Surname	Centre Number	Candidate Number
First name(s)		0

GCSE

S25-3410UA0-1

3410UA0-1

FRIDAY, 13 JUNE 2025 – MORNING

CHEMISTRY – Unit 1:
Chemical Substances, Reactions and Essential Resources
HIGHER TIER

1 hour 45 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**5**	
2.	**6**	
3.	**9**	
4.	**5**	
5.	**8**	
6.	**6**	
7.	**6**	
8.	**10**	
9.	**5**	
10.	**3**	
11.	**8**	
12.	**9**	
Total	**80**	

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ADDITIONAL MATERIALS

In addition to this examination paper you will need a calculator and a ruler.

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 at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet. If you run out of space, use the additional page(s) at the back of the booklet, taking care to 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.

Question **6** is a quality of extended response (QER) question where your writing skills will be assessed.

The Periodic Table is printed on the back cover of this paper and the formulae for some common ions on the inside of the back cover.

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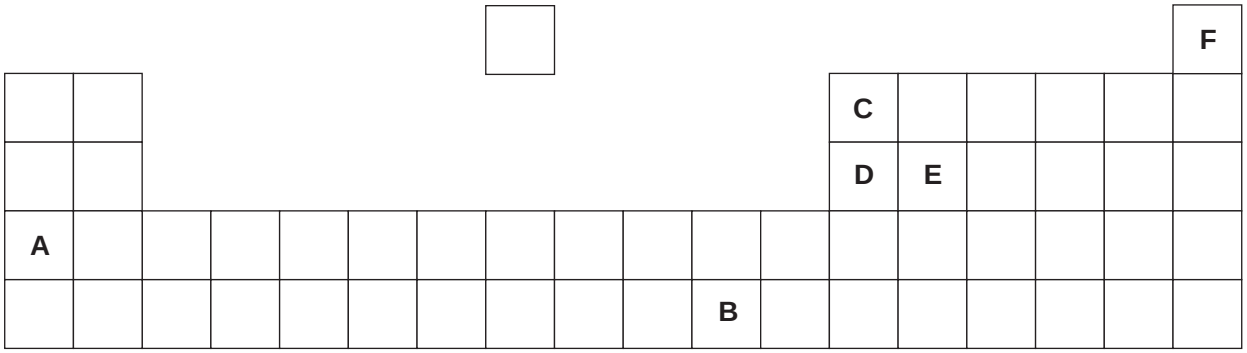
Answer **all** questions.

1. The diagram represents part of the Periodic Table.

The letters shown are **not** the symbols of the elements.



(a) **Use letters from the diagram** to answer parts (i) and (ii).

(i) Give the letters of two elements that have atoms with three electrons in their outer shell. [1]

..... and .....

(ii) Give the letter of the element that has atoms with four electron shells. [1]

.....

(b) Name the element represented by the letter **F**. Give **one** use of this element. [1]

Name .....

Use .....

(c) State **two** properties that you would expect element **B** to have. [2]

Property 1 .....

Property 2 .....

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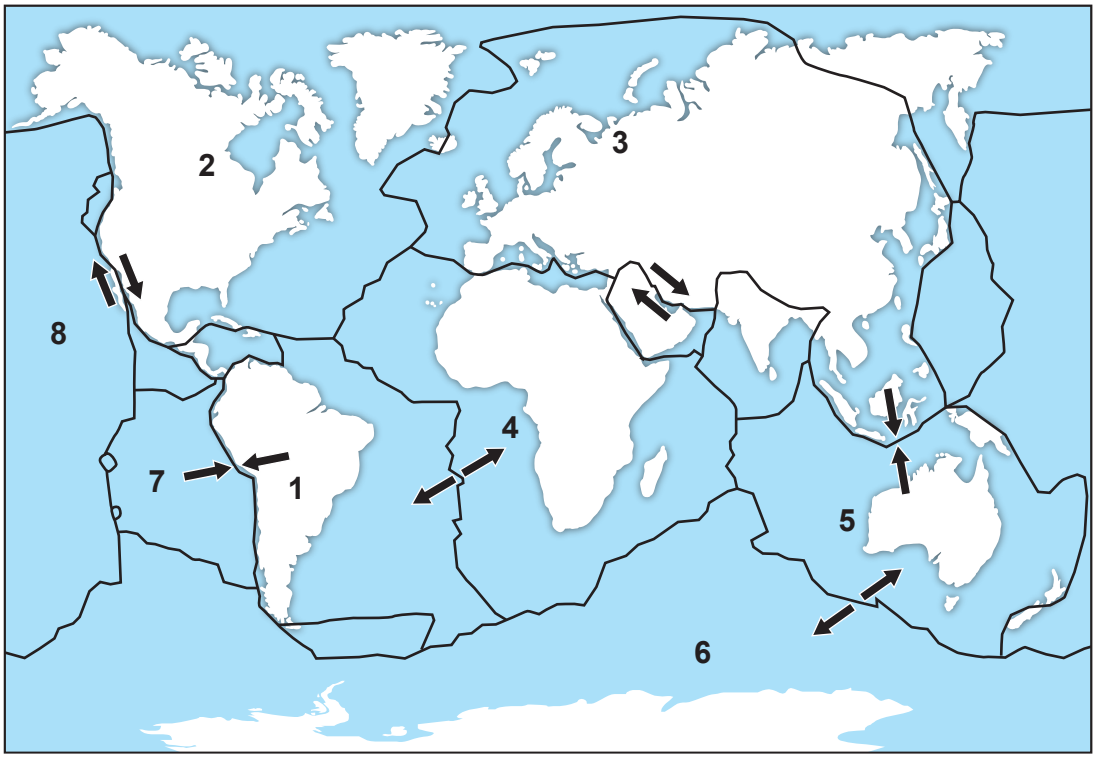
2. (a) The diagram shows some of the Earth's tectonic plates and the directions in which they are moving.



(i) Give the numbers of two plates which share a **constructive** boundary. [1]

..... and .....

(ii) Describe what happens at a **destructive** plate boundary. [2]

.....

.....

.....

.....

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(b) Alfred Wegener proposed that the Earth's continents had once all been joined together in a land mass he called Pangaea and that they had moved apart over time.

He called this the 'theory of continental drift'.

200 million years ago

Present

(i) Give **two** pieces of evidence that Alfred Wegener used to support his theory of continental drift. [2]

Evidence 1 .....

Evidence 2 .....

(ii) State why Wegener's theory was not initially accepted. [1]

.....

.....

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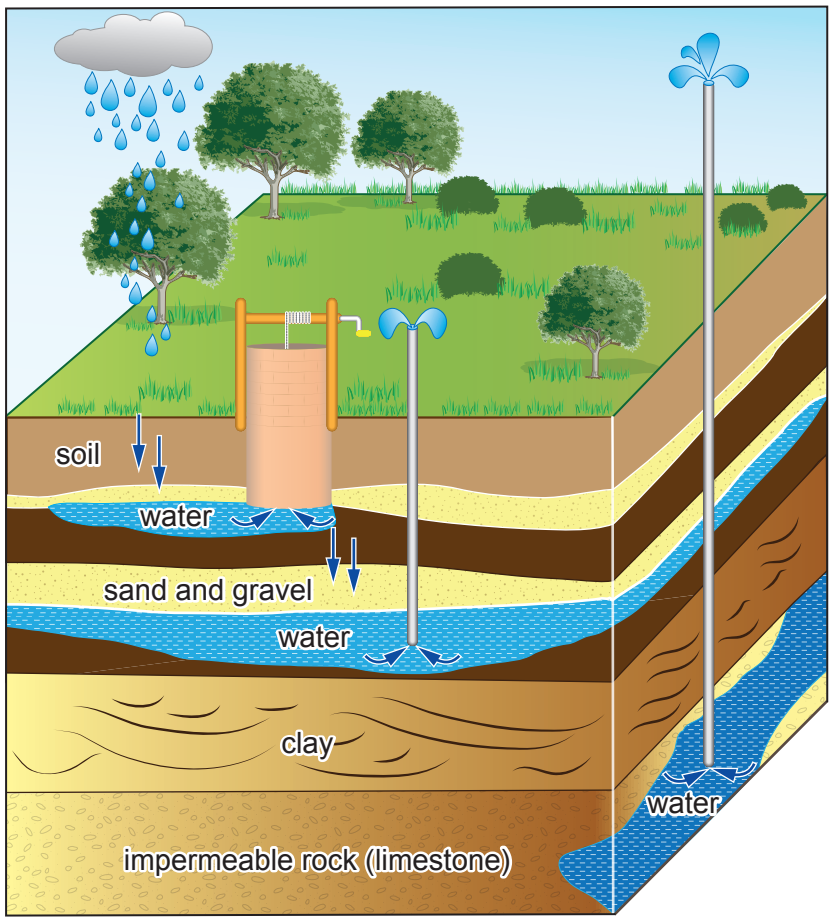
6

3. Groundwater is the water found underground in the cracks and spaces in soil, sand and rock. It is stored in and moves slowly through layers of soil, sand and rocks called aquifers.

Groundwater provides 550 megalitres of the total water needed on average per day in Wales, approximately 5% of the total volume used. Some of the negative ions dissolved in groundwater include carbonate, chloride and sulfate ions.

Groundwater can also contain pollutants which can cause harm to humans if consumed. Many of these pollutants are natural, such as bacteria and viruses. However, there are now a number of man-made pollutants present in our water supplies, including fertilisers, pesticides and chemicals from industrial and household landfill waste.



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(a) (i) Tick (✓) the box next to the approximate total volume of water used daily in Wales. [1]

110 megalitres ☐

550 megalitres ☐

11 000 megalitres ☐

(ii) Suggest why recycling more industrial chemicals could improve the quality of groundwater. [1]

.....

.....

(iii) Tick (✓) the box next to the solution that could be used to identify one of the negative ions present in groundwater supplies. [1]

sodium hydroxide, NaOH ☐

silver nitrate, $AgNO_3$ ☐

potassium nitrate, KNO_3 ☐

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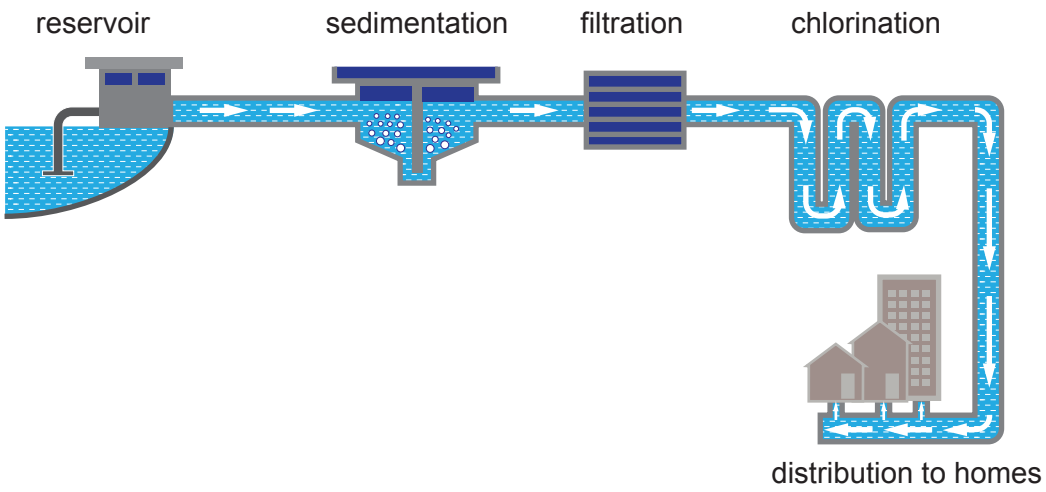
(b) The diagram shows the stages of treatment of the public water supply when it leaves reservoirs before being distributed to our homes.



The first stage of treatment of the public water supply is sedimentation.

The purpose of sedimentation is to remove large insoluble particles from the water.

Give the purpose of the filtration and chlorination stages of water treatment. [2]

Filtration .....

.....

Chlorination .....

.....

(c) (i) In some areas, fluoride is added to water supplies.

Give the reason why fluoride is added to water supplies. [1]

.....

(ii) Give **one** reason why some people disagree with the addition of fluoride to water supplies. [1]

.....

.....

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(iii) Fluoride is added to water in compounds such as sodium fluorosilicate, Na_2SiF_6.

The relative formula mass (M_r) of Na_2SiF_6 is 188.

Calculate the percentage by mass of sodium in Na_2SiF_6. [2]

$A_r(Na) = 23$

Percentage = ... %

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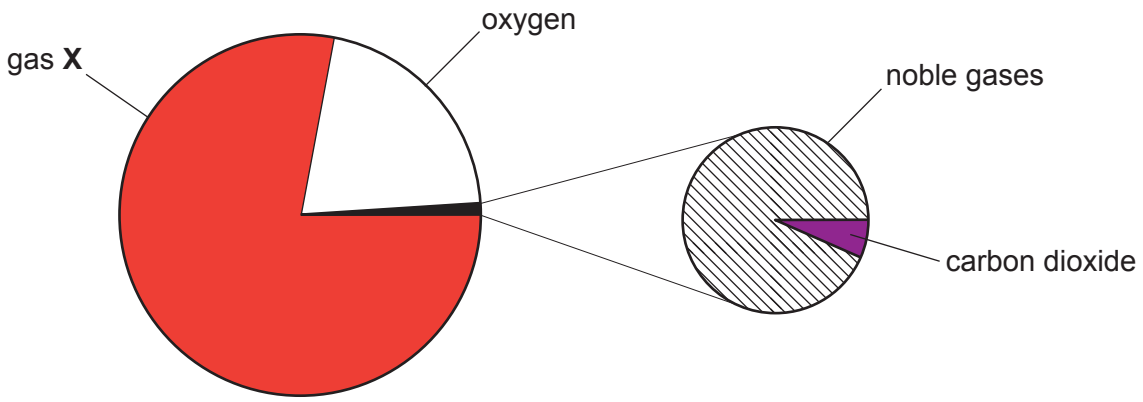
4. The diagram shows the composition of the Earth's atmosphere.



(a) Give the name of gas **X**. [1]

.....

(b) Explain how the levels of oxygen and carbon dioxide in the atmosphere are kept broadly the same through biological processes. [3]

.....

.....

.....

.....

.....

(c) Describe the test that can be used to identify oxygen gas. Include the observation made in a positive test. [1]

.....

.....

5

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5. This question is about reactions of Group 1 and Group 2 metals.

(a) (i) State **two** observations you would make when a small piece of lithium is added to a large trough of water. [2]

.....

.....

(ii) When lithium reacts with water, lithium hydroxide and hydrogen gas are produced.

Describe how you could show that the lithium hydroxide formed is an alkali. [1]

.....

.....

(b) Magnesium does not react with cold water.

Explain in terms of electronic structure why Group 2 metals are less reactive than Group 1 metals. [2]

.....

.....

.....

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(c) (i) Potassium reacts with oxygen to form potassium oxide.

Complete the equation for this reaction by

- giving the formula of potassium oxide
- putting numbers in the boxes to balance the equation [2]

$\square$ K + O_2 ⟶ $\square$ .....

(ii) During a reaction 0.015 mol of oxygen gas reacted with potassium.

Calculate the number of molecules in 0.015 mol of oxygen gas. [1]

Avogadro's number = 6×10^{23}

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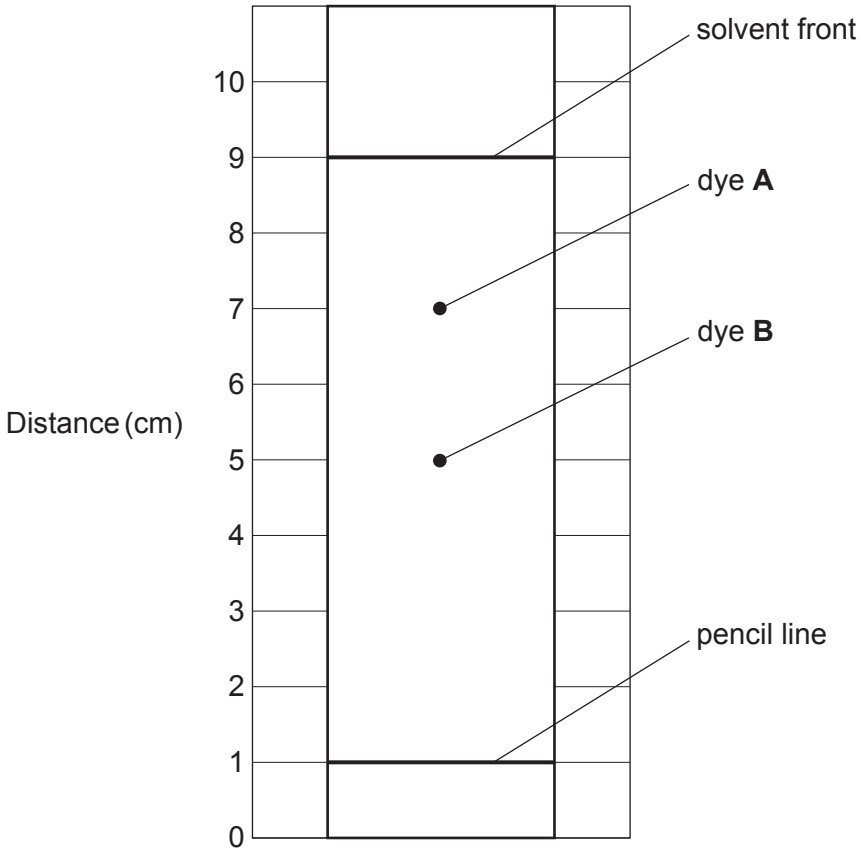
Number of molecules = ...

8

6. The diagram shows a chromatogram produced from a green food colouring which is a mixture of two dyes.



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Calculate the R_f values of each of the dyes in the food colouring.

Explain why the dyes have different R_f values. [6 QER]

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7. (a) Gallium is a metallic element in Group 3.

Gallium(III) oxide contains gallium ions (Ga^{3+}) and oxide ions (O^{2-}).

Describe how these ions are formed from gallium atoms and oxygen atoms. [2]

.....

.....

.....

(b) A sample of gallium metal contains two isotopes – $^{69}_{31}Ga$ and $^{71}_{31}Ga$.

(i) Use this information to give **one** similarity and **one** difference in the **nuclei** of these isotopes. [2]

Similarity .....

Difference .....

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(ii) The table shows the abundance of each isotope in the sample.

Isotope	Abundance (%)
^{69}Ga	60
^{71}Ga	40

The relative atomic mass (A_r) of the gallium in the sample can be found using the following equation.

$$A_r = \frac{(\text{mass of isotope} \times \text{abundance}) + (\text{mass of isotope} \times \text{abundance})}{100}$$

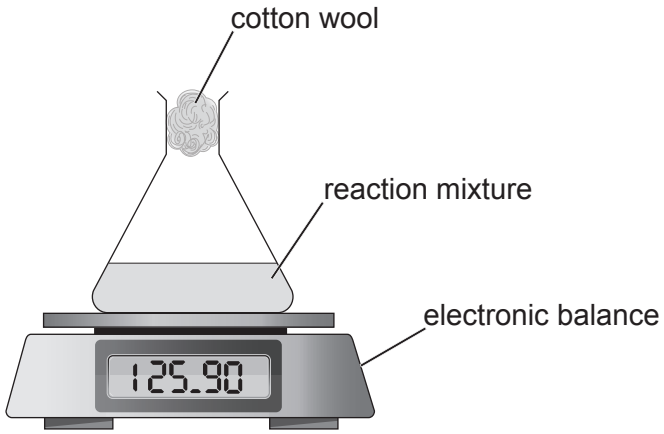
Calculate the relative atomic mass of the gallium in the sample. [2]

A_r = ...

6

8. One method of investigating the rate of a reaction is to measure the change in mass of the reaction mixture as the reaction progresses.

Marble chips contain calcium carbonate which reacts with hydrochloric acid to release carbon dioxide gas.



A student added some marble chips to hydrochloric acid and recorded the mass of the conical flask and the reaction mixture every 20 s for two minutes.

Time (s)	Mass of flask and reaction mixture (g)
0	125.90
20	125.60
40	125.45
60	125.35
80	125.30
100	125.26
120	125.25

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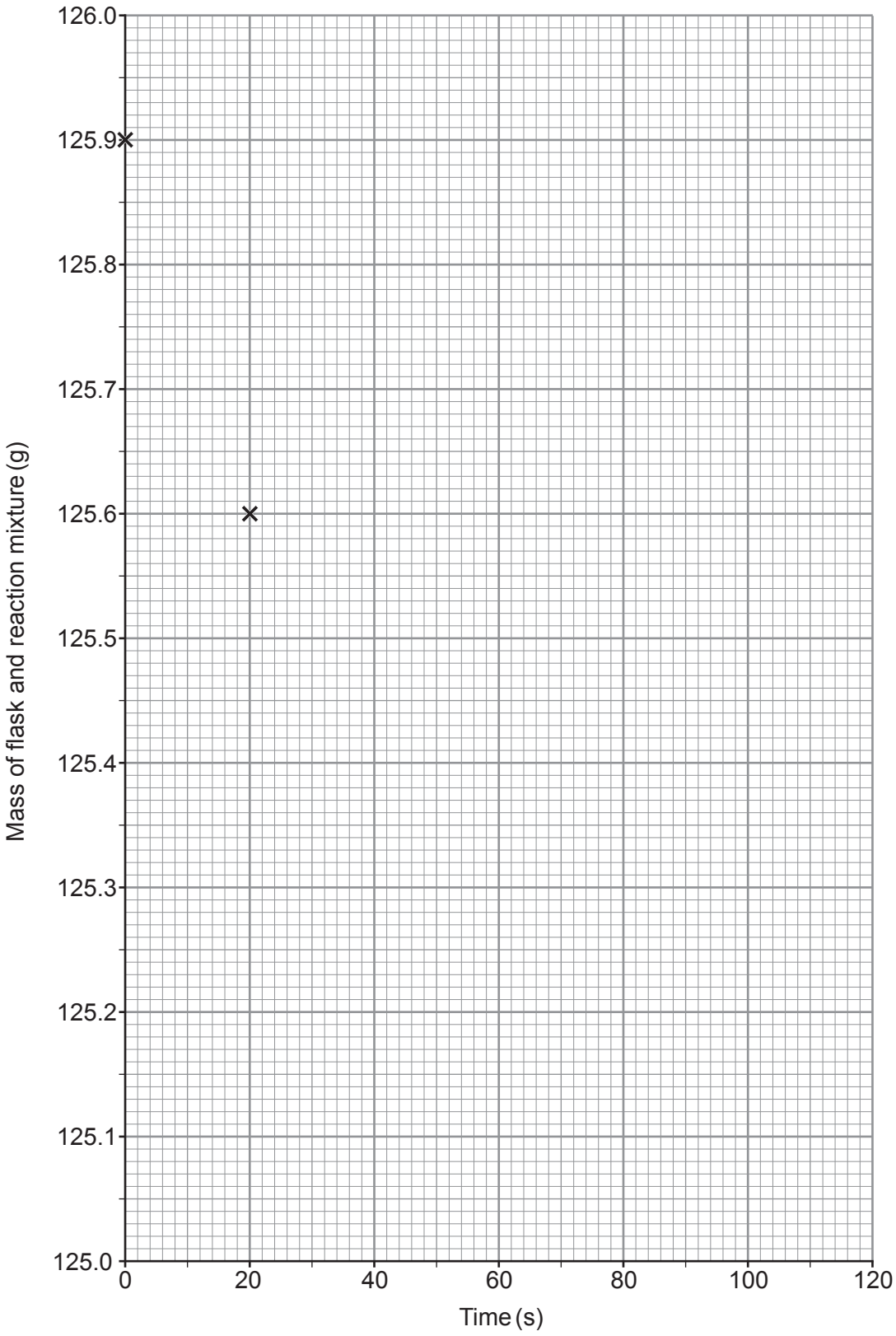
(a) Plot the results from the table on the grid. The first two points have been plotted for you. Draw a suitable line. [3]



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(b) Use the equation below to calculate the number of moles of carbon dioxide released after 120 s. [2]

$$\text{number of moles of carbon dioxide} = \frac{\text{mass of carbon dioxide}}{44}$$

Number of moles = ... mol

(c) Describe how the shape of the graph shows the change in the rate of the reaction over the two minutes. [2]

.....

.....

.....

(d) State **one** change that can be made to the **acid** to increase the rate of this reaction.

Explain your answer using particle theory. [3]

.....

.....

.....

.....

10

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9. A student is comparing the thermal decomposition of carbonate powders.

Compound	Appearance before heating	Appearance after heating
sodium carbonate	white solid	white solid
copper(II) carbonate	green solid	.....

(a) **Complete the table** by giving the expected observation when copper(II) carbonate powder is heated. [1]

(b) State the conclusion that can be drawn about the relative reactivity of copper and sodium metals from these observations. Explain your answer. [2]

.....

.....

.....

(c) Complete the balanced symbol equation for the thermal decomposition of copper(II) carbonate to form copper(II) oxide and carbon dioxide. [2]

..... $\longrightarrow$ ..... + CO_2

5

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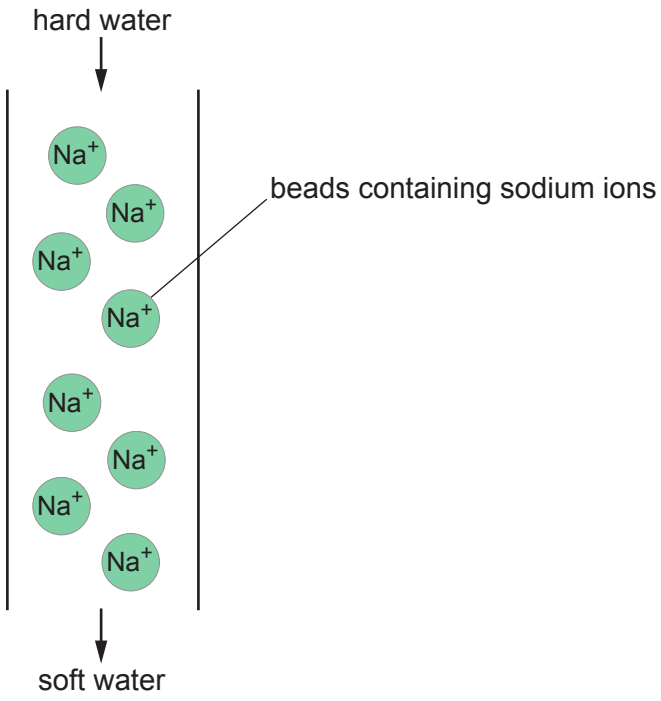
10. Hard water can be softened using the column shown in the diagram.



(a) Describe how hard water is softened in the column and state why the beads must eventually be regenerated. [2]

.....

.....

.....

.....

(b) Give a different method of softening temporary hard water. [1]

.....

3

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11. (a) Some students were asked to identify the negative ions present in two compounds of potassium.

They tested solutions of each of the compounds and their results are shown.

Compound	Test 1 Add acid	Test 2 Add silver nitrate solution
A	no reaction	cream precipitate forms
B	fizzing	

(i) Give the names of compounds **A** and **B**. [2]

Compound **A** potassium .....

Compound **B** potassium .....

(ii) Explain why a flame test would **not** be useful in distinguishing between compounds **A** and **B**. [1]

.....

.....

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(b) Another compound was identified using ion tests.

It gave no flame colour in a flame test and reacted with silver nitrate solution.

It was identified as magnesium chloride.

Give the **ionic** equation to show the formation of the silver chloride precipitate during the reaction of silver nitrate and magnesium chloride solutions.

Include state symbols. [3]

.....

(c) Magnesium oxide can be produced by heating a strip of magnesium in a crucible.

$$2Mg + O_2 \longrightarrow 2MgO$$

A student recorded the following results.

Mass of crucible	19.38 g
Mass of crucible and magnesium strip	19.58 g
Mass of crucible and magnesium oxide	19.64 g

The student expected 0.33 g of magnesium oxide to be produced.

Use the table to find the actual mass of magnesium oxide produced and calculate the percentage yield for the reaction. [2]

Percentage yield = ... %

8

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12. (a) When chlorine is added to a colourless solution of potassium iodide, an orange-brown colour is seen.

(i) Explain this colour change in terms of the reactivity and electronic structure of the halogens. [3]

.....

.....

.....

.....

(ii) Give a balanced equation for the reaction of chlorine, Cl_2, with potassium iodide. [3]

.....

(b) Chlorine gas also reacts upon heating with iron to produce iron(III) chloride.

$$2\,Fe + 3\,Cl_2 \longrightarrow 2\,FeCl_3$$

Calculate the mass of chlorine needed to produce 32.5 g of iron(III) chloride. [3]

$A_r(Cl) = 35.5$ $A_r(Fe) = 56$

Mass = ... g

9

END OF PAPER

Question number	Additional page, if required. Write the question number(s) in the left-hand margin.

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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 1	2											3	4	5	6	7	0
						1 H Hydrogen 1											4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4											11 B Boron 5	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	59 Co Cobalt 27	59 Ni Nickel 28	63.5 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
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	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
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	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	210 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86
223 Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89															

Key