurate/exact</u>.

Exercise 6.5C Galaxies in space 2

1 a gas, stars, planets/solar systems

b Each particle of dust causes a small force of gravity; there are very many particles of dust; the gravity from all of them adds up to a large force.

2 a stars

b Any two from: they do not reflect light; they absorb light; they do not give out light.

3 Any two from: fewer will be seen; they will be dimmer; they will appear smaller.

4 a Count the number of grains in a small volume / volume given, for example 0.1 cubic centimetre; then estimate the volume of sand on the whole beach by multiplying length × width × depth; convert both volumes to the same unit; divide the volume of the sand on the whole beach by the volume of the small sample; multiply the counted number of grains by the result of this calculation.

b The total number cannot be counted accurately; the method for both estimates is the same; both methods assume the spacing of objects is uniform.

Topic 6.6 Rocks in space

Exercise 6.6A Describing asteroids

1 Asteroids are made from rock. Asteroids can have irregular shapes.

2 Between the orbits of Mars and Jupiter.

3 orbit

Exercise 6.6B Asteroids and planets

1 Any two from: asteroids are smaller than Earth; asteroids have no atmosphere; asteroids have no oceans; (many) asteroids have an irregular shape.

2 There are too many asteroids/not all have been discovered/difficulty telling them apart by appearance.

3 $\frac{5000}{10} = 500\,\text{km}$

Exercise 6.6C Asteroids and planets

1 Any two from: both orbit the Sun; both are part of the Solar System; both contain rock.

2 Asteroids are too small/gravity from asteroids is too low to attract/hold a moon.

3 There was not enough gravity between them to form a planet; there were not enough of them to form a planet.

4 Answer can refer to: poor quality/low resolution of the photograph; lack of evidence that aliens exist; desire to attract attention to the website/make a sensational claim; light reflecting off a crater is more likely/more realistic; alien building is exciting but not realistic explanation; universities will have experts looking at the picture; independent website may not have experts contributing; opinions can vary on interpreting photographs; reference to opinion or fact.

Unit 7 Diet and growth

Topic 7.1 Nutrients

Exercise 7.1A Nutrients and their functions

protein ➔ for growth (making new cells)

vitamin A ➔ to help with night vision

calcium ➔ for strong bones and teeth

carbohydrate ➔ to use in respiration to release energy

iron ➔ to make haemoglobin

vitamin D ➔ to help us to absorb calcium, for strong bones and teeth

fat and oil ➔ to use in respiration to release energy, and to make an energy store under the skin

vitamin C ➔ to keep skin strong and able to heal quickly

Exercise 7.1B Analysing information about nutrients

1 chicken

2 orange

3 8 g

4 Sofia is right. Brazil nuts contain 60 g of fat, but only 16.18 g of other nutrients.

5 Brazil nuts, because they contain the most calcium.

Alternatively, learners may suggest milk. This has the second highest quantity of calcium, but learners may think it is easier to digest than brazil nuts. It also has less fat and oil, which they may think makes it a better choice.

Exercise 7.1C Summarising functions and sources of different nutrients

Accept any one or two functions and sources.

Nutrient	Function in the body	Some good sources
protein	growth; making new cells; repairing damaged tissues; making haemoglobin and antibodies	meat, fish, pulses
fat and oil	for energy; as a layer under the skin, it forms an energy store and provides insulation	butter, margarine, cooking oils, fried foods, meat, eggs
carbohydrate	for energy, which is released by respiration	grains (e.g. rice, wheat, oats, corn), potatoes, sweet potatoes, pasta, bread
vitamin A	for good vision, especially at night; helping white blood cells to fight pathogens	green vegetables, carrots, dairy products (foods made from milk)
vitamin C	keeps skin strong	citrus fruits, potatoes, berries
vitamin D	helps us to absorb calcium	sunlight on skin
calcium	strong teeth and bones	dairy products, seeds
iron	making haemoglobin	meat, dark green vegetables, fish, shellfish, nuts and seeds
water	a solvent for many different chemicals	any drink that contains water

Topic 7.2 A balanced diet

Exercise 7.2A Fibre in food

1 Fibre helps to keep food moving easily through the alimentary canal.

2 Chicken, eggs, fish and mutton – that is, foods from animal sources.

3 200 g of chicken contains no fibre. 200 g of rice contains $2 \times 3 = 6$ g. 100 g of spinach contains 6 g.
Total $= 6 + 6 = 12$ g.

4 Bar charts will vary according to the ten foods and bar widths chosen.

- The names of the foods should be written beneath the bars.
- The bars should be carefully drawn using a ruler. They should be drawn accurately They should all be of equal width. It is preferable if they do not touch.
- The sequence of foods in the chart should have some logic behind it – for example, from lowest to highest fibre content, or from highest to lowest fibre content, or all animal foods grouped together and then plant foods.

Exercise 7.2B Energy requirements

1 carbohydrate and fat

2 His weight will increase. The excess nutrients will be turned into fat, and stored in his body

3 a 2.8 MJ

b 2.8 MJ (the answer is the same as **a**)

c Both boys are likely to use a lot of energy each day, especially for movement and growth. However, an eight-year-old boy has fewer cells in his body than a teenage boy – his body mass is smaller. It is the cells that use energy, so if you have fewer of them, you use less energy. If less energy is used, then less energy needs to be taken in.

d Learners do not have any specific knowledge to enable them to answer this, so any reasonable suggestion should be accepted. For example: women, on average, have a lower body mass than men; women may be less active than men.

Exercise 7.2C Planning a diet

Look for:

- foods that contain all six nutrients (including vitamins A, C and D, calcium and iron) and some fibre – with the nutrients contained in at least some of the foods described
- interesting, balanced meals that would appeal to an eight-year-old
- attention given to the quantity of energy in the diet
- not too much fat or oil

Topic 7.3 Growth, development and health

Exercise 7.3A Interpreting data about smoking

1 a respiratory diseases

b diseases of the digestive system

2 39%

3 2 × 39 (or answer to question **2**) = 78

4 21%

5 5 × 21 (or answer to question **4**) = 105

6 The bar chart shows that the percentages of deaths due to smoking were greater for men than for women OR smaller for women than for men.

7 Accept any explanation that suggests that more men than women are smokers, or that men smoke more than women, or that men are more susceptible to those diseases.

Exercise 7.3B Smoking statistics

1 Answers will depend on the country that learners choose.

2 The bar chart should have:

- 'Country' on the horizontal axis, with individual bars labelled with the name of the country
- different style bars for men and women, indicated with a key
- women and men for the same country shown as bars close together, or touching
- bars for different countries a little further apart, not touching
- each bar drawn with a ruler, all the same width and correctly plotted.
- 'Percentage of people who smoked' on the vertical axis
- a scale on the vertical axis running from 0 to at least 65 in sensible steps (e.g. in fives or tens)

3 a Chile

a Indonesia

b Indonesia

Exercise 7.3C Looking at data on giving up smoking

1. Learners could choose to display any of these sets of data:
   - the percentages of men and women who have given up smoking already, and the percentages of those who are trying to give up smoking
   - the reasons for successfully giving up smoking
   - the reasons for failing to give up smoking.
2. Look for:
   - a neatly drawn chart with ruled columns and rows
   - clear headings with units
   - correct entries, with no units included in the body of the chart.
3. The chosen method of display should be clearly presented and labelled, so that it is easy to understand.
4. The answer should include some of the following points:
   - reference to the fact that people find giving up smoking difficult because nicotine is addictive
   - reference to the percentage of people whose reasons for smoking appear to be related to addiction (learners should refer directly to the data here, for example, 54% of people say they went back to smoking because they could not manage without cigarettes)
   - the idea that e-cigarettes supply users with nicotine, so they will still get the drug to which they are addicted, but can gradually reduce the amount of nicotine in the e-cigarettes until they are 'smoking' nicotine-free e-cigarettes.

Topic 7.4 Moving the body

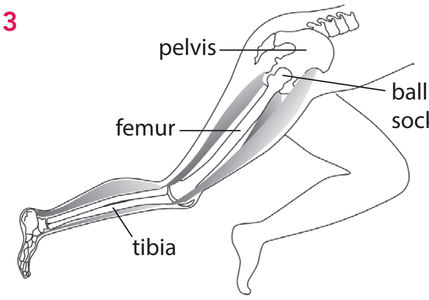
Exercise 7.4A The skeleton and forces

1. Sofia, 28 N
2.

	Force in N	
	Right hand	Left hand
thumb	27	25
first finger	28	25
second finger	22	19
third finger	21	16
little finger	19	17

Exercise 7.4B Antagonistic muscles in the leg

1 and 3



2. hinge joint
4. The leg will bend at the knee.
5. It will straighten – the lower leg will be pulled forward.
6. A and B; C and D

Exercise 7.4C Choosing a hypothesis about bones to investigate

1. Thick bones are stronger than thin bones. Long bones break more easily than short bones.

2 **a** There should be a clear statement of either the thickness or length of the straw (depending on the chosen question).

b The force needed to bend the straw.

c Look for at least two correct answers. They should be things that would actually affect the results if they were altered, for example: the length of the straw (if testing the thickness); the thickness of the straw (if testing the length); the position of the hook on the straw; the angle at which the force meter is pulled; the material from which the straw is made.

d The description should state clearly what the learner would do, in a suitable sequence. A good measure of success is whether someone else could follow these instructions without having to ask for further guidance.

e This is a low risk experiment. Care should be taken not to pull suddenly on the forcemeter/newton meter, which could become detached from the straw and suddenly fly upwards.

f The results chart should be drawn with a ruler and a pencil. The first column (or row) should be headed with the variable that will be changed (either the thickness or length of the straw) with the appropriate unit. The second column (or row) should be headed Force needed to bend the straw in newtons. Some learners may decide to make repeat measurements, in which case they will need to include columns (or rows) for each of the force measurements, and another column (or row) for the calculated mean.

g Accept any prediction that relates to the stated hypothesis. It does not have to be a 'correct' prediction. For example, for the first question, any of these predictions would be appropriate:

- Thick bones are stronger than thin bones.
- Thick bones are not stronger than thin bones.
- Thin bones are stronger than thick bones.
- There is no difference in the strength of thick bones and thin bones.

Unit 8 Chemical reactions

Topic 8.1 Exothermic reactions

Exercise 8.1A Investigating an exothermic reaction

1 the length of the magnesium ribbon

2 the change in temperature

3 the type of acid used; the volume of acid used; credit any other sensible control variables

4

Length of ribbon in cm	Start temperature in °C	End temperature in °C	Temperature change in °C
0.5	19.0	36.0	17.0
1.0	19.0	36.0	17.0
1.5	19.0	36.5	17.5

5 The results show that changing the length of magnesium used makes very little difference to the end temperature.

6 No. They have only used a very small range of lengths of magnesium.

7 0.5 cm

8 A larger interval in length. Because then any differences in the temperature rise will be more obvious.

9 Accept any sensible number from 5 upwards.

10 Credit any sensible suggestion to reduce heat loss to the room. Ideas such as wrapping the test tube in some sort of a jacket are the most likely, but there should be some comment about still being able to read the thermometer.

11 They can repeat the investigation with each length of magnesium ribbon at least twice.

Exercise 8.1B Investigating exothermic reactions between metals and acid

1 magnesium + sulfuric acid → magnesium sulfate + hydrogen

2 a They needed to change the metal they place into the acid.

b The variables they have kept the same are the type of acid used, the volume of acid used and the method they used.

c The variable they should have kept the same is the mass of the metal used (X is described as 'small', but Y is not).

d You cannot form a reliable conclusion with these results because they have not used the same mass of each metal.

e They could improve their investigation and make the results more reliable by using the same mass of each metal. Repeating their experiments several times, so that they allow for any errors, would also improve the reliability of the results.

Exercise 8.1C Exothermic reactions with metals

1 potassium + water → potassium hydroxide + hydrogen

2 thermal, light and sound energy

3 Wear safety glasses and carry out the reaction behind a safety screen.

4 Measure any increase in the temperature of the water. Learners should make some comment about it being difficult to measure the amount of light and/or sound energy.

5 Learners should include the following points:

- Use the same acid, use the same volume of acid.
- Use the same mass of the different metals.
- The measured volume of acid should be placed in a test tube, the temperature taken and recorded and then the metal added.
- The temperature is taken again after the reaction has finished. (Mention could be made that the rise in temperature is what is required, so if there are slightly different starting temperatures, it is not significant.)
- Safety aspects such as wearing safety glasses.

6 The results should be presented as a bar chart, because the temperature rises are for four different metals (the type of metal is a discrete variable) so it is best not to use a line graph.

Topic 8.2 Endothermic reactions

Exercise 8.2A Energy changes

1

Reaction	Start temperature in °C	Final temperature in °C	Exothermic or endothermic
A	21	45	exothermic
B	18	22	exothermic
C	19	16	endothermic
D	18	20	exothermic

2 endothermic

3 exothermic

Exercise 8.2B Exothermic or endothermic?

1 a The reaction between sodium hydrogencarbonate and citric acid is endothermic. The reactions between sodium hydroxide and sulfuric acid, between hydrochloric acid and zinc, and between copper sulfate and magnesium powder are exothermic.

b The reaction between copper sulfate solution and magnesium powder has the largest temperature change.

c It was sensible to use polystyrene cups rather than test tubes or glass beakers because polystyrene is a good insulator, so that less of the heat energy produced in the reaction was lost to the environment. There would be a more accurate temperature reading taken.

2 Credit any useful product, such as self-heating food or drink cans. Credit any sensible original ideas.

3 Credit any ideas, such as 'chemical ice-packs' or self-cooling drinks.

Exercise 8.2C Endothermic reactions and processes

1 In an endothermic reaction, a chemical reaction takes place with new products being formed. Energy is taken from the environment, so there is a decrease in temperature. An example is the reaction of sodium hydrogen carbonate with citric acid to produce sodium citrate, water and carbon dioxide. In an endothermic process, energy is also taken in from the environment, but there are no new products formed. For example, ice melting takes in energy from the environment, so it is endothermic, but since no new products are formed (water merely changes state) it is an endothermic process. (Credit any other suitable examples such as potassium chloride dissolving in water as an endothermic process.)

2 The water in the bowl soaks into the cloth over the soda bottles. The liquid water evaporates as it heats up in the hot weather. The particles in the liquid water move all the time and can slide past each other as they only have weak forces holding them in place. The more energy the particles have, the more they can move. When the particles have enough energy transferred from the surroundings, they escape the forces holding them together in the liquid and change into gas and evaporate. Since the energy to do this comes from the surrounding water in the bowl, this water cools down and keeps the bottles of soda cool.

Topic 8.3 Metals and their reactions with oxygen

Exercise 8.3 Why does iron rust?

1 iron oxide

2 The nail in tube B will go rusty.

3 The water has been boiled to remove any dissolved air and the layer of oil on the top of the water prevents any more air from entering.

4 a No, this is not an expected result.

b The nail in the dry air may have gone rusty because Zara has not put the stopper into the tube firmly enough and some moisture from the air has entered.

5 Credit any two sensible ideas, such as painting, galvanising or coating with any other suitable material, such as plastic or grease.

6 The plan for the investigation should clearly state the variable the learner will change, the temperature of the nail. This can be done in a variety of ways. As long as the method is clear and workable, credit it. A suggestion may be to place new shiny nails of the same shape, size and composition into test tubes containing water at different temperatures. Credit learners if they give a suitable range of temperatures.

Learners may decide to keep the test tubes in a water bath to maintain the different temperatures.

There must be a clear indication of the variables to be controlled, such as the type and size of the nail, the volume of water used and the time for the experiment. There should also be a clear indication of the dependent variable (rusting) and how they will measure it. This will probably be by eye and a comparison of the rust on the nails after a given time.

Credit should be given to a plan that considers the practicality of the approach.

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Topic 8.4 Reactions of metals with water

Exercise 8.4 Reactions with water and steam

1 In order starting with the most reactive: potassium; magnesium; zinc; copper.

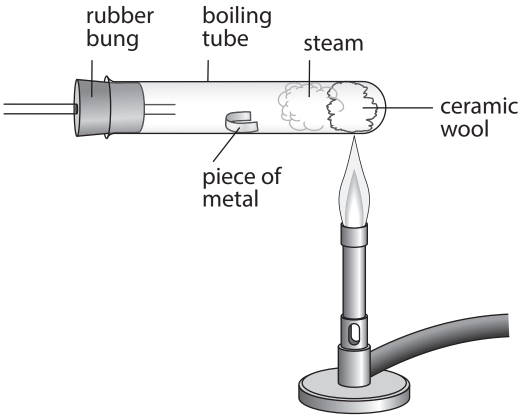
2 potassium + water → potassium hydroxide + hydrogen

3 sodium or lithium

4 Copper can be used for roofs because it does not react with water. Magnesium reacts slowly with water, so would not be used for a roof, as it would react when there is rain or snow.

5 calcium + water → calcium hydroxide + hydrogen

6

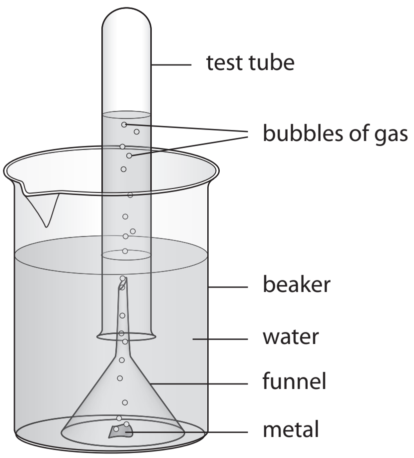


7 hydrogen

8 The test for hydrogen gas is to place a lighted splint in the gas to see whether it makes a squeaky pop sound when it burns.

9 magnesium + steam → magnesium oxide + hydrogen

10



11 Copper does not react with water. This is why it is used for pipes carrying water. Iron does not react with water either but it does react with oxygen if it is in the presence of water. So the iron in the pipes would react with any dissolved oxygen in the water and rust. Iron oxide would form. This would result in the water being coloured reddish brown with the iron oxide, and the pipes would eventually collapse.

Topic 8.5 Reactions of metals with dilute acids

Exercise 8.5A Investigating reactivity

1 The test tube with metal C has less acid than the others, so it is not a fair test. All the test tubes should have the same volume of acid. The volume of acid must be one of the control variables.

2 They have put on safety glasses.

3 Because the tube with metal A contains a different acid, nitric acid; the others have hydrochloric acid. The type of acid must be one of the control variables.

4 No, because the piece of metal B is larger than the pieces of the other metals. The size of the pieces of metal must be one of the control variables.

5 how reactive different metals are with dilute acids

6 the type of metal used

7 the amount of bubbling/number of bubbles there are when the metal reacts with the acid

8 The volume of acid used, the type of acid used, the mass of metal used. Credit also 'the same temperature', and any mention of the form the metal is in, i.e. powder, lump or ribbon, which would show a high degree of understanding.

Exercise 8.5B Reactions of metals with dilute acids

1 They can tell that a reaction has taken place if there is a colour change, bubbles of gas are given off or if there is a change in temperature.

2 They can tell which metal is more reactive by comparing the number of bubbles given off in a given time or comparing the temperature changes. Colour change is not a reliable or practical way to compare reactions.

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3 They cannot use their observations to compare copper, aluminium, zinc and lead because the two boys have used different acids. The acids are also of different concentrations and different volumes.

4 The plan should use the concept that the only variable to be changed is the type of metal. The type, volume and concentration of the acid used should be the same in each test. The mass of metal used should be the same. There should be an indication of how these variables will be measured to ensure they are the same in each case. For example, the use of a measuring cylinder to measure the volume of the acid. There should be some indication of how the number or volume of bubbles of hydrogen given off will be compared. This could be by doing the tests at the same time and comparing by eye. There should be an equipment list or indication of what equipment will be required. Safety information, such as wearing safety glasses and how to use reagent bottles, replacing stoppers and so on, should be included. The plan should be presented in a logical sequence and manner.

Exercise 8.5C How reactive are these metals?

1 The mass of metal used; the volume of acid used; the type of acid and its concentration. Also, the inverted test tube must always be completely full of water at the start of the investigation; the timer must be started at the same point in the investigation: when the delivery tube is back in place, for example; the test tube of gas must be completely full when timing is stopped.

2 Copper does not react in dilute acid.

3 Learners should draw a bar chart, with the bars in order of height, the tallest bar furthest left.

4 Accept any sensible suggestions, for example: she might have misread the timer, or not stopped it at exactly the right time; she might have got the mass of metal wrong, or mixed up which metal she was using.

5 Learners could mention the difficulties of keeping the delivery tube in place so that no hydrogen is lost; getting the delivery tube back in place in the conical flask after adding the metal; being exactly sure when the tube is completely full of gas.

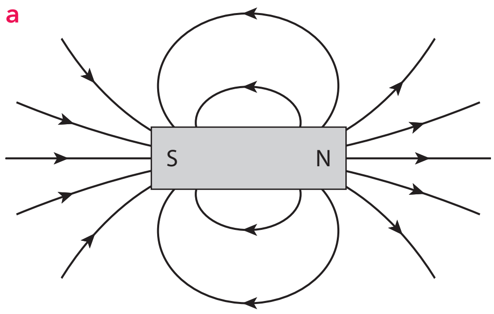
6 Accept sensible suggestions to improve accuracy; **do not** accept repeating the experiments with each metal, as this improves the reliability, not the accuracy. Suggestions that might be expected and which would provide evidence that learners have thought carefully about the practical aspects of the investigation are: one person adding the metal and another person putting the delivery tube back; using a graduated tube or measuring cylinder or marking the test tube so that it is easier to see when the gas reaches a particular level.

Unit 9 Magnetism

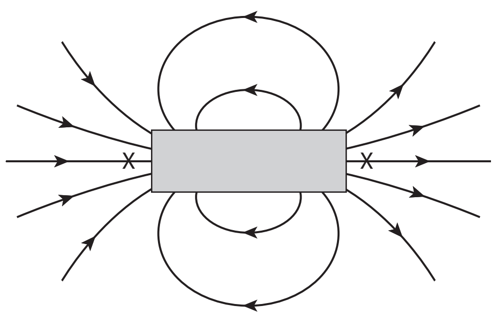
Topic 9.1 Magnetic fields

Exercise 9.1A Magnetic field patterns

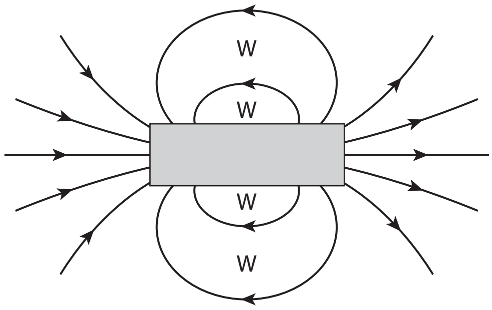
1 a



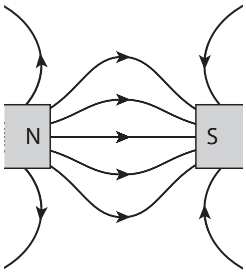
b X in either of the positions shown.



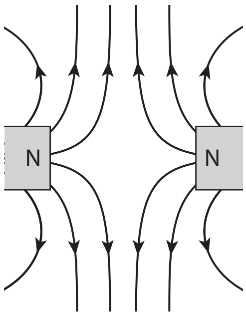
c W in any of the positions shown.



2 a



b



Exercise 9.1B Magnetic fields

1 a The area around a magnet where the effect of the magnet can be detected.

b A magnetic compass will turn according to the position of a magnetic object; the needle will point in the direction of magnetic field lines.

2 a gets weaker

b gets weaker (to the middle of the magnet) then gets stronger again

Exercise 9.1C Interaction of magnetic fields

1 The magnetic field lines between the two poles are in opposite directions; **repel**.

The magnetic field lines between the two poles are in the same directions; **attract**.

2 Place two magnets on a surface with the two south poles facing; place a piece of paper over both magnets; sprinkle iron filings on the paper.

Topic 9.2 The Earth as a giant magnet

Exercise 9.2A The Earth's magnetic field

1 The Earth's magnetic poles have not always been in the same positions.
The Earth's magnetic poles are similar to the poles of a bar magnet.

2 The Earth's magnetic field occurs all around the Earth.

3 a core

b iron and nickel

Exercise 9.2B Direction of the Earth's magnetic field

1 toward geographic north

2 south

3 a Stroke the needle with the magnet; use the same pole of the magnet; stroke several times; stroke in the same direction each time.

b Any method that will allow the needle to rotate freely, such as float on a cork in water or suspend horizontally using a thread.

4 Attach the string to the middle of the magnet using the adhesive tape; hang the bar magnet so it is horizontal and supported from the wooden clamp stand; allow the magnet to turn. The magnet will align close to the geographic north-south direction; the north pole of the magnet will point closely to geographic north.

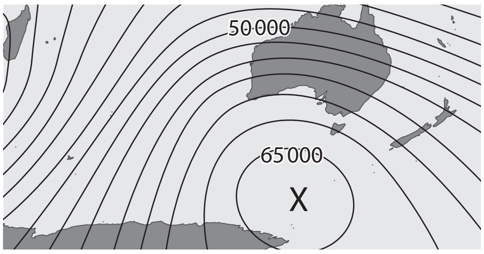
Exercise 9.2C Strength of the Earth's magnetic field

1 The strength of the magnetic field 1 cm from the end of a bar magnet. Reason: the Earth's magnetic field will not make a paperclip move, but when 1 cm from the end of a bar magnet, a paperclip will move.

2 a 4

b 2500

c



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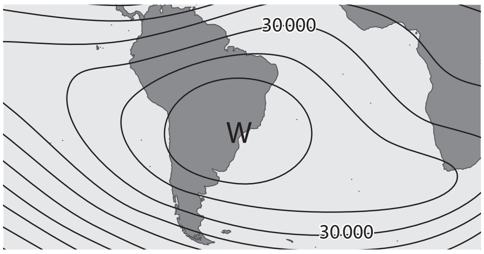

e The learner's position should be correctly identified; if the learner's location is between two lines then any value between the values of those lines can be given.

Topic 9.3 Electromagnets

Exercise 9.3A Electromagnets 1

1 a wire to make the coil; iron or steel rod/nail for the core

b steel paperclips

2 steel and iron

3 The electromagnet uses electricity/current to work; the electromagnet can be switched on and off.

Exercise 9.3B Electromagnets 2

1 Any two from: lifting/sorting scrap metal; toaster; electric bell; electric motor; holding doors open.

2 a When current flows, the nail is magnetised; the pins are magnetic and will be attracted to the nail.

b When current stops flowing, the nail is no longer magnetised; the pins will no longer be attracted to the nail.

c Either: bring a magnetic compass close to the end; if the compass points towards the end of the nail, it is south; if the compass points away from the end of the nail, it is north; OR bring the north pole of a bar magnet to the end of the nail; if it attracts it is south; if it repels, it is north.

Exercise 9.3C Electromagnets 3

1 a It could be a south pole.

b Bring the north pole of a bar magnet toward the end of the nail; if they repel, then the end of the nail is a north; if they attract, then the end of the nail is a south (accept explanation using south pole with opposite effects).

c Reverse the current in the coil/reverse the cell in the circuit; remove the nail from the coil and insert the other way round / wind the coil in the opposite direction.

Topic 9.4 Investigating electromagnets

Exercise 9.4A Strength of electromagnets 1

1 a As the number of turns on the coil increases, the number of paperclips lifted **increases**. This means the electromagnet gets **stronger** as the number of turns on the coil **increases**.

b 20 turns/5 paperclips

c repeat it/do it again (**not** check it)

d size of the paperclips; current in the coil; material in the core

Exercise 9.4B Strength of electromagnets 2

1 a material in the core; number of turns in the coil; same size paper clips

b i Cells can run out/run low, whereas the power supply will not/power supply is more reliable; easier to change the current with the power supply than connecting/disconnecting cells.

ii The wire in the coil gets too hot.

c i 50 pins

ii 12 or 13 pins (not 12.5)

Exercise 9.4C Strength of electromagnets 3

1 a current in the coil and material in the core

b small paperclips; a better range of values can be measured/measurement is in smaller intervals/can detect smaller changes in electromagnetic strength

2 a The reading on the balance will decrease; the iron block will be attracted up to the electromagnet; the force of attraction on the block is in the opposite direction to the weight of the block; the force down on the balance is less.

b As the current in the electromagnet increases, the reading on the balance will get smaller/decrease.

c No, this is not correct; if the connection is reversed, then the current will be reversed; the poles on the electromagnet will be reversed; whichever pole is close to the iron block will still attract the block equally.