Answers

Chemical changes and structure

Chapter 1 Rates of reaction 1

Exercise 1A Chemical reactions

1 A new substance is formed.

2 Any **four** of: colour change; gas produced; solid produced; temperature change; light produced.

3 **a** The calcium has reacted (with the water).

b A gas (hydrogen) was being produced.

4 Flame produced and white solid formed.

5 **a** A change in temperature.

b Put a thermometer in the beaker and note any difference (change) in temperature.

Exercise 1B Speeding up chemical reactions

1 **a** Powdered metals react faster (because they have greater surface area than lumps of equivalent mass (weight)).

b The temperature is lower in the fridge so reactions which cause the milk to go sour are slowed down.

c Increase temperature and increase concentration.

2 **a i** A

ii More bubbles produced in A than in B or C.

b Warm it and increase the concentration.

c Use powder (smaller particle size).

3 **a** A catalyst speeds up a chemical reaction.

b Smaller pieces have a bigger surface area for the reaction to take place on.

c For example: a catalytic converter in a car exhaust; making industrial chemicals like ammonia. (You may have other answers – ask your teacher to check your answers.)

d It can be used again so saves money (is economical).

4 **a** For example: fireworks exploding; a car air bag inflating; burning gas in a cooker.

b For example: rusting; paper ageing; milk going sour.

5 **a** To see if changing particle size has any effect on the rate of reaction (between marble and hydrochloric acid).

b Bubbles of gas were produced.

c

Particle size	Observations
small lumps	gas produced quickly
large lumps	gas produced very slowly
powdered	gas produced very fast

d So that comparisons were fair, they needed to keep these variables the same: concentration of the acid; temperature of the acid; mass (weight) of marble.

e The smaller the particles/the larger the surface area, the faster the reaction.

6 **a** C

b i Because two variables have been changed (the concentration of the acid and the particle size).

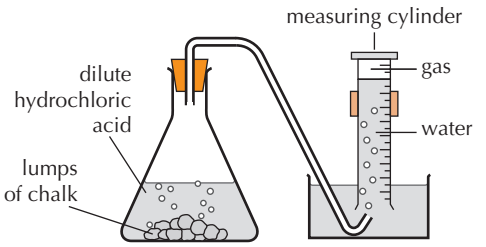
ii A and D

c D

Chapter 2 Rates of reaction 2

Exercise 2A Monitoring the rate of a reaction

1 a i



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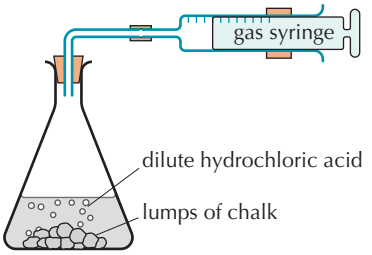


b Any gas can be collected using a syringe but only insoluble gases can be collected over water **OR** A gas syringe is more accurate.

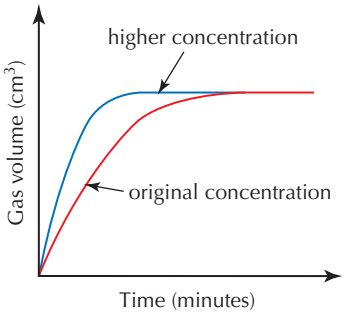
c i A

ii This is the steepest part of the graph so reaction is fastest.

iii 10 cm^3

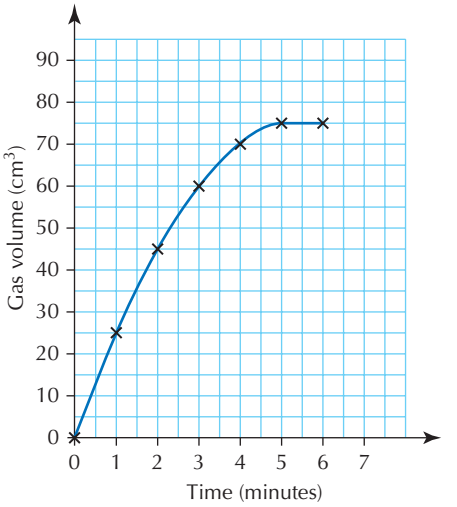
iv 6 minutes

d



2 a 75 cm^3

b



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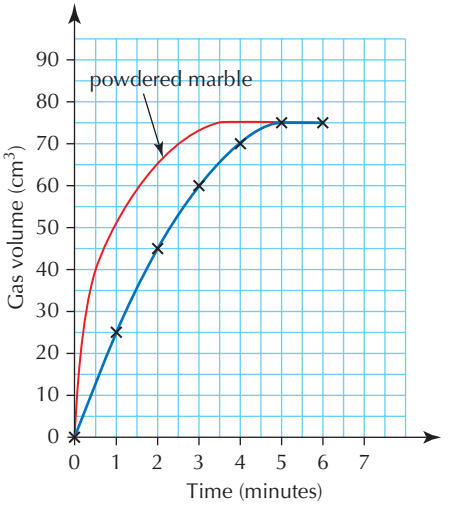


3 a As the reaction progresses the reading on the balance **decreases**.

b The reading on the balance would decrease faster because the rate of reaction is faster.

4 a i 1

ii The reaction is faster at 30 °C; line 1 is steeper than line 2, so it represents the reaction at 30 °C.

b 3·5 minutes

c i 0·4 g

ii The same mass of zinc has reacted in each experiment; both experiments reached endpoint.

5 **a** A

b The line is steepest.

c C

d The line has levelled off.

e 149·5 – 146·0 = 3·5 g

f 146·0 g

Chapter 3 Chemical structure

Exercise 3A Substances and their states

1 The three states of matter are **solid**, **liquid** and **gas**.

2 **a** A substance which dissolves in water is said to be **soluble**.

b A **solute** is a substance which dissolves.

c The liquid in which a substance dissolves is called the **solvent**.

d A **solution** is formed when a substance dissolves.

e When no more of a substance will dissolve in a liquid the **solution** is said to be **saturated**.

3 **a** Water

b Carbonic acid

c Carbon dioxide

4 **a** To see how soluble different chemicals are in the same amount of water **OR** To measure how many spoonfuls of different chemicals can dissolve in the same volume of water.

b

Chemical	Number of spoonfuls dissolved
copper sulfate	3
sodium chloride	4
sugar	9

c The volume of water was kept the same in order to have a fair comparison.

d The chemicals would stop dissolving/ chemical would be seen lying at the bottom of the test tube.

e Saturated

f Different amounts of chemical can be dissolved in the same volume of water **OR** There is a limit to how much of a chemical will dissolve in water. (Water can only dissolve a certain amount of chemical.)

Exercise 3B Elements, compounds and mixtures

1 **a** Everything is made up of **atoms**.

b **Elements** are made up from one kind of atom.

c **Compounds** are made up of different atoms **joined** together.

d In a **mixture** of elements the atoms are not joined.

2 After the mixture is heated the iron and sulfur (atoms) join to form a compound and the atoms are difficult to separate in a compound.

3 **a** Filtering

b Evaporation

c Evaporation

d Filtering

4 **a** D

b B

c A and C

5

Elements reacting	Name of compound formed
sodium and iodine	sodium iodide
silicon and carbon	silicon carbide
magnesium and chlorine	magnesium chloride
potassium and sulfur	potassium sulfide
lead and bromine	lead bromide
magnesium and oxygen	magnesium oxide

6 sodium + iodine → sodium iodide

silicon + carbon → silicon carbide

magnesium + chlorine → magnesium chloride

potassium + sulfur → potassium sulfide

lead + bromine → lead bromide

magnesium + oxygen → magnesium oxide

Exercise 3C Elements and the periodic table

1 **a** Elements are made from the same **atoms**.

b The elements are arranged in the **periodic** table.

c Elements with similar chemical properties are in the same vertical **group**.

d Each element has its own **symbol** and **atomic** number.

2 **a** Rb

b Kr

c C

d 1

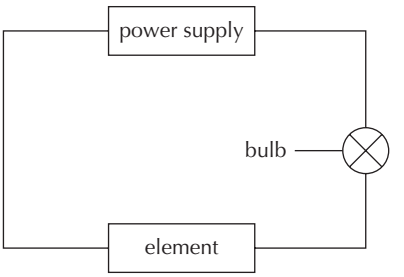
3 **a** **i** Copper

ii Metal

b **i** Iodine, 53

ii Non-metal

c Connect the element into an electrical circuit. If the bulb lights, the element is a metal; if the bulb does not light, the element is a non-metal.



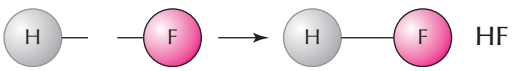
4 **a** **i** Y

ii X

b **i** Under oil

ii Group 1 or alkali metals

Exercise 3D Chemical formulae of compounds

1 **a** 

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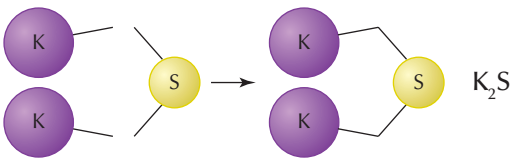
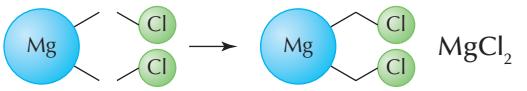
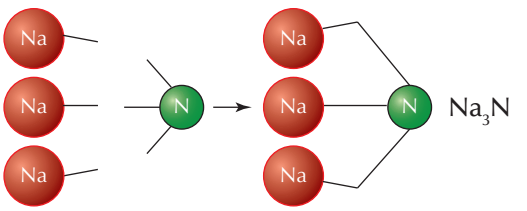
c 

d 

e 

2 **a** ICl

b NO_2

c NF_3

d $SiCl_4$

e PBr_5

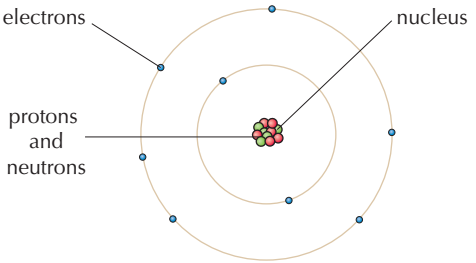
Chapter 4 Atomic structure and bonding related to properties of materials

Exercise 4A Atomic structure

1 a

Particle	Charge	Mass
proton (**p**)	**1+**	**1**
electron (e^-)	**1–**	almost zero
neutron (**n**)	no charge	**1**

b i, ii



2 a Positive particles are protons; negative particles are electrons.

b i Neutron

ii Nucleus

3 a Atomic number is the number of protons.

b They have the same number of positive and negative particles so their charges balance each other.

c Mass number is the number of protons and neutrons added together.

4

Element	Symbol	Atomic number	Protons	Electrons	Neutrons	Mass number
fluorine	**F**	**9**	**9**	**9**	10	**19**
potassium	**K**	**19**	19	**19**	**20**	39
krypton	**Kr**	36	**36**	**36**	44	**80**

5 There are more neutrons than protons in an atom.

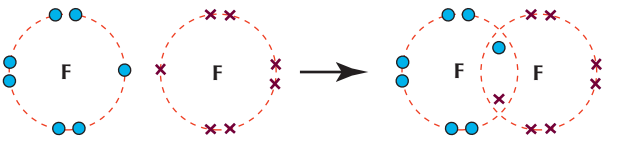
Exercise 4B Bonding

1 a Molecules

b Covalent

c In a covalent bond atoms share a pair of electrons.

d i



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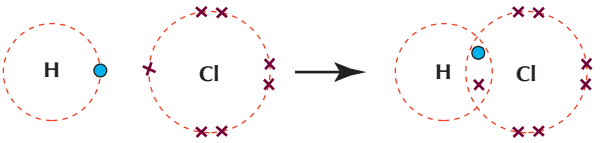


e F–F and H–Cl

2 a Ions

b Positive

c Negative

d Electron(s) move from a metal atom to a non-metal atom.

3 a Ionic

b The positive sodium ions attract the negative chloride ions.

4

Element	Symbol	Number of electrons in atom	Electrons lost or gained	Ion symbol	Number of electrons in ion
lithium	Li	**3**	loses $1e^-$	**Li^+**	**2**
sulfur	**S**	**16**	**gains $2e^-$**	S^{2-}	**18**

5 a Ionic

b Ionic

c Covalent

d Covalent

Exercise 4C Properties of covalent and ionic substances

1 a A gas; B liquid; C solid; D solid

b i A and B

ii C and D

c i Covalent substances generally have **low** melting points and boiling points and exist mainly as **gases** and **liquids**.

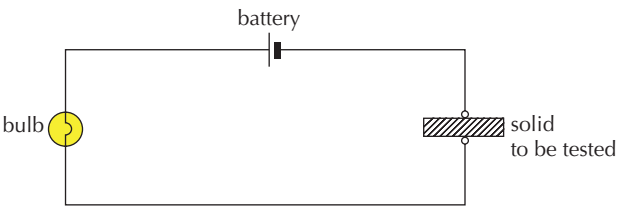
ii Ionic substances generally have **high** melting points and boiling points and exist as **solids**.

d Bromine

2

Ionic bonding	Covalent bonding
Found in **compounds** formed between metals and non-metals. Examples: sodium chloride and **magnesium oxide**	Found in elements and compounds made up of **non-metal** atoms. Examples: chlorine and **water**.
Formed when metal atoms **lose** electrons and form **positively** charged **ions**. Non-metal atoms **gain** electrons to form **negatively** charged ions. Oppositely charged ions **attract** each other and form a giant crystal structure.	Formed when **pairs** of electrons are shared between non-metal **atoms**. Exist as individual **molecules**.
All exist as **solids** at room temperature. Conduct **electricity** when in **solution** or melted.	Can exist as **gases**, liquids and solids at room temperature.

3 **a** Make an electrical circuit using a battery and a bulb with a gap to put the solid to be tested in.



b If the solid is a conductor the bulb will light.

c Solid ionic compounds do not conduct.

The students should have dissolved the solid in water or melted it then tested it. If it was a covalent substance it still would not conduct. Ionic solutions and metals would conduct electricity.

4 **a** **i** Covalent

ii Covalent substances generally have low melting points and boiling points.

b **i** Gas

ii Solid

iii Liquid

c Solid (s); liquid (l); gas (g)

d (aq)

Exercise 4D Formulae of elements and compounds

1 **a** K

b Ca

c Br_2

d F_2

e Ar

f N_2

2

Name of compound	Elements present in compound
calcium chloride	calcium and chlorine
iron sulfate	iron, sulfur and oxygen
zinc carbonate	zinc, carbon and oxygen
copper nitrite	copper, nitrogen and oxygen
potassium sulfite	potassium, sulfur and oxygen
magnesium nitrate	magnesium, nitrogen and oxygen

3 **a** SO_2

b C_2H_6

c SiH_4

d C_4H_8

4 **a** $MgCl_2$

b HF

c AlH_3

d BaS

e Mg_2C

5 **a** $Mg + Cl_2 \rightarrow MgCl_2$

b $H_2 + I_2 \rightarrow HI$

c $Li + S \rightarrow Li_2S$

d $C + O_2 \rightarrow CO_2$

6 **a** 71

b 28

c 119

d 78

e 102

7 **a** Anywhere in the range 50–70 °C is acceptable.

b As the relative atomic mass increases the melting point decreases.

Chapter 5 Energy changes of chemical reactions

Exercise 5A Exothermic and endothermic reactions

1 **a** The first experiment

b The temperature went up after the acid and alkali were mixed.

c Exothermic

d Endothermic

2 **a i** Reactions 1 and 2 are exothermic. Reaction 3 is endothermic.

ii In reactions 1 and 2 there is a rise in temperature after the solutions are mixed. In reaction 3 there is a drop in temperature after the reactants are mixed.

b i Reaction 2

ii Reaction 2 has the biggest increase in temperature.

3 **a** The calcium oxide and water react.

b Exothermic

4 **a** The temperature dropped so much that it froze the water under the flask.

b Endothermic

5 **a** To find out if the reaction between hydrochloric acid (an acid) and sodium hydroxide (an alkali) is exothermic or endothermic.

b Measure out equal volumes of hydrochloric acid and sodium hydroxide.
Measure the temperature of each.
Mix the two solutions together.
Measure the temperature of the mixture.

c If there is a rise in temperature the reaction is exothermic. If there is a drop in temperature the reaction is endothermic.

6 **a i** Endothermic

ii Exothermic

iii Endothermic

iv Exothermic

b i, iii Energy is taken in, so the reactions are endothermic.

ii, iv Energy is given out, so the reactions are exothermic.

7 Exothermic

Chapter 6 Acids and bases 1

Exercise 6A Acids and alkalis

1 **a** The pH scale is a numbered scale from below **zero** to above **14**.

b Acids have a pH **below** 7.

c Alkalis have a pH **above** 7.

d Neutral solutions have a pH of **exactly** 7.

2 **a** Red

b Blue (purple)

c i A solution with pH 1 is **more** acidic than a solution with pH 6.

ii A solution with pH 8 is **less** alkaline than a solution with pH 14.

3

Sub-stance	Acid/Alkali/ Neutral	pH 7/below 7/ above 7	Colour of universal indicator
vinegar	**acid**	**below 7**	red
water	**neutral**	7	**(lime) green**
bicar-bonate of soda	alkali	**above 7**	**blue**

4 **a** **i** Lemon juice and tea

ii Lemon juice

b **i** Milk of magnesia and oven cleaner

ii Oven cleaner

c **i** Red

ii Blue

5 **a** It is alkaline.

b The indicator is red at the start (pH 7); the indicator didn't change colour so the solution could be neutral or acidic.

c **i** Red cabbage

ii It will change colour when both acid and alkali are added.

6 **a** As the days go by the milk becomes more **acidic**.

b 5·0

7 **a** When water is added to acid, the acid becomes more **dilute** and the pH of the acid **increases** towards 7.

b When water is added to alkali, the alkali becomes more **dilute** and the pH of the alkali **decreases** towards 7.

8 **a** Less than 7

b Acid reacts with teeth enamel and causes tooth decay.

9 **a** Citrus fruit (e.g. orange, lemon, lime, etc.)

b It is acting as a preservative.

Exercise 6B Neutralisation

1 **a** Adding water diluted the acid so it becomes less acidic (pH increases).

b pH increases

c pH decreases

d Neutralisation

e Water and a salt

2 **a** Blue/purple

b Above 7

c Moves from blue/purple towards green.

d Moves down

e Lime green

f Neutral

3 **a** Magnesium chloride, magnesium sulfate, magnesium nitrate

b Salts

4 **a** potassium hydroxide + hydrochloric acid → water + **potassium chloride**

b lithium hydroxide + sulfuric acid → water + **lithium sulfate**

c calcium hydroxide + **nitric acid** → **water** + calcium nitrate

5 **a** It is alkaline.

b Neutralisation

6 **a** Alkalis/bases

b Neutralisation

Exercise 6C Acidic gases and the environment

1 **a** Carbon dioxide

b Sulfur dioxide and nitrogen oxides

c Burning fossil fuels

d **i** It dissolves the nutrients that plants need, so it stops them taking in the nutrients.

ii It kills fish because it lowers the pH of the water.

e Adding lime (alkali/base)

f Burn less fossil fuel.

2 **a** Use an indicator such as universal indicator or a pH meter.

b **i** The water might have dissolved other chemicals on the roof and so give a false result.

ii Leave a container outside to collect the rainwater which cannot be contaminated by other substances.

3 **a** 55%

b

Source of sulfur dioxide	Percentage reduction (%)
energy used in industry	20
homes and businesses	15
road transport	5
manufacturing	5
energy production	55

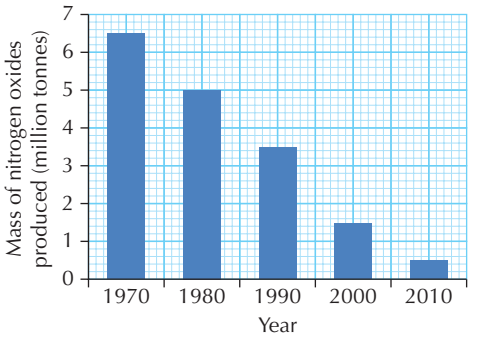
c A energy production; B energy used in industry; C homes and businesses; D road transport or manufacturing; E manufacturing or road transport

4 **a** Emissions of nitrogen dioxide have been decreasing.

b **i** 2020

ii The UK is on target.

5 **a**



b Decreasing

c Between 0·2 and 0·3

d It should reduce the amount being produced.

6 **a** It reduces the amount of carbon dioxide in the atmosphere.

b They are becoming more acidic.

Exercise 6D Greenhouse gases and global warming

1 Carbon dioxide is one of the gases in the **atmosphere** which is thought to be preventing **heat** from the Earth escaping into space. This is known as the **greenhouse** effect. This effect is causing the temperature of the Earth to **rise**. This is known as global **warming** which many scientists think is contributing to **climate** change.

2 **a** Any **two** of: polar ice melting; unusual weather patterns; expanding deserts; forest fires.

b Burn less fossil fuel.

3 **a** Increasing

b 1930

c **i** 0·04

ii It will increase.

Chapter 7 Acids and bases 2

Exercise 7A Bases

1 A **base** is a compound which can react with an acid to form **water** and a **salt**.

This is called **neutralisation**. Soluble bases can **dissolve** in water to form **alkaline** solutions. The pH of water changes from 7 to **above** 7.

2 **a** **i** Potassium oxide, **ii** Magnesium carbonate and **iv** Sodium hydroxide

b **i** Potassium oxide and **iv** Sodium hydroxide

3 **a** Hydrogen (H)

b **i** Copper chloride; copper nitrate; copper sulfate

ii Barium chloride; barium nitrate; barium sulfate

iii Magnesium chloride; magnesium nitrate; magnesium sulfate

4 **a** **i** nickel oxide + nitric acid → water + **nickel nitrate**

ii magnesium hydroxide + sulfuric acid → **water** + **magnesium sulfate**

iii barium carbonate + hydrochloric acid → **water** + **barium chloride** + **carbon dioxide**

iv **zinc carbonate** + **nitric** acid → **water** + zinc nitrate + carbon dioxide

b Neutralisation

5 **a** Oxides X and Y are both **soluble**.

b **i** X

ii Soluble metal oxides form alkaline solutions.

c Because it has no effect on the pH of water, it is insoluble.

6 **a** Calcium chloride

b Neutralisation

c No more bubbles would be seen.

Exercise 7B Gases and the environment

1 **a** **i** Carbon dioxide

ii Burning fossil fuels

iii Use a scrubber to take the gases out before they leave the chimney.

b Carbon footprint is a measure of how much carbon dioxide our activities cause to be released into the atmosphere.

2 **a** There has been a decrease in sulfur dioxide emissions since 1990.

b Yes, the UK reached its target.

c Yes the UK will reach its target **OR** The UK reached its 2020 target in 2015.

d Burning fossil fuels

Nature's chemistry

Chapter 8 Fuels and energy 1: Fuels

Exercise 8A Energy from fuels

1 For example: heating our buildings; cooking food; fuel for transport.

2 **a** Fuel

b The main type of energy given out when a substance burns is **heat**.

c Oxygen

3 **a** **i** A fossil fuel is a fuel made from the remains of plants and animals which lived and died millions of years ago.

ii Fossil fuels are **natural**.

b **i** Coal, natural gas and peat

ii Petrol and diesel

iii Distillation

4 **a** A compound made from hydrogen and carbon **only**.

b **i** CH_4

ii C_3H_8

iii C_8H_{18}

iv C_2H_4

5 **a** **i** C_2H_6, **ii** C_4H_8 and **iv** C_6H_{14}

b They are not made only of hydrogen and carbon.

6 **a** **i** Limewater

ii It turns cloudy/milky.

b **i** It would change from blue to pink.

ii Test the pH – it should be 7.

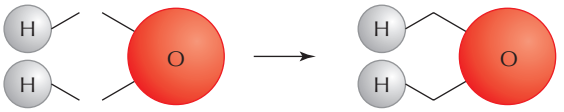
iii To cool the water vapour and change it into a liquid.

c i hydrocarbon + oxygen → carbon dioxide + water

ii Element: oxygen

Compound: hydrocarbon, carbon dioxide, water

iii



H_2O

iv CO_2

7 a Carbon dioxide

b Energy

8 a To find out which substance in foods gives out most energy **OR** To compare the amount of energy given out by different substances found in foods.

b i Vegetable oil

ii Burning vegetable oil caused the greatest temperature rise.

c To make the comparison fair.

d Any **one** of: volume of water; distance of flame from the test tube; length of time substance is burned.

e So that an average result can be worked out and so results are more reliable/accurate.

f **All** of the substances tested produced energy when burned.

9 a C_2H_6O (or any other formula which correctly shows two carbons, six hydrogens and one oxygen).

b i Ethanol has oxygen in it as well as hydrogen and carbon so is not a hydrocarbon.

ii It turns limewater cloudy/milky.

iii Water turns blue cobalt chloride paper pink; test the pH of the water using indicator or pH meter (water has a pH of 7).

c ethanol + oxygen → carbon dioxide + water

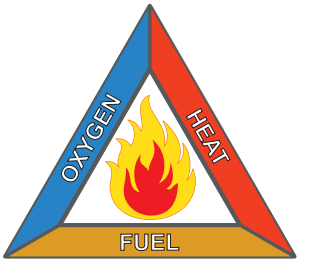
Chapter 9 Fuels and energy 2: Controlling fires

Exercise 9A The fire triangle

1 a The air

b A fuel and heat

c



2 a i Pour water on the fire to remove the **heat**.

ii Shovel earth onto the fire to remove the **oxygen**.

b The fuel would eventually run out.

3 a i Carbon dioxide (foam could also be used but it is not practical to have one in the home).

ii Dry powder or carbon dioxide

iii Dry powder

iv Water (or dry powder)

b There is a risk of being electrocuted.

c So that the label stands out clearly and the correct extinguisher is used for the type of fire.

4 a Using a fire blanket to cover a chip pan which is on fire removes the **oxygen**.

b Spraying a layer of powder over a fire removes the **oxygen**.

c A water extinguisher removes the **heat**.

d Carbon dioxide from an extinguisher removes the **oxygen**.

5 Water removes heat from the fire (so a water sprinkler system would stop a fire from spreading from one apartment to the other).

6 **a** Water removes heat from fire.

b The water sticks to the fuel better.

c **i** High winds supply extra **oxygen**.

ii The chemical in the sticky water also helps stop **oxygen** reaching the fuel.

iii If left to burn, a wildfire will not stop until it runs out of **fuel**.

Chapter 10 Fuels 1: Fossil fuels

Exercise 10A Formation of fossil fuels and new technologies

1 **a** carbon dioxide + water → glucose + oxygen

b The Sun

c Endothermic

d In the chemical bonds

e Chlorophyll

f Photosynthesis

2 Trees are **plants** which provide us with **wood** which can be burned to give us **energy**. Plants trap the **Sun's** energy in chemical **bonds** through a process called **photosynthesis**.

Even when plants die they can still be used as a **fuel**. For example, **coal** was formed from trees and other plants which lived and died **millions** of years ago. When they died their remains partly **decayed** (rotted) and were gradually covered in layers of mud and sand. The **weight** of these layers combined with the **heat** from within the **Earth** and gradually changed the plant material into coal.

Crude **oil** and natural **gas** were formed in a similar way but from dead sea **animals** and plants.

These fuels are known as **fossil** fuels.

3 **a** A finite resource is a source of energy which will eventually run out and cannot be replaced.

b **i** Oil had just been discovered.

ii 1999

c **i** Generally, oil production has decreased since 2000 (although there was a temporary increase in 2013–2015).

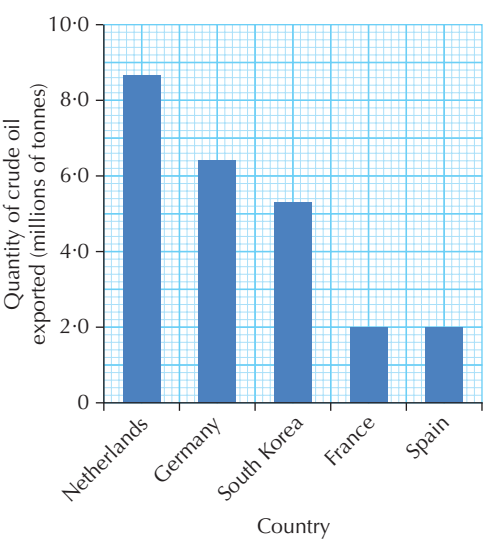
ii The oil is running out **OR** New, cleaner technologies make oil production less attractive/economical.

4 **a** **i** 2004

ii Gas production decreased over time.

b Gas has been imported from other countries.

5



6 **a** Natural gas

b It provides the UK with another energy source; it will create thousands of jobs; it could save the UK from having to import more natural gas to meet its needs.

c Any **three** of: contaminates water supplies; causes earthquakes; destroys the local environment; undermines the country's efforts to tackle climate change.

d If energy is produced by fracking, the government will have less need to look elsewhere for clean (non-fossil fuel) sources of energy.

e It includes positive and negative points about fracking.

Exercise 10B Burning fuels

1 Throughout the world fossil fuels are burned to produce **energy**. When a fuel burns it reacts with **oxygen** from the air so the process is an example of **oxidation**. Burning is also known as **combustion**. When there is **unlimited** (lots of) oxygen present only **carbon dioxide** and **water** are produced. This is known as **complete** combustion. If there is **limited** (not a lot) oxygen, **carbon monoxide** and **carbon** are formed. This is known as **incomplete** combustion.

2 **a** A compound made from hydrogen and carbon only.

b methane + oxygen → carbon dioxide + water

c Exothermic

3 **a** Complete

b **i** It turns limewater cloudy.

ii Blue cobalt chloride paper turns pink.

Test the pH with an indicator or pH meter. The pH will be 7 for water.

4 **a** Not enough oxygen is present so carbon monoxide is produced instead of carbon dioxide (incomplete combustion).

b **i** It is poisonous/toxic.

ii Carbon monoxide is colourless and odourless so it is difficult to detect.

c CO

d Carbon

5 **a** Carbon

b **i** Yellow or safety flame

ii The air hole on the Bunsen is closed so limited air (oxygen) is present.

c Incomplete combustion

6 **a** Not enough air is present to enable complete combustion (causing incomplete combustion).

b **i** Catalytic converter

ii carbon monoxide + oxygen → carbon dioxide

7 **a** **i** Respiration

ii Carbon dioxide

iii Oxygen

b Endothermic

c Energy is given out.

8 **a** For a fire to start and keep burning it needs three things: heat to start the fire, a material (fuel) to burn and a supply of oxygen (from the air).

b If any of the three requirements for burning to occur are removed then the fire will stop.

9 **a** When the collar on the Bunsen is adjusted so that **a lot of** air gets into the Bunsen burner, the flame is hot.

b When the gas tap is switched off, the flame goes out because the **fuel** is removed.

10 **a** **i** 1 carbon atom, 4 hydrogen atoms, 4 oxygen atoms

ii 1 carbon atom, 4 hydrogen atoms, 4 oxygen atoms

b The number of each type of atom is the same so the mass of the products is equal to the mass of the reactants.

11 The 'missing 9 g' have been changed into products (mainly carbon dioxide and water which cannot be seen or easily weighed).

Chapter 11 Fuels and energy 3: The problems with fossil fuels

Exercise 11A The impact of burning fossil fuels

1 Fossil fuels are mainly made up of **hydrocarbon** compounds. **Carbon dioxide** is one of the gases which is produced when fossil fuels **burn**. Carbon dioxide is known as a **greenhouse** gas. Increased levels of carbon dioxide is one of the main reasons that the **atmosphere** is trapping more **heat** causing global **warming** which is affecting the world's **climate**.

2 **a** sulfur + oxygen → sulfur dioxide

b SO_2

c **i** Acid rain

ii Any **one** of: acidification of lochs; damage to plants; damage to the stonework of buildings.

3 Not burning coal will reduce the amount of carbon dioxide in the atmosphere (a product of burning coal) which contributes to global warming.

4 **a** Burning of coal produces smoke so closing coal-fired stations means less smoke to combine with fog to make smog.

b Smog makes it difficult to breathe.

5 **a** In a smoke control area, it is not allowed to burn fuels such as coal.

b 'Auld Reekie' got its name from the smoke which came from the burning of coal in homes and businesses. The soot was part of the smoke.

6 **a** Any **two** of: oxides of nitrogen; small particles (particulates); unburned hydrocarbons; carbon monoxide.

b Difficulty breathing or damaging the lungs

c To try to avoid breathing in the harmful gases and particles.

7 **a**

Year	Proportion of low carbon emission buses (%)
2017	10
2021	20
2025	30
2028	40
2032	50

b To reduce the amount of greenhouse gases getting into the atmosphere.

8 **a** Global warming

b The build-up of greenhouse gases in the atmosphere traps more heat.

9 **a** Climate change/global warming

b **i** It could increase the greenhouse effect.

ii It could increase the size of the crater and more methane could be released.

Chapter 12 Fuels and energy 4: Meeting energy needs in the future

Exercise 12A Sustainable sources of energy

1 Our **fossil** fuels will run out eventually so we need to use other energy sources. We also need to use less fossil fuel to reduce the amount of **carbon dioxide** produced when fossil fuels **burn**. Carbon dioxide is a **greenhouse** gas which causes **global** warming. We need to develop energy sources which reduce carbon dioxide emissions and which are **sustainable** – they will be able to be used by future generations. They include **renewable** energy sources such as wind and **solar** power and **non-renewable** energy sources such as **nuclear** energy.

2 **a** Biomass

b Wood

c **i** Biofuels

ii Biodiesel

3 **a** A renewable resource is a resource which can be replaced.

b A lot of sugar cane is grown in Brazil.

c Carbon dioxide is a greenhouse gas. The build-up of greenhouse gases causes global warming.

d 25% ethanol and 75% petrol

e As a fuel

4 **a** **i** Heat

ii Exothermic

b **i** hydrogen + oxygen → water

ii No carbon dioxide produced **OR** The only product is water.

5 **a** A natural gas, oil, B nuclear, C other renewables, D hydro, E coal, peat

b 66%

c Use more renewables, hydroelectricity and nuclear.

d To reduce the amount of carbon dioxide (or greenhouse gases) being released into the atmosphere.

e Any **two** of: wind; waves and tides; Sun; hydroelectricity; geothermal; hydrogen.

6 **a** **i** Finite

ii Renewable

iii Finite

iv Renewable

v Renewable

b **i** A sustainable resource is one which **will** be available to us in the future.

ii Waves and tides, wind, Sun

c **i** The Sun doesn't always shine and there isn't always enough wind.

ii Solar panel sites are **expensive** to set up.

d Electricity (from movement (kinetic) energy)

7 **a** No carbon dioxide is produced.

b Scotland has mountains and fast-flowing rivers/lochs.

c Cruachan power station is a pump-storage **hydroelectric** power station in Argyle and Bute, Scotland. It uses cheap electricity produced at **night** to pump water from Loch Awe to a **reservoir** over 300 metres high in the **mountains**. The water can then be **released** during the day to make **electricity** when it is most needed.

Chapter 13 Fuels 2: Solutions to fossil fuel problems

Exercise 13A The carbon cycle and reducing carbon dioxide emissions

1 All living things are made from **carbon** compounds. The carbon needed to make these compounds comes from **carbon dioxide** in the atmosphere. Green **plants** remove carbon dioxide from the atmosphere by **photosynthesis**. Carbon in plants is passed onto **animals** along food chains. Carbon dioxide passes **back** into the atmosphere by a process called **respiration**. Respiration happens in living things and involves the production of **energy** and carbon dioxide. Under certain conditions carbon compounds are **trapped** in the Earth when living things die and carbon dioxide is **not** released back into the atmosphere. This is what happened **millions** of years ago when **fossil** fuels were formed. These processes combined are known as the carbon **cycle**.

2 **a** Any **two** of: wood; animal waste; waste material from growing crops.

b The carbon dioxide that is released when biomass burns is replacing the carbon dioxide taken from the atmosphere during photosynthesis.

c **i** Food waste or human waste

ii To stop carbon dioxide being released into the atmosphere when the biogas is burned. Carbon dioxide doesn't burn.

d **i** Biodiesel and bioethanol

ii It doesn't need to be disposed of in another way.

3 Plants absorb carbon dioxide so there will be less carbon dioxide in the atmosphere.

4 **a** Carbon neutral means that as much carbon dioxide is removed from the atmosphere as is released into it **OR** To achieve a zero carbon footprint.

b Carbon dioxide can be liquefied and stored underground.

c Scotland has a number of depleted oil wells in the North Sea.

d Carbon capture and storage reduces the amount of carbon dioxide being released into the atmosphere and stores the carbon dioxide for a long time.

e Carbon capture and storage is expensive and could cause acidification of the oceans.

5 **a i** A photosynthesis, B respiration, C combustion

ii Fossil fuels

b The Sun

c The carbon cycle

d i Burning of fossil fuels

ii Carbon dioxide is a greenhouse gas which causes global warming.

iii Stop or reduce burning fossil fuels and use more renewable energy sources.

6 **a** To compare the amount of biogas obtained from different types of biomass.

b They could time how long each flame burned for.

c Collect the gas over water, using a measuring cylinder to measure the volume of gas **OR** Collect the gas in a gas syringe.

d Use the same mass (weight) of each type of biomass.

7 **a** Nuclear energy is **sustainable** and **non-renewable**.

b i Naturally hot water from under the ground.

ii Geothermal energy is **sustainable** and **renewable**.

8

Type of energy	Advantages	Disadvantages
a Geothermal	Reliable Plentiful source	High cost Possible greenhouse gas emissions
b Biomass	Carbon neutral Can be used to make biofuels	Land could be used to grow food crops Needs fertilisers which can cause pollution
c Wave and tidal	No greenhouse gas emissions It is known in advance how much electricity will be made	Needs to be sited near land High cost
d Hydro-electricity	No greenhouse gas emissions Can be switched on and off quickly	Can only be built in certain areas Land and wildlife affected when reservoirs built
e Wind	No greenhouse gas emissions Can be sited offshore	Dependent on weather conditions Some people think it spoils the environment
f Solar	No greenhouse gas emissions Energy from the Sun costs nothing	Dependent on weather conditions Less energy is produced in the winter when it is needed the most
g Nuclear	No greenhouse gas emissions Reliable	Difficult to get rid of waste Risk of accidents

Chapter 14 Fuels 3: Hydrocarbons

Exercise 14A Fractional distillation

1 Crude **oil** is a complicated mixture of **hydrocarbons** which is not very useful when it comes out of the ground. To make it useful, the oil is **separated** into smaller **mixtures**. This is known as **refining** the oil and the first step in the process is called **fractional** distillation. The oil is **heated** and compounds with similar **boiling** points are collected together. These mixtures are known as **fractions**.

2 **a** A 4, B 2, C 1, D 3

b **i** B **ii** A

iii B **iv** D

v B **vi** A

c Fractional distillation

3

Fraction	Uses
refinery gas	**bottled gas**
petrol	**fuel for cars**
naphtha	**making chemicals**
kerosene	**jet fuel**
diesel	**fuel for cars, lorries and trains**
lubricating oil	engine oil
fuel oil	**fuel for ships**
bitumen	**tar for roads**

4 **a** **i** Condensate can be described as a **volatile** liquid.

ii Condensate is likely to contain **quite large** molecules.

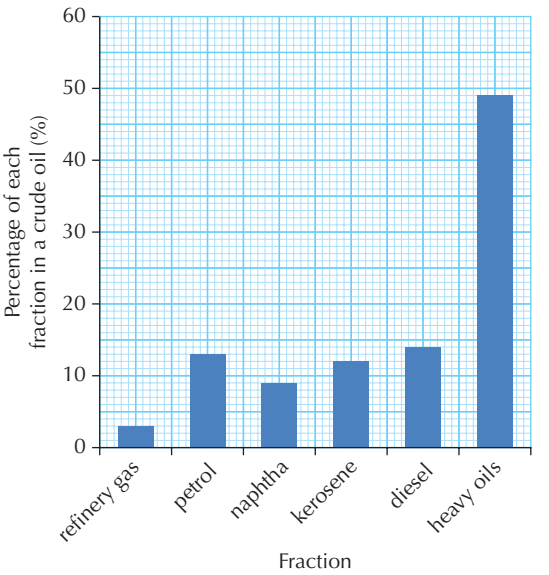
iii Condensate is likely produced at the **middle** of a fractionating tower.

b Burns easily

c The condensate catching fire

d It is difficult to see where it is in the water.

5



Exercise 14B Alkanes and alkenes

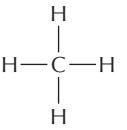
1 **a** Carbon and hydrogen

b Hydrocarbon

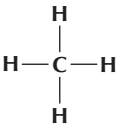
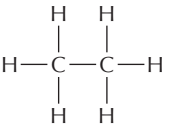
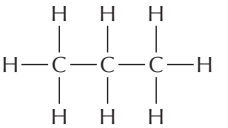
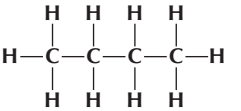
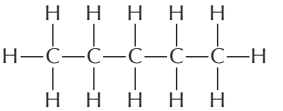
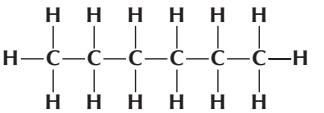
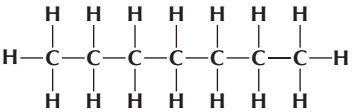
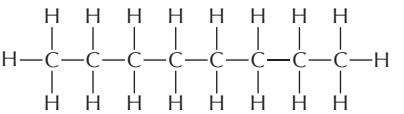
c Alkanes

d CH_4

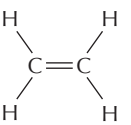
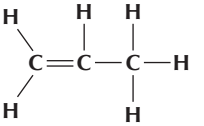
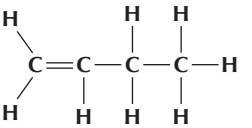
e



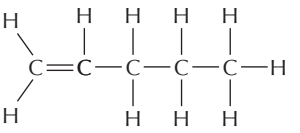
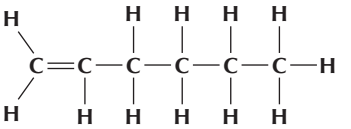
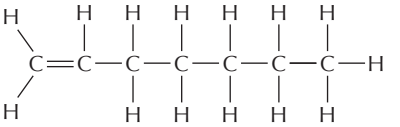
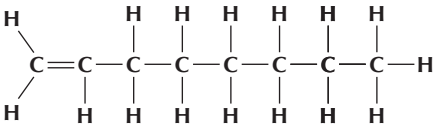
2

Alkane name	Number of carbons	Number of hydrogens	Molecular formula	Full structural formula
methane	1	4	CH_4	
ethane	**2**	**6**	C_2H_6	
propane	3	**8**	C_3H_8	
butane	**4**	**10**	C_4H_{10}	
pentane	**5**	12	C_5H_{12}	
hexane	6	14	C_6H_{14}	
heptane	**7**	**16**	C_7H_{16}	
octane	**8**	**18**	C_8H_{18}	

3 **a**

Alkene name	Number of carbons	Number of hydrogens	Molecular formula	Full structural formula
ethene	**2**	**4**	C_2H_4	
propene	**3**	6	C_3H_6	
butene	4	8	C_4H_8	

(continued)

Alkene name	Number of carbons	Number of hydrogens	Molecular formula	Full structural formula
pentene	**5**	**10**	C_5H_{10}	
hexene	**6**	**12**	C_6H_{12}	
heptene	**7**	**14**	C_7H_{14}	
octene	8	16	C_8H_{16}	

b Alkenes must have a C=C double bond (there must be at least 2 C atoms) so the first alkene is ethene (C_2H_4).

4 **a** Alkanes and alkenes are both families of **hydrocarbons**.

b Nonane is an **alkane**.

c Decene is an **alkene**.

d The carbon atoms in alkanes are joined by **single** bonds.

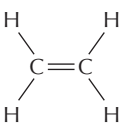
e **Alkenes** contain a carbon-to-carbon double bond.

f **Alkenes** decolourise bromine solution quickly.

5 **a** Tarring roads

b **i** Catalytic cracking

ii Fuels or making plastics

c **i** 

ethene

ii Alkenes

iii X hexane, Y butane

iv Alkanes

d **i** It quickly decolourises.

ii An alkene is produced which reacts with the bromine solution, causing it to decolourise.

iii It speeds up a reaction.

iv Remove the delivery tube from the bromine solution before removing the heat.

Chapter 15 Everyday consumer products 1: Plants for food

Exercise 15A What's in our food?

1 Plants are **foods** which are a good source of the **nutrients** we need for us to grow and keep our bodies **healthy**. We need to eat the correct foods so we get the essential elements and **compounds** our bodies need. This is known as a **balanced** diet. There are five main food groups that should be part of our **diet** to provide the nutrients we need. They are **carbohydrates**, fats and **oils**, proteins, **vitamins** and minerals.

2 **a** 1 D, 2 C, 3 E, 4 A, 5 B

b 1 B, 2 E, 3 D, 4 C, 5 A

c Balanced

d Eating too much food containing carbohydrates, fats and oils is unhealthy because these food groups are high in energy (calories) so a person who does this risks becoming overweight.

3 **a** Starch **b** Protein

c Benedict's solution will change from **blue** to **orange** when glucose is tested.

d Fat/oil

4 **a**

BMI	Normal/Overweight/ Obese
19–25	normal
25–30	overweight
more than 30	obese

b **i** 34·7 (kg/m^2)

ii Obese

iii Carbohydrate and fats/oils

iv Exercise

v Any **two** of: heart disease; type 2 diabetes; high blood pressure.

5 **a** **i** B

ii Sample B has fewer red blood cells than sample A.

b **i** Soybeans

ii Sunflower seeds and spinach

iii They contain iron which helps prevent anaemia.

iv Kiwi fruit or red pepper

6 **a** **i** Essential fatty acids in the diet are thought to **decrease** unhealthy blood fat.

ii Essential fatty acids **cannot** be made in the body.

iii The best sources of omega 3 and 6 essential fatty acids are **plants**.

b **i** Our bodies **cannot** store protein.

ii We get our protein from **food**.

iii There are thought to be health benefits from eating more **plant** protein.

Exercise 15B Alcohols and fertilisers

1 Alcohol can be produced from the **sugars** found in **plants** by a process called **fermentation**. Beer and **wine** are examples of drinks containing **alcohol**. Beer generally has around **4%** alcohol. Wine can contain up to **15%** alcohol. Drinks such as brandy and whisky contain around **40%** alcohol. To increase the alcohol content of a drink the fermented solution has to be **distilled**. This involves **heating** the solution until the alcohol **separates** from the water and is collected.

2 **a** Too much alcohol causes health problems.

b **i** 6 **ii** 8 **iii** 14

c **i** Alcohol has a negative effect on a person's judgement and driving skills.

ii Don't drink and drive.

3 **a** **i** Nutrients

ii Nitrogen, potassium and phosphorus.

iii The soil

iv Add fertilisers

v We eat plants and/or animals which have eaten plants.

b **i** A

ii It hasn't grown as well as plant B.

Chapter 16 Everyday consumer products 2: Cosmetic products

Exercise 16A Plants, cosmetics and essential oils

1 Plant products such as **carbohydrates**, fats and **oils** are used in the **cosmetics** industry. Cosmetics are used to **change** the way the body **looks** or smells. A carbohydrate extracted from seaweed is added to **creams** used to soften the **skin** and hair. Cocoa butter is a **fat** obtained from the **cocoa** bean. It is in many **moisturising** body creams. Plant oils like **olive** oil are included in creams which keep the skin **soft** by preventing the loss of water.

Half the weight of a lipstick is due to castor oil **extracted** from the castor bean. It forms a tough **shiny** film when it dries.

2 **a** Pleasant smell

b i Orange peel oil

ii Shea butter

iii Orange peel oil

iv Soybean oil

3 **a i** Lavender: flower (and leaves)

ii Peppermint: leaves

iii Ginger: root

iv Lemon: fruit

b i Peppermint

ii Lemon

iii Lavender

iv Ginger

4 **a** Steam distillation

b To contain (hold) the orange peel.

c To cool the gas and change it into liquid.

d A pleasant smell or oily liquid seen.

e Cold pressing or use a solvent.

5 **a i** A blend is a mixture.

ii They have a pleasant smell.

b i Top

ii Middle or base

iii Any **one** of: sandalwood; cinnamon; clove; patchouli vanilla; vetiver; ylang ylang.

iv So that the smell lasts for many hours.

6 **a** 18%

b £2·16 billion

Chapter 17 Everyday consumer products 3: Plants for energy

Exercise 17A Carbohydrates, fats and oils

1 **a** Plants

b Food and fuels

2 **a** $C_6H_{12}O_6$

b 2:1

c Carbohydrates (sugars)

3 **a** Carbon

b i Hydrogen and oxygen (steam is hot water)

ii Exothermic

4 **a i** Glucose is a **simple** carbohydrate.

ii Starch is a **complex** carbohydrate.

b $C_6H_{12}O_6$

c Lots of glucose molecules join together to form a starch molecule.

d In starch molecules

5 **a** When iodine is added to starch, a **blue–black** colour appears.

b When a mixture of Benedict's solution and glucose is warmed, the colour changes from **blue** to **orange**.

6 Add iodine to a sample of each; the starch sample would turn blue–black but the glucose sample would not.

Warm some Benedict's solution with a sample of each; the blue Benedict's solution would turn orange when warmed with glucose but not with starch.

Exercise 17B Enzymes and digestion

1 **a** Digestion

b Glucose

c The molecules formed when starch breaks down are smaller than starch molecules.

2 **a i** Respiration

ii Energy

b i glucose + oxygen → carbon dioxide + water

ii $C_6H_{12}O_6 + O_2 \rightarrow CO_2 + H_2O$

3 **a** To find out if amylase can break down starch.

b There was no starch present.

c A blue–black colour would appear.

d Amylase breaks down starch.

e Warm with blue Benedict's solution. If glucose is present the colour will change from blue to orange.

f The enzyme works best over this temperature range. (This is close to body temperature.)

g It speeds up the reaction.

4 **a** Ethanol

b Glucose

c Enzymes

d i Enzymes are killed (stop working) at this percentage of alcohol.

ii The fermented mixture is distilled, allowing a higher percentage of alcohol to be obtained.

e The plants from which the drinks are made are different, and also different flavourings and sugars are added.

5 **a i** 28 °C

ii It is killed (won't work at all).

b Pepsin

c Optimum conditions

6 26·6 units

Chapter 18 Plants to products

Exercise 18A Products from plants

1 **Chemists** have an important role to play in the design and **manufacture** of products which can be obtained from **plants**. This includes: processing plants to produce **food** for us to eat; **extracting** compounds such as **dyes** and **compounds** which can be used as medicines; making new products such as soaps, **shampoos** and cosmetics.

2 **a** Corn flakes

b For example, bread, pasta, cakes, biscuits.

3 **a i** Blue

ii The dye won't be washed out of the clothes.

b Food colouring

4 Palm oil: soap; willow bark: aspirin; wheat: breakfast cereal; saffron: food colouring; argan essential oil: cosmetics; aloe vera: shampoo; opium poppy: morphine

5 **a i** Medicines which come directly from plants are said to be **natural**.

ii Medicines made by chemists are **synthetic**.

b Active compound (ingredient)

c Ibuprofen

d i To mix up the contents so the active ingredients are distributed evenly.

ii One 2·5 ml spoonful 3–4 times a day.

iii Four

iv Talk to a doctor.

6 **a** Salicin

b Meadowsweet flowers found in Europe and western Asia.

c Acetyl salicylate

d It reduces fever or inflammation or pain.

e To thin the blood to reduce risk of stroke or reduce risk of heart attack.

7 **a** **i** Morphine

ii It can be addictive and harm the user's health.

b **i** Heroin

ii It is highly addictive and very harmful.

c It can relieve pain caused by some conditions.

Chemistry in society

Chapter 19 Properties of materials 1

Exercise 19A Materials

1 Materials which come from plants, animals or out of the earth are said to be **natural**. Materials which are made from chemicals are said to be **synthetic**. Materials which are made from natural materials are said to be **manufactured**.

2 **a** Natural

b Manufactured

c Synthetic

3 **a** 1 C, 2 D, 3 A, 4 B

b Cotton

4 **a** **i** Metal

ii Ceramic

iii Ceramic and plastic

b **i** Plastic

ii Ceramic

iii Metal

iv Plastic

v Metal

vi Ceramic

5 **a** Electrical conductor

b Electrical insulator

c So that the cable can bend.

6 **a** Metal teaspoon

b Use the same size of spoon.

7 **a** A plastic which can be melted and reshaped is called **thermoplastic**.

b A plastic which cannot be melted and reshaped is called **thermosetting**.

8 **a** Thermosetting plastics don't melt but thermoplastics do, and it would be dangerous to have an electrical socket that could melt.

b Thermoplastic

c Thermoplastics can be melted and reshaped but thermosetting don't melt.

9 **a** Any **one** of: plastics cause pollution; throwing plastic bags away wastes money and/or plastic.

b Plastic which has been melted and made into something useful.

10 **a** They absorb lots of water (urine).

b If the frames get bent they can easily be reshaped.

c Plastics are usually good insulators of electricity.

d A colour change could indicate when the food was hot (cooked) enough to eat.

Exercise 19B Fibres and fabrics

1 **a** **i**

Fibre	Natural or synthetic
wool	natural
polyester	synthetic
nylon	synthetic
cotton	natural
silk	natural

ii Wool: animals; cotton: plants; silk: animals (silkworm).

b i Heat insulator (traps heat) **OR** Flexible

ii Water resistant or hard wearing

iii It is good at absorbing water

iv Strength

v Making clothes, especially delicate clothes that are worn next to the skin.

2 **a** To test (compare) the strength of different (natural/synthetic) fibres.

b i Nylon

ii It needs the greatest weight to break the thread.

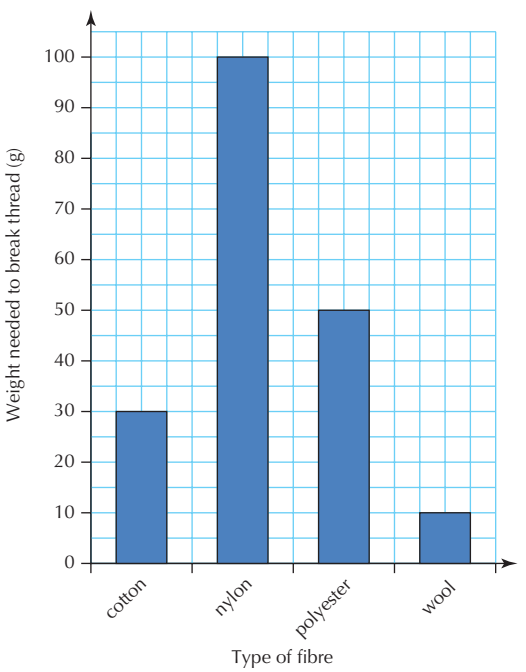
c Natural

d It would break too easily.

e i To make the comparison fair.

ii The thickness of each thread.

d



3 **a**

Fibre	Percentage (%)
cotton	55
nylon	38
viscose	7

b Mixing fibres combines the properties of the different fibres.

c i The material is easily damaged in the wash (may shrink).

ii The material is easily damaged by heat (may melt some fibres).

iii The material is flammable (catches fire easily).

4 Carpets C, clothing D, household textiles B, industrial textiles A

5 Some outdoor jackets are made up of layers of different **materials**. The outside layer is usually **windproof** and **water** resistant. The middle layer traps **heat** from the body to keep you warm. All the layers allow **moisture** to escape from the body. This is said to make the jacket **breathable**.

6 **a** Jute

b Polypropylene

c Long fibres (can be made into strong threads)

d Stronger/more hard wearing.

7 **a i** A

ii Natural fibres are rougher than synthetic fibres.

b i A

ii The dust gets trapped in the rough fibres.

Chapter 20 Properties of materials 2

Exercise 20A Polymers

1 **a** Poly(propene)

b Polymer

c Polymerisation

d Monomers

2 **a i** It is waterproof.

ii It is hard wearing.

b i It would melt (it is thermosoftening/thermoplastic).

ii Can be melted, reshaped and made into something else.

iii Thermosoftening/thermoplastic

3 **a** Glucose

b Cellulose

c Polymerisation

d It is found in plants.

4

Monomer	Polymer
ethene	**poly(ethene)**
chloroethene	**poly(chloroethene)**
propene	poly(propene)
phenylethene	poly(phenylethene)

5 **a i** HDPE

ii It is more rigid and stronger than LDPE.

b i LDPE

ii It is easy to stretch and not rigid.

6 **a** It is non-stick.

b It is hard and resistant to rot.

c i It can be melted and reshaped.

ii It won't melt so it can't be reshaped.

iii So it won't melt in high temperatures.

iv Being thermosetting, they can't be melted so can't be reshaped and used for something else.

7 **a** Recycled: melted and made into something new.

Polymer: a long-chain molecule.

Thermosoftening: can be melted and reshaped.

b Thermosoftening polymers can be melted and reshaped, so can be recycled, but thermosetting can't be melted.

8 **a** The item can be recycled.

b Polystyrene

c Thermoplastic

9 Polythene: carbon monoxide

PVC: carbon monoxide and hydrogen chloride

Nylon: carbon monoxide and hydrogen cyanide

10 **a** Polythene

b PVC

c Nylon

11 **a** The material has been tested to make sure it resists burning.

b Armchair or sofa

c To show that they have been tested for fire-resistance (will not catch fire if a flame or cigarette is dropped on them).

12 **a** They will not break down/rot/decay for many years.

b i It will break down naturally/be broken down by microbes.

ii Biodegradable bags break down much more quickly than non-biodegradable.

c Harmful (toxic) gases could be produced.

d Any **one** of: reduce usage in the first place; reuse bags; recycle bottles and cartons.

Exercise 20B Ceramics and novel materials

1 **a** High wear-resistance

b Low heat conductivity

c High wear-resistance

d High resistance to chemical attack

e Very hard

2 **a** Polymers are usually resistant to water.

b Any **one** of: inside the lining of a baby's nappy; hair gel; contact lens.

3 Oil is a (mixture of) hydrocarbons so will be attracted to the Envirobond but water will not.

4 **a** Hard wearing, waterproof

b Withstands high temperatures, waterproof

c Electrical insulator

d Sets like rubber

5 **a** It is an electrical conductor.

b Seawater could be filtered to produce fresh water for drinking.

Chapter 21 Properties of metals 1

Exercise 21A Metals

1 Metals are good conductors of **heat** and **electricity**. They are generally **strong** and can be pressed into different **shapes**. They can be drawn out to form **wires** which can be twisted together to form cables for **electrical** appliances and cables that are strong enough to hold the **weight** of large structures such as the Forth Road Bridge.

2 **a** Y, Z, X

b zinc + oxygen → zinc oxide

3 **a** 2, 1, 3

b 3

c calcium + water → calcium hydroxide + hydrogen

4 They are very reactive with air, so submerging them in oil prevents contact with air.

5 **a** Corrosion

b Water and oxygen

c Rusting

6 **a** Iron (steel) is reactive; gold is not reactive.

b It is painted.

c Salt from the sea speeds up corrosion (rusting).

7 **a** **i** Painting

ii Dip in zinc (galvanise) or painting

iii Oiling/greasing

iv Coat with tin or plastic

b Protecting the metal by coating it with another long-lasting/not very reactive metal.

8 **a** It speeds it up.

b The water in oceans is salty, so encourages rusting.

9 **a**

Name of ore	Metal
haematite	iron
malachite	copper
galena	lead
bauxite	aluminium

b Gold can be found in the pure state in the ground because it is very **unreactive**.

c **i** Silver can be obtained from its ore by **heat** alone.

ii Iron can be extracted from its ore by first mixing it with **carbon** then heating it.

iii Aluminium is obtained by first melting the bauxite then passing **electricity** through it.

d Aluminium, iron, silver

Exercise 21B Metals and batteries

1 **a** Batteries use metals to produce **electricity**.

b A chemical **reaction** takes place inside a battery.

c Batteries stop working when the **chemicals** get used up.

d The metals in used batteries should be **recycled**.

e **Rechargeable** batteries can be charged up again when they run down.

f Smartphones and **laptops** use rechargeable batteries.

2 **a** A chemical reaction takes place.

b No more electricity would be produced **OR** The bulb would go out.

c The battery runs out of chemicals **OR** The chemical reaction stops.

3 **a** Bubbles of gas are produced.

b **i** A chemical reaction is producing electricity.

ii The bulb would go out.

c Bubbles of gas would be produced again.

Chapter 22 Properties of metals 2

Exercise 22A Reactivity of metals and alloying

1 1 D, 2 E, 3 B, 4 C, 5 A

2 **a** **i** X copper, Y iron, Z magnesium

ii Metal X reacts only slightly so must be the least reactive (copper).

Metal Z produces the brightest flame so is the most reactive (magnesium).

Metal Y is more reactive than X but less than Z so must be iron.

b $Mg + O_2 \rightarrow MgO$

c Exothermic

3 **a** **i** Metal A is **sodium**.

ii Metal B is **tin**.

iii Metal C is **calcium**.

b When a lighted splint is brought close to hydrogen it pops.

c **i** lithium + water → lithium hydroxide + hydrogen

ii It is alkaline.

4 **a** **i** A magnesium, B iron, C silver

ii A has the most bubbles so must have the most reactive metal (magnesium).

C has no bubbles so must have the least reactive metal (silver).

B has some bubbles but fewer than A, so must have the metal less reactive than magnesium but more reactive than silver (iron).

b $Mg + HCl \rightarrow MgCl_2 + H_2$

5 **a** Reactivity series

b **i** The most reactive metals are found at the **top** of the list.

ii The most unreactive metals are found at the **bottom** of the list.

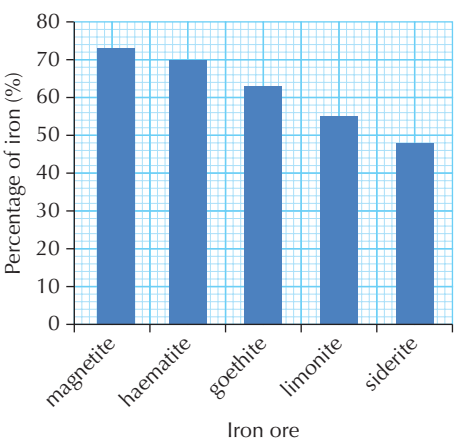
c **i** Using electricity

ii Heat with carbon

iii Heat

d Top

6 **a**



b **i** Magnetite, haematite and goethite

ii Carbon

c **i** Alloy

ii Strength

7 **a** A Brazil, B China, C India, D Australia

b Buy (import) it from other countries (e.g. Australia).

8 Metals such as aluminium need electricity which wasn't available thousands of years ago but metals such as copper and lead only need carbon and heat which were easily available even 5000 years ago.

9 **a** It is a metal mixed with other elements.

b i Low melting point

ii Hard wearing and resistant to corrosion

iii Steel is both strong and hard wearing but corrodes. Stainless steel is resistant to corrosion as well as being strong and hard wearing.

10 **a i** 9 carat (ct)

ii It has the least amount of gold in it.

b i 22 carat (ct)

ii It has the most amount of gold in it.

c 18 carat (ct)

Exercise 22B Corrosion and the electrochemical series

1 **a i** Air and water

ii Both air and water are present, and both are needed for corrosion to take place.

b Rusting

c i Positive

ii Metal atoms lose electrons.

2 **a i** Both the iron and the copper are corroding (reacting with the atmosphere).

ii Iron corrodes (reacts) faster than copper.

b i Rust

ii Paint them

iii Paint stops oxygen (air) and water reaching the iron.

3 **a** Desert is very dry so little water present.

b No (little) air present.

4 **a** Ferroxyl

b Ferroxyl changes from green (yellow/green) to (dark) blue.

5 **a** It is rusting.

b The copper is causing the rusting to speed up.

c The magnesium is stopping the iron nail from rusting.

d To compare the effect of attaching different metals to iron on the rate of rusting.

e Magnesium stops iron rusting when it is attached but copper speeds up rusting.

6 **a** Coating the steel with another metal that is less reactive than steel.

b Copper or silver

7 **a** Electrons

b The salt in the water speeds up rusting.

8 **a** It will rust.

b Rusted steel loses its strength.

c The car body would be less able to protect passengers if there is an accident.

d Painting

9 **a** Sacrificial protection

b Electrons

c i Any **one** of: sodium; magnesium; aluminium; zinc.

ii The metals are higher than iron in the electrochemical series.

d Magnesium attached to underground pipes made of steel.

10 **a** Electricity

b Electrolyte

c i Zinc to copper (through the wire)

ii Zinc is higher than copper in the electrochemical series.

11 **a** 0·9 V (accept any number between 0·4 and 1·4)

b **i** Magnesium and lead

ii Magnesium to lead

iii Magnesium is higher than lead in the electrochemical series.

Chapter 23 Properties of solutions

Exercise 23A Solubility of substances

1 **a** Water

b Coffee powder

c Add more coffee powder **OR** Use less water.

d A solution

e Soluble

2 **a** Sodium compounds and metal nitrates

b Silver sulfate

c Silver chloride

d Add water. Silver nitrate dissolves. Silver carbonate doesn't. Filter the mixture to obtain silver carbonate.

3 As the temperature **increases** the amount of copper sulfate dissolving **increases OR** As the temperature **decreases** the amount of copper sulfate dissolving **decreases.**

4 **a** Sugar (sucrose)

b To make the comparison fair.

5 **a** Water dissolves many substances.

b **i** They are soluble in warm/hot water.

ii The molecules are not soluble in oil at a warm/hot temperature.

6 **a** 13 g/100 cm^3 of water

b 60 °C

c 19 g/100 cm^3 of water

7 **a** **i** White spirit

ii Alcohol

b Alcohol

8 Wax is insoluble in water.

9 **a** They are not soluble in water.

b It can be harmful to the environment; it can be collected and reused.

Chapter 24 Fertilisers

Exercise 24A Growing healthy plants

1 **a** Nutrients are elements needed by plants.

b Plants need nutrients for healthy growth.

c Nitrogen, phosphorus and potassium.

d Any **one** of: dead (decaying) plants or leaves; animal waste.

e Plants are important to animals because they contain nutrients the animals need. Humans eat these animals and plants. Plants also produce oxygen.

2 **a** It supplies plants with nutrients.

b **i** Compost and manure.

ii Compost: rotted plant material.

Manure: animal waste.

c **i** Made from chemicals.

ii There is not enough natural fertiliser to meet consumer demand for food so farmers use synthetic fertilisers to help produce more food.

3 **a** ammonia + nitric acid → ammonium nitrate

b Neutralisation

c **i** 35%

ii It is soluble in water.

d **i** Phosphoric acid

ii It supplies nitrogen and phosphorus.

4 **a** 52·3%

b It supplies more of the main elements (potassium, sulfur, magnesium and calcium) than potassium chloride.

c Very little needed.

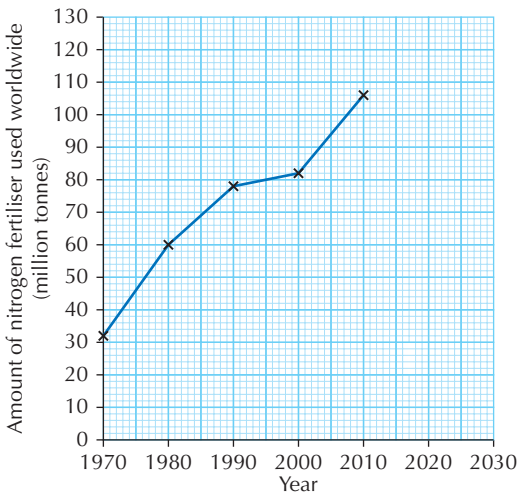
5 **a** N = nitrogen, P = phosphorus, K = potassium

b The fertiliser is made up of 28% nitrogen, 14% phosphorus and 14% potassium.

c It supplies each of the nutrients in the quantities needed by the plants that the farmer is growing.

6 Nitrogen fertiliser doesn't have to be added. There is an unlimited supply of nitrogen in the air.

7 **a**



b 130 million tonnes

c It is increasing.

d As the world population increases more food has to be produced, and so more fertiliser is needed.

8 **a** As the temperature increases so does the solubility of both compounds.

b So the roots of the plant can take the nutrients in.

c **i** The loss of water-soluble plant nutrients from the soil.

ii Algal blooms form which take oxygen out of the water, killing marine life.

iii It wastes fertiliser or wastes money.

d **i** Urea is less soluble than ammonium nitrate so there is less chance of urea leaching out.

ii Ammonium nitrate

iii Ammonium nitrate is more soluble (and the risk of leaching due to flooding is low).

e **i** 46·7%

ii Urea

9 **a**

Area	Amount of nitrogen fertiliser needed (million tonnes)
Africa	4
Europe	17
The Americas	29
Asia	73

b **i** Asia

ii Asia has the biggest population in the world so needs a lot of food, therefore needs more fertiliser.

Chapter 25 Nuclear chemistry

Exercise 25A Formation of elements and background radiation

1 **a** The Big Bang is thought to have produced all of the **hydrogen** and helium in the universe. These elements are the **lightest** elements. In **stars**, hydrogen atoms **join** with each other and form **helium**. More atoms combine forming **heavier** elements. This process continues until iron is formed.

b **two** hydrogen atoms → one **helium** atom

$$H + H \rightarrow \mathbf{He}$$

Atomic number:

$$\mathbf{1} + \mathbf{1} \rightarrow 2$$

c Overall, heat energy is taken in during the reaction.

2 **a i** **three** helium atoms → one **carbon** atom

$$He + He + \mathbf{He} \rightarrow C$$

Atomic number:

$$2 + 2 + 2 \rightarrow \mathbf{6}$$

ii one carbon atom + one **helium** atom → **one** oxygen atom

$$\mathbf{C} + \mathbf{He} \rightarrow O$$

Atomic number:

$$6 + 2 \rightarrow \mathbf{8}$$

b Nuclear fusion

c Exothermic

3

Atoms joining	Atom formed
helium (2) and lithium (3)	**boron** (5)
boron (5) and sulfur (16)	**scandium** (**21**)
oxygen (8) and fluorine (9)	**chlorine** (**17**)
hydrogen (1) and **aluminium** (**13**)	silicon (14)
beryllium (4) and **nitrogen** (7)	sodium (**11**)
magnesium (**12**) and **boron** (**5**)	**chlorine** (17)

4 **a** Background radiation

b Any **two** of: cosmic rays (from space); living things (plants and animals) which are consumed as food/drink; the ground/rocks/soil.

c Medical devices

d Natural

5 **a** A breathing air, B from space, C food and drink, D the ground

b Natural

c Radioactivity damages human cells.

6 **a** 6 hours

b 0·25 g

7 **a** Radioactivity is harmful to humans and other animals which eat the radioactive plants and animals.

b To stop the radioactivity getting into the air.

8 **a** To test whether radioactivity has been released into the environment.

b Geiger–Müller tube (Geiger counter).

9 Aircraft fly at heights where there is less protection from cosmic rays.

Chapter 26 Chemical analysis 1

Exercise 26A Chemical hazards and analysis

1 **a** Mossmorran and Grangemouth

b GlaxoSmithKline and MacFarlan Smith

c (Crude) oil

d Fire risk, especially if there is an accident

2 **a** 12%

b

Chemicals from oil	Percentage produced (%)
petrol and diesel	46
fuel and gas oil	23
fuel gas and jet fuel	19
chemicals used to make plastic	12

3 **a** Eye protection, gloves, lab coat/overalls

b Safety goggles (glasses)

4 **a** A 3, B 6, C 5, D 1, E 2, F 4

b **i** E

ii B

iii A

iv D

c **i** B and E

ii A

d i They may be injured in an accident and not able to speak, therefore unable to tell others of any hazardous contents being carried.

ii Hazard symbols are attached to the tanker.

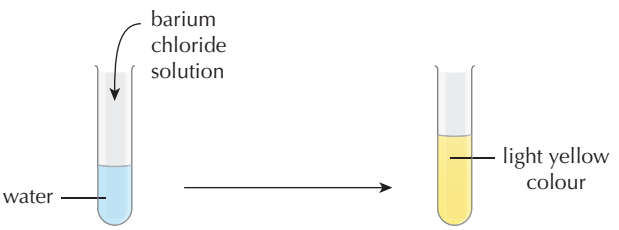
5 a Test the pH of a sample of the water by adding universal indicator, or pH paper or using a pH meter.

b Universal indicator turns yellow/red, pH paper turns red, or pH is measured as less than 7.

c To make sure the pollution isn't coming from somewhere upstream and not the factory.

6 a X potassium chromate, Y orange colour, Z water

b



Chapter 27 Chemical analysis 2

Exercise 27A The role of analytical chemists and techniques

1 a To make sure there is nothing in the food which will make us ill.

b To make sure there is nothing in the cleaning fluid which could harm you or damage whatever is being cleaned.

c To find out which metals are in the ore.

d To see if they can match them with a suspect's clothing.

e To make sure it has the right pH for growing crops or other plants (e.g. flowers, trees).

f To see which nutrients might need to be added for healthy plant growth.

g To check there are no harmful or untreated chemicals being discharged.

h To check for harmful polluting gases from vehicles.

i To make sure there are no harmful chemicals in it, or the water has been treated properly.

2 a To make sure that a company's own chemists are doing the correct analysis **OR** To investigate incidents such as food poisoning outbreaks or the source of water pollution, etc.

b i FSA

ii They are the agency who analyse food and drinks.

c i SEPA

ii They are the agency which deals with causes of water pollution which may have killed the fish.

iii pH test

3 a Filtering. The soil is trapped in the filter paper and the water passes through.

b You have to know the pH of the water before and after mixing with the soil so that you can see if there is any change in the pH of the water as a result of the mixing after it is mixed with the soil.

c Use a pH meter.

d i Acidic

ii Orange/yellow

iii Alkaline

iv Dark green/blue

v Acid

4 a To dissolve the salt.

b To make sure all the salt dissolved as quickly as possible.

c Filtering

d Warm the solution until all the water has evaporated.

e 80·6%

f They are correct.

5 **a** Distillation

b **i** The one with the lower boiling point (100 °C).

ii Water

6 **a** It is not necessarily lithium as strontium also produces a red flame.

b **i** Copper

ii There may not be enough of the metal to make it worth mining.

7 **a** The sample found at the crime scene matches the paint on the suspect's car.

b Both sets of spots match exactly.

8 **a** Two

b **i** One

ii Only one spot matches with the spots in the permitted colour.

c **i** They shouldn't use the colouring.

ii There is only one permitted dye in the bought colouring. The other dye might be harmful if eaten.