

WJEC GCSE

The Sciences (Double Award)

Approved by Qualifications Wales

Sample Assessment Materials

Unit 2: Chemistry - Chemical Substances and How They Behave
Foundation Tier

Teaching from 2026
For award from 2028



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Surname
First name(s)

Centre number

Candidate number
0



GCSE

3455U2

**The Sciences (Double Award) – Unit 2
Chemistry: Chemical Substances and
How They Behave**

FOUNDATION TIER

1 hour 15 minutes

**SAMPLE ASSESSMENT
MATERIALS**

Additional materials

A calculator and ruler are permitted.

Instructions to candidates

Use black ink or black ball-point pen. Do **not** use gel pen or correction fluid.

You may use a pencil for graphs and diagrams only.

Write your name, centre number and candidate number in the spaces provided at the top of this page.

Answer **all** questions.

For examiner's use only		
Question	Maximum mark	Mark awarded
1.	6	
2.	5	
3.	5	
4.	8	
5.	10	
6.	8	
7.	7	
8.	7	
Total	56	

Write your answers in the spaces in this booklet. If you need more space, use the additional page(s) at the back of this booklet. Number the question(s) correctly.

Information for candidates

The number of marks is given in brackets at the end of each question or part-question.

The total number of marks available is **56**.

You should think carefully about how you use your time.

Your responses must be clear, accurate and well presented.

Answer **all** questions.

1. This question is about elements, compounds and ions.

Examiner
only

- (a) (i) Sodium reacts with chlorine to produce sodium chloride.

Draw one line from each substance to the correct description of that substance.

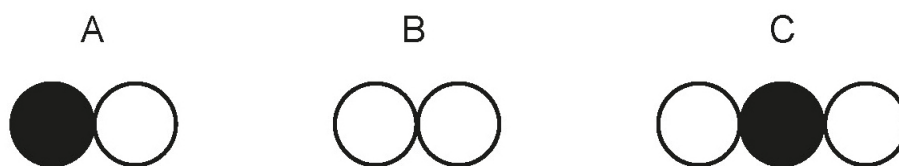
[2]

Substance	Description
Sodium chloride	compound
	metal
chlorine	element
	mixture

- (ii) The chemical formula for chlorine is Cl_2 .

Give the letter of the diagram below that represents a molecule of chlorine.

[1]



Letter:.....

- (b) Sodium chloride contains the ions Na^+ and Cl^- .

Underline the correct chemical formula for sodium chloride.

[1]

NaCl

NaCl₂

Na₂Cl

(c) Sodium chloride is common salt used in cooking and food preparation.

- (i) A flame test was carried out on a sample of sodium chloride.

Choose from the box below the colour you would see due to the presence of sodium ions.

[1]

red	lilac	yellow
------------	--------------	---------------

Colour:

- (ii) Silver nitrate solution was added to a solution of sodium chloride.

Choose from the box below the colour of the precipitate you would see due to the presence of chloride ions.

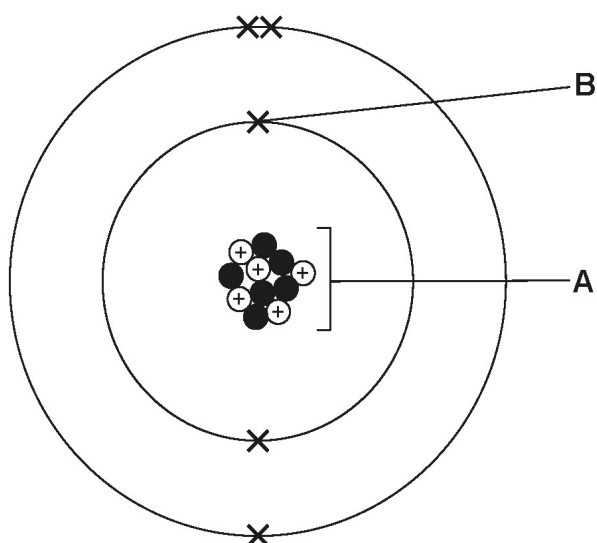
[1]

white	cream	yellow
--------------	--------------	---------------

Colour:

6

2. (a) The diagram below represents an atom of element **Z**.



- (i) Circle the name of the part of the atom labelled **A**.

[1]

proton nucleus electron neutron

- (ii) Circle the name of the part of the atom labelled **B**.

[1]

proton nucleus electron neutron

- (iii) Use the diagram above to find the mass number of element **Z**.

Choose a number from the box.

[1]

11	5	6	16
-----------	----------	----------	-----------

Mass number:

- (b) Isotopes are atoms of the same element that have the same number of protons but different numbers of neutrons.

Identify the atom that is **not** an isotope of bromine.

Give a reason for your answer.

[2]

Atom	Mass number	Atomic number
A	79	35
B	80	34
C	81	35

Atom:

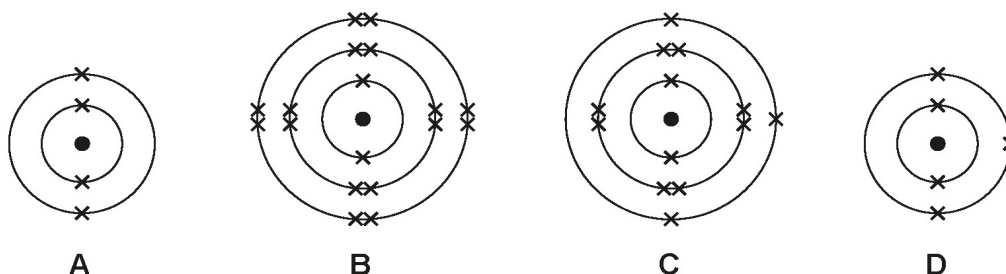
Reason:

.....
.....

3. This question is about electronic structure and the periodic table.

The diagrams below show the electronic structures of four elements, **A**, **B**, **C** and **D**.

The letters are not the symbols of the elements.



Use letters **A-D** to answer the questions that follow.

- (a) Give the letters of the elements found in group 3 of the periodic table.

Give the reason for your choice.

[2]

Letters:and.....

Reason:

.....

- (b) Give the letters of the elements found in period 2 of the periodic table.

Give the reason for your choice.

[2]

Letters:and.....

Reason:

.....

- (c) The inert gases are unreactive because they have a full outer shell of electrons.

Give the letter of the element that is an inert gas.

[1]

Letter:

4. Climate change is reducing the supply of water in many countries at the same time as demand for clean drinking water is increasing.

(a) Chose a word from the box to complete the description of potable water.

[1]

dissolved	floating	solid
------------------	-----------------	--------------

Water that is safe for humans to drink is called potable water.

Potable water is not pure water because it almost always

contains impurities.

- (b) “Forever chemicals” are chemicals that do not break down easily in the environment or in our bodies. Forever chemicals called PFAs are found in household chemicals and prescription drugs.

A PFA used to make fabric stain resistant has the molecular formula $C_8HF_{17}O_3S$.

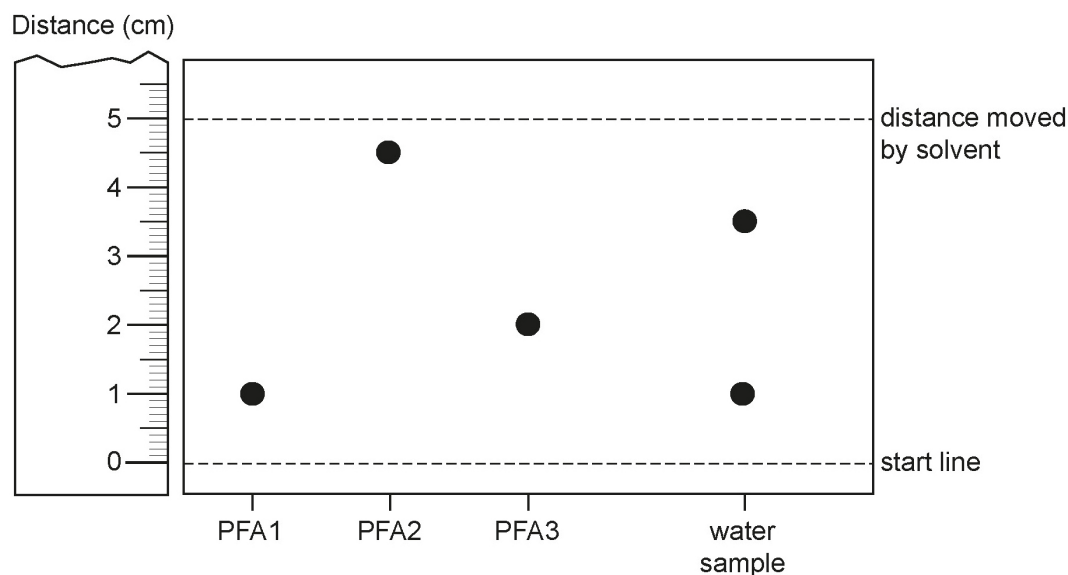
State the number of oxygen atoms in one molecule of $C_8HF_{17}O_3S$.

[1]

.....

- (c) When PFAs enter the sewage system they are not removed by standard water treatment so could contaminate the water supply. It is important that drinking water is routinely checked for these potentially toxic chemicals.

A water company tested a sample of water taken from a reservoir. The results are shown below.



- (i) Name the separation technique that generated these results. [1]

.....

- (ii) Identify the PFA present in the water sample.

Give a reason for your answer.

[2]

PFA:

Reason:

.....

.....

(iii) Calculate the R_f value for PFA2 using the equation given.

[2] Examiner only

$$R_f = \frac{\text{distance moved by PFA2}}{\text{distance moved by solvent}}$$

$R_f =$

(d) Suggest a separation technique that could be used to obtain pure water from drinking water that contains dissolved PFAs.

[1]

8

.....

5. This question is about the reactions of the group 1 metals.

- (a) Sodium and potassium are group 1 metals. When they react, they form ions with a +1 charge.

Put a tick (✓) in the box next to the statement that explains why the charge on a group 1 metal ion is +1.

[1]

the metal ion has more protons than electrons

☐

the metal ion has more electrons than protons

☐

the metal ion has equal numbers of protons and electrons

☐

- (b) Read the following passage from a newspaper article.

Residents evacuated after sodium blaze

On 14 November 2019, fire crews were called out after an explosion in a garage in a residential area of Birmingham. People living nearby were evacuated from their homes.

About 30 containers of sodium had been stored in the garage for many years. Over time the roof began to leak and some of the containers rusted. Rainwater began reacting with the sodium, producing hydrogen gas and causing the temperature inside the containers to increase. The gas eventually exploded causing the fire. A corrosive alkaline solution was also formed.

Containers which had not exploded were carefully placed in barrels of an unreactive liquid and left to cool.

- (i) State why the group 1 metals are called the “alkali” metals. [1]

.....
.....

- (ii) Sodium reacts with oxygen in the air to form sodium oxide.

- I. Write the formula for sodium oxide. [1]

.....

- II. Suggest how sodium should be stored to prevent this reaction from happening. [1]

.....

- (iii) Complete the word equation for the reaction of the sodium with water. [1]

sodium + water → + hydrogen

- (iv) State the term used to describe a reaction that gives out heat. [1]

.....

- (c) The table below shows the observations made when group 1 metals react with water.

Group 1 metal	Observations
lithium	bubbles moves slowly on the surface
sodium	bubbles quickly melts into a ball moves quickly on the surface
potassium	
rubidium	sinks explodes with a flame

State **two** observations that would be made when potassium reacts with water and describe the trend in reactivity down the group.

[3]

Observation 1:

Observation 2:

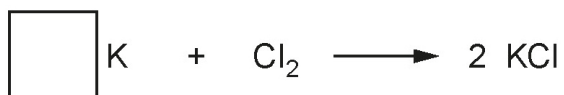
Trend:

.....

- (d) Potassium reacts with chlorine to form potassium chloride.

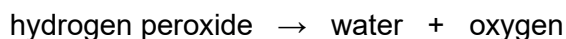
Complete the equation for the reaction by putting a number in the box to balance the equation.

[1]



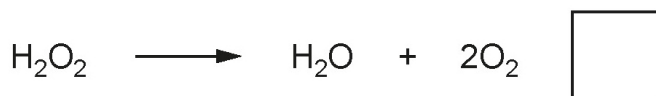
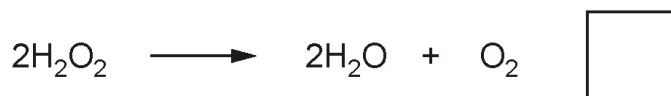
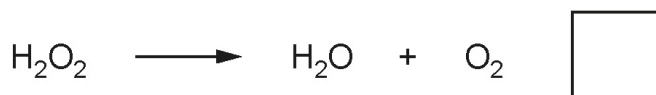
10

6. Hydrogen peroxide is a chemical used to dye hair. When a bottle of hydrogen peroxide solution is opened, it starts to break down, as shown in the word equation below.



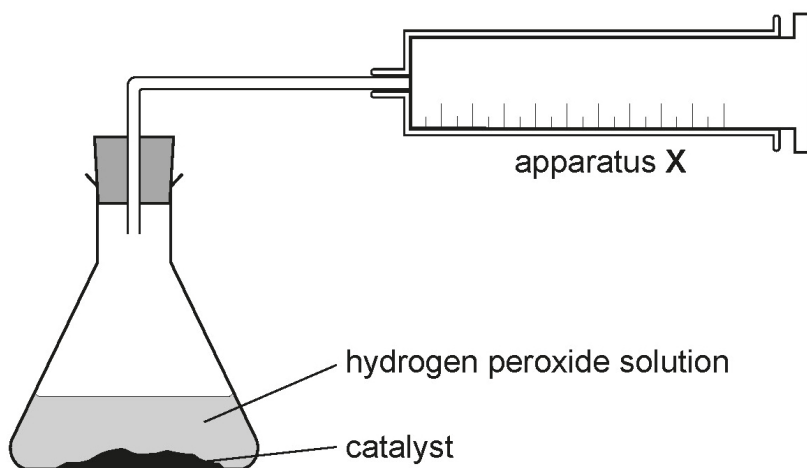
- (a) Put a tick (✓) in the box next to the correctly balanced equation for the breakdown of hydrogen peroxide solution.

[1]



- (b) The reaction is very slow at room temperature but its rate can be increased by using a catalyst.

The apparatus below is used to investigate the effect of two different catalysts on the rate of this reaction.



- (i) Name apparatus **X** which is used to measure the volume of oxygen formed.

[1]

.....

- (ii) Describe the chemical test you would carry out to show that the gas formed is oxygen. State the expected result.

[1]

.....

.....

- (c) A student investigates the effect of two catalysts on the breakdown of hydrogen peroxide by measuring the volume of oxygen gas formed every 50 seconds for 500 seconds.

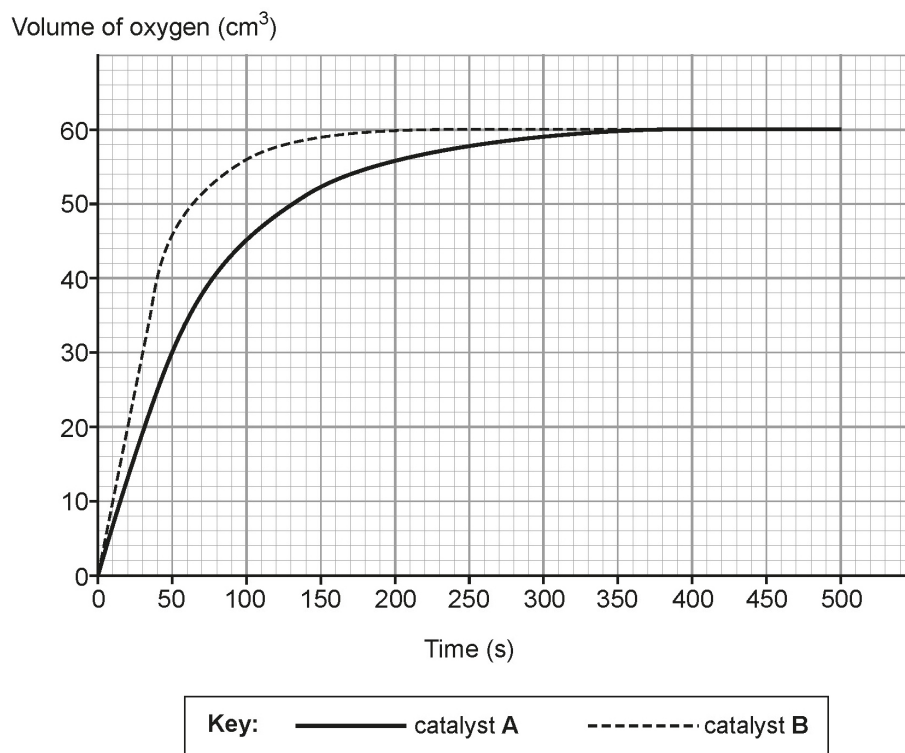
The student uses 50 cm³ of hydrogen peroxide and 1.0 g of the catalyst in each experiment.

- (i) It is important that the volume of hydrogen peroxide is kept the same to make it a fair test. State **one** other variable should be kept the same to make the investigation a fair test.

[1]

.....

- (ii) The results collected are shown in the graph below.



- I. Use the graph to find the time taken for 60 cm^3 of oxygen to be formed using catalyst **B**. [1]

Time = seconds

- II. Calculate the mean rate of the reaction using catalyst **B**. [1]

$$\text{mean rate of reaction} = \frac{\text{volume of oxygen formed}}{\text{time taken}}$$

Mean rate of reaction = cm^3/s

- (iii) Catalyst **B** is more effective than catalyst **A**.

Underline the correct word(s) in the brackets below to explain how the graph shows this.

[2]

The graph shows that catalyst **B** is more effective than catalyst **A**

because the steepness of the line for catalyst **B** is

(**greater than** / **the same as** / **less than**) the steepness of the line for catalyst **A**.

It takes (**less** / **the same** / **more**) time for the reaction to end when using catalyst **B**.

8

7. Every electric vehicle needs a battery, and those batteries are manufactured from a range of materials, including lithium. Lithium is extracted from finite supplies of lithium ore found in the Earth's crust.

- (a) State what is meant when a raw material such as lithium ore is described as being finite. [1]

.....
.....

- (b) Much of the lithium used to make batteries is produced from a solution of lithium salts pumped from underground into huge lakes in South America. The lakes are reduced to a wet slurry over several months as the solution becomes more concentrated. The slurry is then processed to form a dry powder.

- (i) I. Complete the following sentence. [1]

The solution of lithium salts becomes more concentrated because
water changes from the state to the
..... state.

- II. Suggest what separation method is used to obtain a dry powder from a wet slurry. [1]

.....
.....

- (ii) One mine produces 5000 tonnes of lithium per year. This is enough to make batteries for 80 000 electric vehicles.

Calculate the mass of lithium needed to make batteries for the 14 000 000 electric vehicles sold worldwide in 2023.

[2]

Mass of lithium = tonnes

- (c) Many people living in areas where lithium is mined do not want the works to be expanded despite the potential for new jobs.

Give **one** reason why this may be the case. Explain your answer.

[2]

.....

.....

.....

.....

7

8. Scientists agree that increased levels of greenhouse gases in the atmosphere as a result of human activity are responsible climate change.

- (a) Explain how increased use of fossil fuels has contributed to increased mean global temperatures.

[3]

Examiner
only

.....

.....

.....

.....

.....

.....

- (b) Transportation is a major source of greenhouse gas generation.

The table below shows the amount of a greenhouse gas generated, **in kilograms (kg)**, at different stages of the life cycle for an electric vehicle and a fossil fuel powered vehicle.

Stage of life cycle	Mass of greenhouse gases generated (kg)	
	Electric vehicle	Fossil fuel
Production of battery	60 000	0
Production of car	40 000	60 000
Electricity and fuel	40 000	160 000
Disposal of car	40 000	20 000

The 'carbon footprint' of a product is the total amount of greenhouse gases emitted over the full life cycle of a product.

The carbon footprint of the electric vehicle is 180 tonnes of greenhouse gases.

Use the table above to calculate the carbon footprint of the fossil fuel vehicle **in tonnes**.

[2]

(1 tonne = 1000 kg)

Carbon footprint =tonnes

- (c) Technologies are being developed to remove one greenhouse gas from waste gas emissions to reduce the volume released into the atmosphere.

Cryogenic capture is shown in the diagram below.

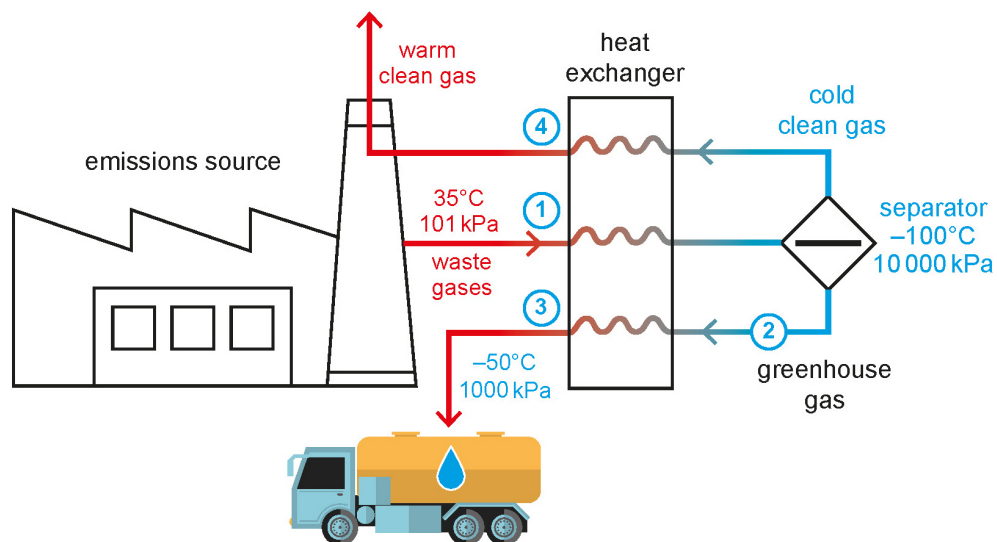
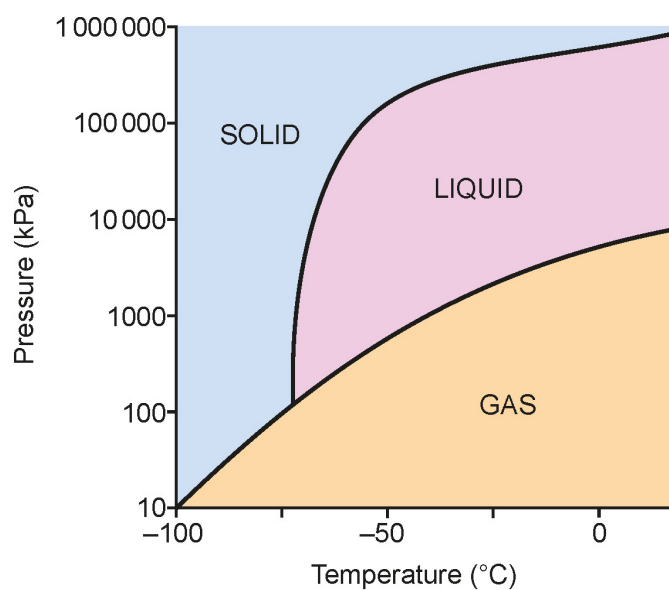


Figure 1 shows the state of the greenhouse gas at different temperatures and pressures.



Use the information in the diagram and **Figure 1** to answer these questions.

- (i) Give the state of the greenhouse gas as it leaves the separator (stage 2).

[1]

Examiner
only

.....

- (ii) Name the physical process that describes the change of state that happens between stages 2 and 3.

[1]

.....

7

END OF PAPER

FORMULAE FOR SOME COMMON IONS

POSITIVE IONS		NEGATIVE IONS	
Name	Formula	Name	Formula
aluminium	Al^{3+}	bromide	Br^-
ammonium	NH_4^+	carbonate	CO_3^{2-}
barium	Ba^{2+}	chloride	Cl^-
calcium	Ca^{2+}	fluoride	F^-
copper(II)	Cu^{2+}	hydroxide	OH^-
hydrogen	H^+	iodide	I^-
iron(II)	Fe^{2+}	nitrate	NO_3^-
iron(III)	Fe^{3+}	oxide	O^{2-}
lithium	Li^+	sulfate	SO_4^{2-}
magnesium	Mg^{2+}		
nickel	Ni^{2+}		
potassium	K^+		
silver	Ag^+		
sodium	Na^+		
zinc	Zn^{2+}		

THE PERIODIC TABLE

Group

0

7

6

5

4

3

2

1

1	2	3	4	5	6	7	0
7 Li Lithium 3	9 Be Beryllium 4	11 Na Sodium 11	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12	27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26
86 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	99 Tc Technetium 43	101 Ru Ruthenium 44
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57	179 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76
223 Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89	272 Lu Lutetium 71	273 Hf Hafnium 72	274 Ta Tantalum 73	276 W Tungsten 74	278 Os Osmium 76
115 In Indium 49	112 Cd Cadmium 48	113 Ag Silver 47	114 Sn Tin 50	116 Sb Antimony 51	118 Te Tellurium 52	120 I Iodine 53	122 Xe Xenon 54
201 Hg Mercury 80	202 Tl Thallium 81	204 Pb Lead 82	207 Bi Bismuth 83	209 Po Polonium 84	210 At Astatine 85	210 Rn Radon 86	222 Fr Francium 87

1 H Hydrogen 1

Key

Ar	relative atomic mass
Symbol	
Name	
Z	atomic number

**THE SCIENCES (DOUBLE AWARD)
UNIT 2**

Chemistry: Chemical Substances and How They Behave

FOUNDATION TIER

MARK SCHEME

Guidance for examiners

Generic marking principles

- Marks awarded are always whole marks (not half marks, or other fractions).
- Answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.
- Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
- Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

Positive marking

It should be remembered that candidates are writing under examination conditions and credit should be given for what the candidate writes, rather than adopting the approach of penalising candidates for any omissions. It should be possible for a very good response to achieve full marks and a very poor one to achieve zero marks. Marks should not be deducted for a less than perfect answer if it satisfies the criteria of the mark scheme.

For questions that are objective or points-based, the mark scheme should be applied precisely. Marks should be awarded as indicated and no further subdivision made.

Mark schemes often list points which may be included in candidates' answers. The list is not exhaustive. The inclusion of '*Credit any other valid response.*' (or similar instruction) within mark schemes allows for the possible variation in candidates' responses. Credit will be given for correct and relevant alternative responses which are not recorded in the mark scheme. Credit should be given according to the accuracy and relevance of candidates' answers.

Appropriate terminology is reflected in exemplar responses in mark schemes. However, unless there is a specific requirement within a question, candidates may be awarded marks where the answer is accurate but expressed in their own words.

Marking abbreviations

The following may be used in marking schemes or in the marking of scripts to indicate reasons for the marks awarded.

ecf = error carried forward

bod = benefit of doubt

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Enquiry Skills
1.	(a)	(i)	Substance Description sodium chloride compound chlorine metal chlorine element mixture award (1) for each correct line do not award credit for a substance with more than one line drawn from it	1	1		2		
		(ii)	B		1		1		
	(b)		NaCl		1		1		
	(c)	(i)	yellow	1			1		
		(ii)	white	1			1		
Question 1 total				3	3	0	6	0	0

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Enquiry Skills
2.	(a)	(i)	nucleus	1			1		
		(ii)	electron	1			1		
		(iii)	11		1		1		
	(b)	B (1) award (1) for any of following it has a different atomic number (to A and C) it has a different number of protons (to A and C) it has 34 protons whereas A and C have 35 protons do not award the second mark if there is any reference to the mass number				2	2		
Question 2 total				2	1	2	5	0	0

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Enquiry Skills
3.	(a)	C and D (both needed) (1) they have three electrons in the outer shell (1)			2		2		
	(b)	A and D (both needed) (1) they have electrons in two shells (1)			2		2		
	(c)	B			1		1		
Question 3 total				0	5	0	5	0	0

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Enquiry Skills
4.	(a)	dissolved		1			1		
	(b)	3		1			1		
	(c)	(i)	chromatography	1			1		
		(ii)	PFA1 (1) award (1) for either of following the water sample has a substance that has travelled the same distance as PFA1 the water sample has a spot at the same height as PFA1			2	2		2
		(iii)	0.84 (2) if incorrect award (1) for 4.2 ecf possible from incorrect measurement do not award credit for calculation based on an incorrect spot		2		2	2	2
	(d)	distillation			1		1		1
Question 4 total				3	3	2	8	2	5

Question		Marking details		Marks available					
				AO1	AO2	AO3	Total	Maths	Enquiry Skills
5.	(a)	the metal ion has more protons than electrons the metal ion has more electrons than protons the metal ion has equal numbers of protons and electrons ☒ ☐ ☐			1		1		
	(b)	(i)	they react with water to form an alkaline solution			1	1		
		(ii)	I. Na ₂ O		1		1		
			II. should be stored in oil			1	1		
		(iii)	sodium hydroxide		1		1		
		(iv)	exothermic	1			1		
	(c)	award (1) each for any two of following bubbles <u>very</u> quickly melts into a ball moves <u>very</u> quickly on the surface ignites / burns (with a lilac flame) reactivity increases down the group (1)			3		3		1

Question		Marking details	Marks available					
			AO1	AO2	AO3	Total	Maths	Enquiry Skills
	(d)	2 K + Cl ₂ → 2 KCl		1		1		
Question 5 total			1	7	2	10	0	1

Question		Marking details		Marks available					
				AO1	AO2	AO3	Total	Maths	Enquiry Skills
6.	(a)	$\text{H}_2\text{O}_2 \longrightarrow \text{H}_2\text{O} + \text{O}_2 \quad \square$ $2\text{H}_2\text{O}_2 \longrightarrow 2\text{H}_2\text{O} + \text{O}_2 \quad \checkmark$ $\text{H}_2\text{O}_2 \longrightarrow \text{H}_2\text{O} + 2\text{O}_2 \quad \square$			1		1		
	(b)	(i)	gas syringe	1			1		
		(ii)	put a <u>glowing</u> splint into the gas – it relights	1			1		
	(c)	(i)	award (1) for any of following temperature (of hydrogen peroxide) concentration (of hydrogen peroxide) surface area of the catalyst / both catalysts in powder form			1	1		1
		(ii)	I. award (1) for any value in the range 180-200 seconds		1		1	1	1
			II. award (1) for any value in the range 0.30-0.33 ecf possible from incorrect value from graph			1	1	1	1
		(iii)	greater than (1) less (1)			2	2		2
Question 6 total				2	2	4	8	2	5

Question					Marking details	Marks available					
						AO1	AO2	AO3	Total	Maths	Enquiry Skills
7.	(a)	award (1) for either of following it will run out there is a limited supply				1			1		
	(b)	(i)	I.	both words below needed for (1) mark ... liquid gaseous/gas ...			1		1		
			II.	award (1) for either of following filtration evaporation			1		1		1
		(ii)	875 000 (2) if incorrect award (1) mark for either of following 175 $\left(\text{from } \frac{14\,000\,000}{80\,000}\right)$ 0.0625 $\left(\text{from } \frac{5000}{80\,000}\right)$ ecf possible					2		2	2

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Enquiry Skills
	(c)	award (1) for any simple point and additional (1) for development of that point e.g. more land is covered by lakes ⇒ less land available for growing crops more land is dug up ⇒ reduces biodiversity more waste is created ⇒ contamination of water supply more dust in the air ⇒ causes respiratory problems credit any sensible suggestions				2	2		
Question 7 total				1	4	2	7	2	1

Question			Marking details		Marks available					
					AO1	AO2	AO3	Total	Maths	Enquiry Skills
8.	(a)	burning fossil fuels increases CO ₂ levels in atmosphere (1) more CO ₂ in the atmosphere means more infrared radiation absorbed / less infrared radiation escapes (into space) (1) accept 'heat' for infrared radiation this warms the Earth's (lower) atmosphere (1)			2	1		3		
	(b)	240 tonnes (2) if incorrect award (1) for either of following 240 000 24				2		2	2	
	(c)	(i)	solid				1	1		1
		(ii)	melting				1	1		
Question 8 total					2	3	2	7	2	1

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL MARK	MATHS	Enquiry Skills
1	3	3	0	6	0	0
2	2	1	2	5	0	0
3	0	5	0	5	0	0
4	3	3	2	8	2	5
5	1	7	2	10	0	1
6	2	2	4	8	2	5
7	1	4	2	7	2	1
8	2	3	2	7	2	1
TOTAL	14	28	14	56	8	13