Surname	Centre Number	Candidate Number
Other Names		0

GCSE – NEW

3410UA0-1

S17-3410UA0-1

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

HIGHER TIER

FRIDAY, 16 JUNE 2017 – MORNING

1 hour 45 minutes

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

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01

ADDITIONAL MATERIALS

In addition to this paper you may require a calculator and a ruler.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.

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 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 **9** 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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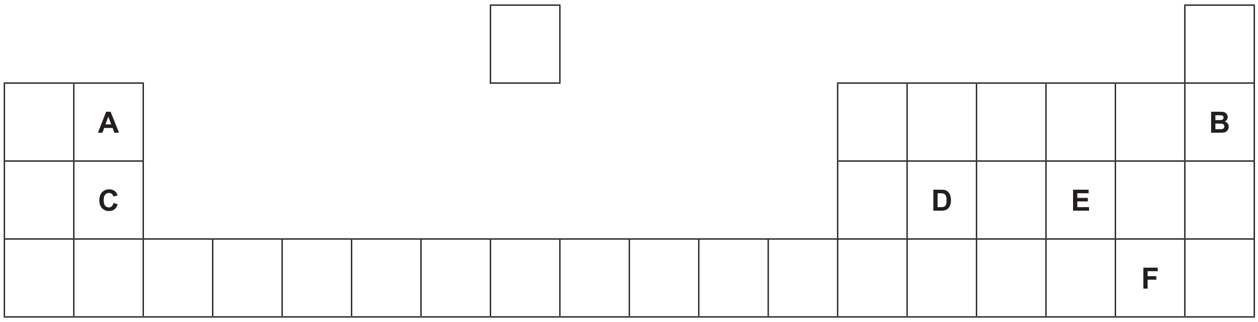
Answer **all** *questions*.

1. *(a)* The following diagram shows an outline of part of the Periodic Table.

The letters shown are NOT the chemical symbols of the elements.

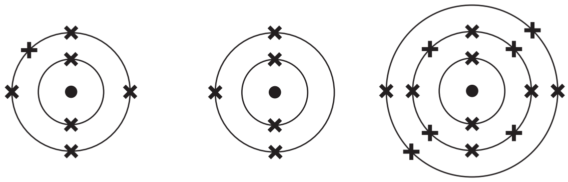


Choose **letters** from the diagram to complete the table below. [5]

	Letter(s)
Two elements in the same group	.... and ....
The element which has 12 protons in its nucleus	....
The element with a full outer shell of electrons	....
The element in Group 2 and Period 2	....
The element with the electronic structure 2,8,4	....

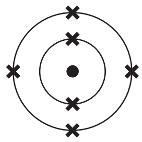
Examiner only

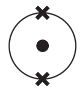
(b) Diagrams **1-5** show the electronic structure of five elements in the Periodic Table.



1 **2** **3** **4** **5**

Give the **number** of the diagram which shows the electronic structure of the element which lies

(i) directly **below**  in the Periodic Table, ... [1]

(ii) to the **left** of  in the Periodic Table. .... [1]

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03

(c) Nitrogen has two stable isotopes – nitrogen-14 and nitrogen-15.

Describe how these isotopes are similar to one another and how they are different. [2]

....

....

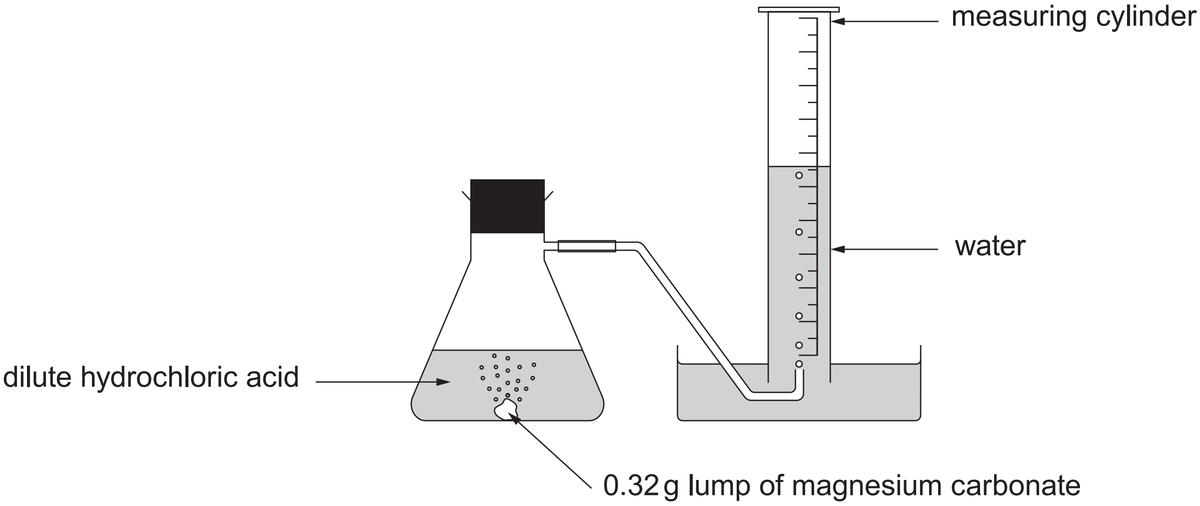
....

9

Examiner only

2. A student carried out an experiment to investigate the speed of the reaction between a **lump** of magnesium carbonate of mass 0.32 g and excess dilute hydrochloric acid at 20 °C.

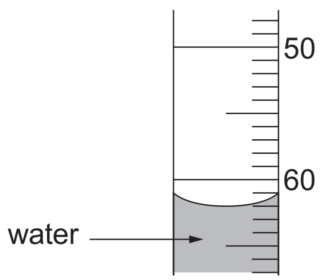
Magnesium carbonate reacts with dilute hydrochloric acid forming carbon dioxide gas. The total volume of carbon dioxide formed was recorded every 5 minutes for 40 minutes.



The results are shown below. The result for 15 minutes is missing.

Time (minutes)	0	5	10	15	20	25	30	35	40
Volume of carbon dioxide formed (cm^3)	0	20	41		79	83	90	90	90

(a) Use the diagram below to find the volume of carbon dioxide gas formed after 15 minutes. [1]



volume of carbon dioxide = ... cm^3

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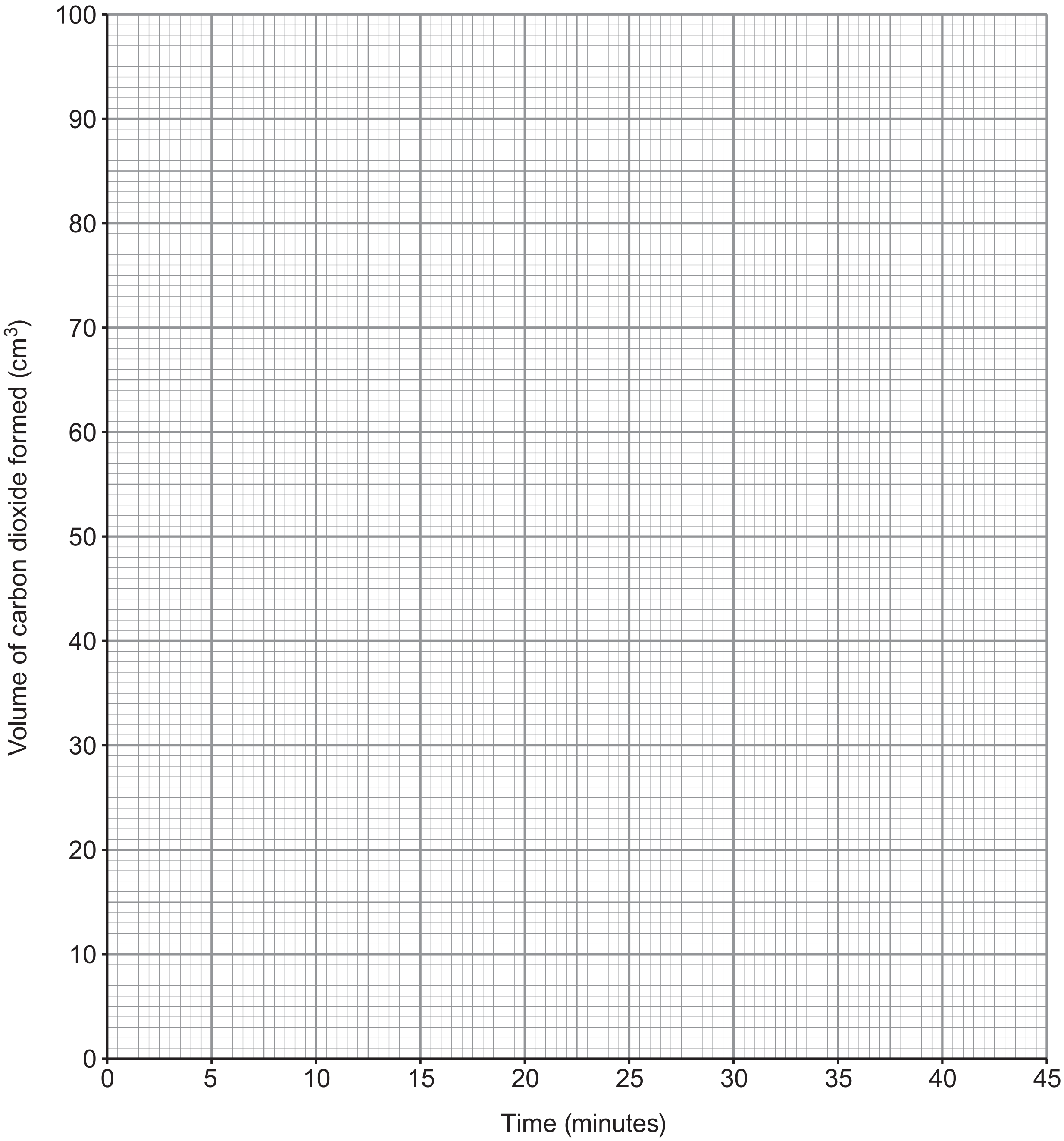
(b) Plot the results from the table, including your answer to part *(a)*, on the grid below. Draw a suitable line and **label this graph X**. [3]



(c) Sketch the graph you would expect if the experiment were repeated using 0.32 g of magnesium carbonate **powder** instead of the lump of magnesium carbonate.
Label this graph Y. [2]

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Examiner only

(d) State and explain, using particle theory, the effect of **increasing** the concentration of the hydrochloric acid. [3]

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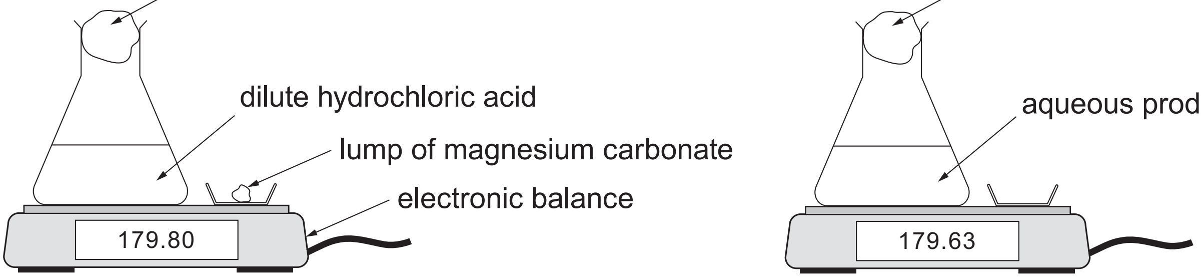
(e) The student investigated the same reaction using a different apparatus. A lump of magnesium carbonate was added to excess dilute hydrochloric acid at 20 °C.

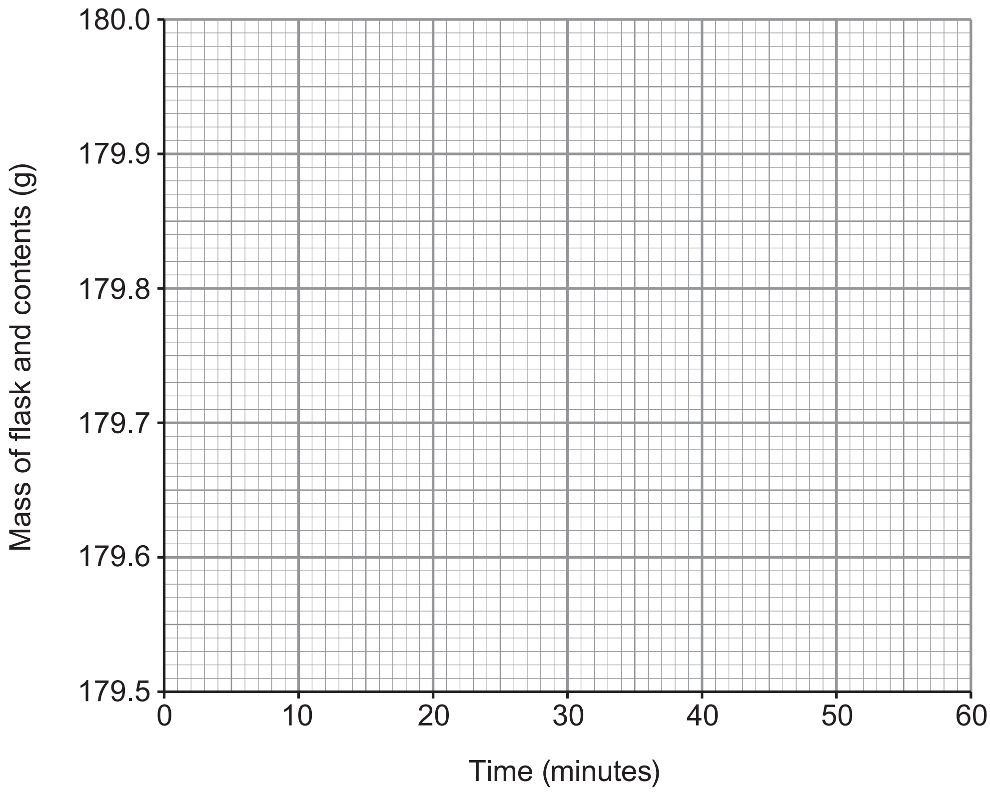


Apparatus at the start

Apparatus after 60 minutes

The change in mass was recorded for 60 minutes and displayed as a graph on a computer screen. The reaction took 40 minutes to complete.

Sketch the graph you would expect to see. [2]



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07

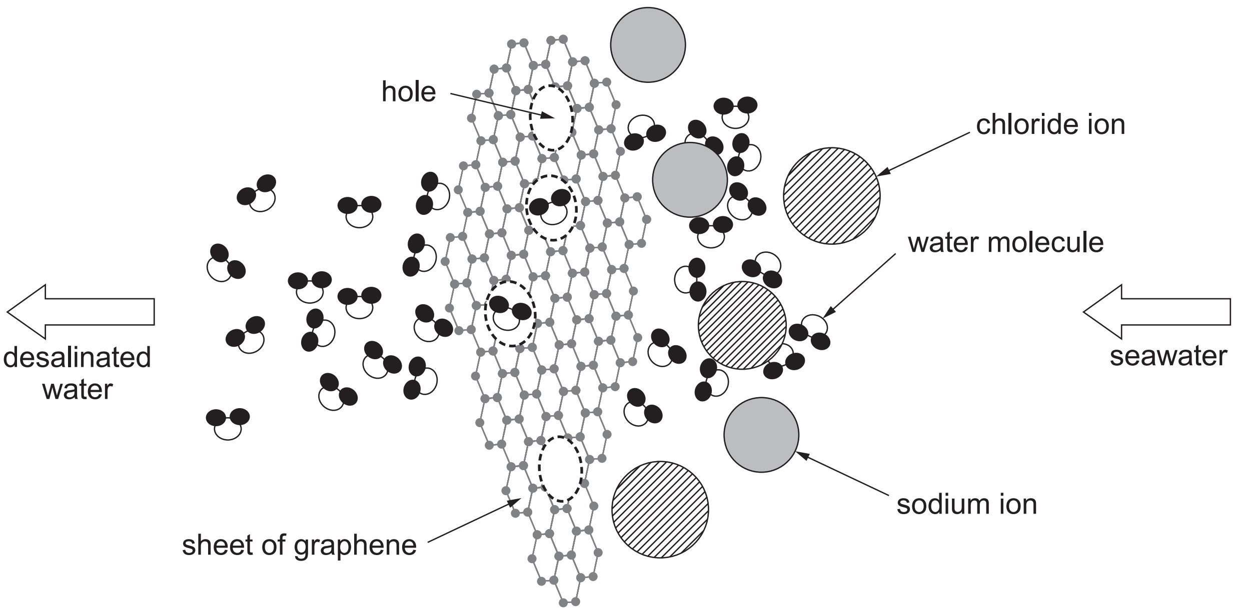
11

3. *(a)* One out of six people today do not have access to safe fresh water. Estimates suggest fresh water supplies will be a major problem for half the countries of the world by 2025 and by 2050 about 75 % of the world's population will experience a serious scarcity of the resource.

As the world's population increases not only will the demand for drinking water and water for sanitation increase, but the demand for water to produce more food will increase. As climate change makes rainfall less predictable and droughts more common, a growing number of countries are turning to desalination.

One method of desalination, called reverse osmosis, uses a thick membrane to filter salt from seawater. But this system requires an extremely high pressure to force water through the membrane and therefore uses a lot of energy.

Researchers in the USA have come up with a new approach using a different kind of filtration material - sheets of graphene - a one-atom-thick form of the element carbon. This new material can be far more efficient and possibly less expensive than existing desalination methods. Sheets of graphene are perforated with precisely-sized holes which only let the water molecules through.



Examiner only

(i) Tick (✓) the box next to the **main** reason why countries are building desalination plants. [1]

water is becoming scarce ☐

each person is drinking more water ☐

climate change affects the availability of drinking water ☐

(ii) Tick (✓) the statement which **best** explains how graphene sheets desalinate water. [1]

water molecules contain atoms and not ions ☐

sheets contain holes which are bigger than ions ☐

sheets contain holes which are bigger than water molecules but smaller than sodium and chloride ions ☐

sheets contain holes which let molecules through but not ions ☐

molecules are smaller than ions ☐

(b) The total volume of water on the Earth is 1.4×10^9 km^3, 97 % of which is seawater. Most of the remaining 3 % is bound up in ice at the poles, leaving 0.3 % available as fresh water.

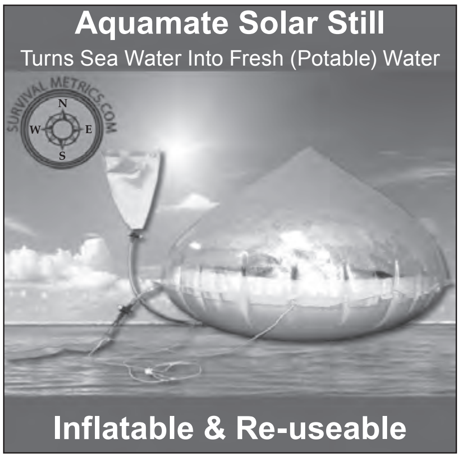
Calculate the volume of the Earth's available fresh water. Give your answer in standard form. [2]

volume of available fresh water = ... km^3

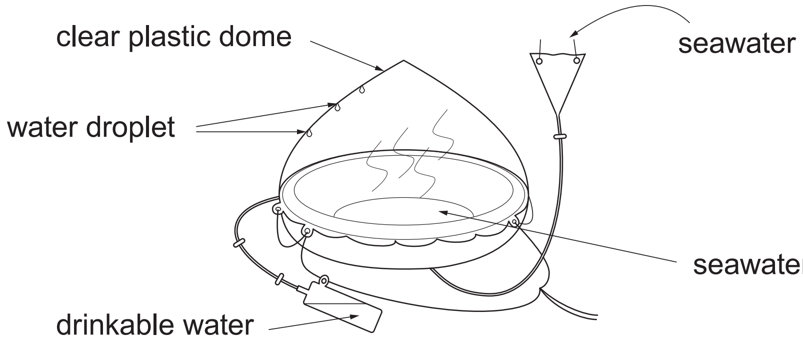
3410NA01 09

Examiner only

(c) One piece of survival equipment found on life rafts is a 'solar still'. Solar stills are used to remove soluble salts from seawater to form drinkable water.



Source: *www.survivalmetrics.com*



State and explain the physical changes that occur in the formation of drinkable water from seawater. Include the name given to the overall process taking place. [4]

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Examiner only

4. *(a)* Limestone quarrying is an important business in the UK. Quarrying creates jobs in areas where there are often limited opportunities. There is a huge demand for the products of quarrying, such as building stone and cement. Good roads and rail links are needed for transporting the products of quarrying. Thousands of people are employed in quarrying and related industries.

Many people argue against the opening of a quarry in their area despite all the benefits of limestone quarrying. Explain **two** reasons local people might use in an attempt to stop the opening of a new quarry in their area. [2]

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(b) When limestone is heated in a lime kiln thermal decomposition takes place.

Write a balanced **symbol** equation for this reaction. [1]

....

3410NA01 11

(c) Calcium silicide is a compound containing calcium and silicon only. A sample of calcium silicide was found to contain 2.0 g of calcium and 2.8 g of silicon.

Calculate the simplest formula for this compound. You **must** show your working. [3]

Simplest formula ....

6

Examiner only

5. *(a)* Gwyn carried out an experiment to find the solubility of potassium nitrate at room temperature, 25 °C. The method he used is shown in stages **1-3**.

Stage **1**

He added solid potassium nitrate to 50 cm^3 of water until a saturated solution was formed.

⇩

Stage **2**

He pipetted 25 cm^3 of the saturated solution into a pre-weighed evaporating basin. He put the basin and the solution into a warm oven.

⇩

Stage **3**

He removed the basin from the oven and allowed it to cool. He weighed the basin and crystals after 2 hours.

His results are shown below.

Mass of evaporating basin	= 42.6 g
Mass of evaporating basin and potassium nitrate crystals	= 54.2 g

(i) State what is meant by a *saturated* solution. [1]

....

....

(ii) Use Gwyn's results to calculate the solubility of potassium nitrate in g / 100 g of water. [2]

solubility = ... g / 100 g of water

Examiner only

(iii) Gwyn's experimental value for the solubility of potassium nitrate is much bigger than expected. Suggest how Gwyn should adapt stage **3** of his method in order to get a more accurate value. Explain your reasoning. [3]

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(iv) Gwyn was asked to find out if sodium chloride is more soluble in water than potassium nitrate. State which variable Gwyn **must keep the same** in his experiment in order for him to be able to compare the two solubilities. [1]

....

(b) (i) The solubility of potassium bromide at 20 °C is 64 g / 100 g of water. Calculate the mass of solid that forms when a solution containing 43.9 g of potassium bromide in 50 g of water is cooled to 20 °C. [2]

mass = ... g

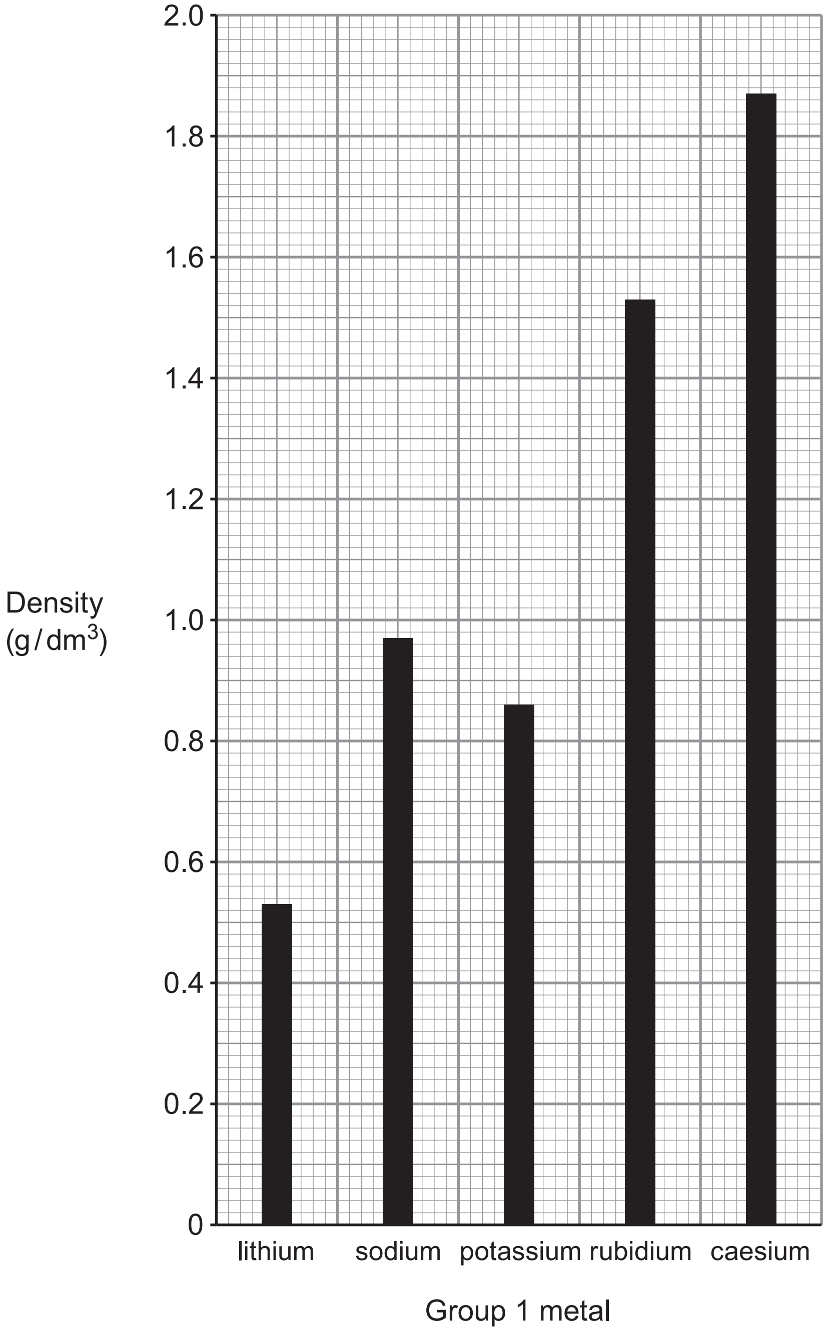
(ii) Calculate the number of moles of potassium bromide, KBr, in 64 g. Give your answer to **two** significant figures. [2]

number of moles = ... mol

11

Examiner only

6. *(a)* The bar graph shows the densities of five Group 1 metals.



Draw a **straight** line on the bar graph showing the general trend in density of Group 1 metals. How does your trend line suggest that potassium and **not** sodium is the anomalous density value? [2]

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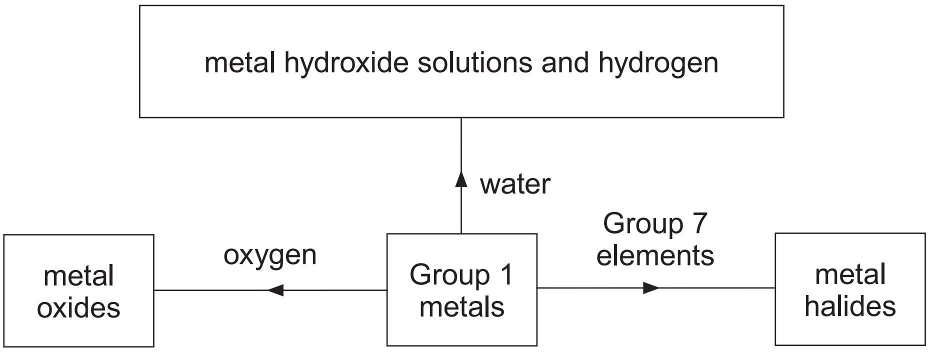
Examiner only

(b) The flow chart shows some reactions of Group 1 metals.



(i) State and explain **one** similarity and **one** difference you would see when lithium and potassium are added separately to a trough of cold water. [4]

Similarity ....

....

Difference ....

....

(ii) Write a balanced **symbol** equation to show the reaction between lithium and oxygen. [3]

....

(iii)

Group 1	**Group 7**
lithium	chlorine
sodium	bromine
potassium	iodine

The boxes show some of the elements in Group 1 and Group 7. Explain, in terms of electronic structure, why potassium and chlorine would react the most violently. [3]

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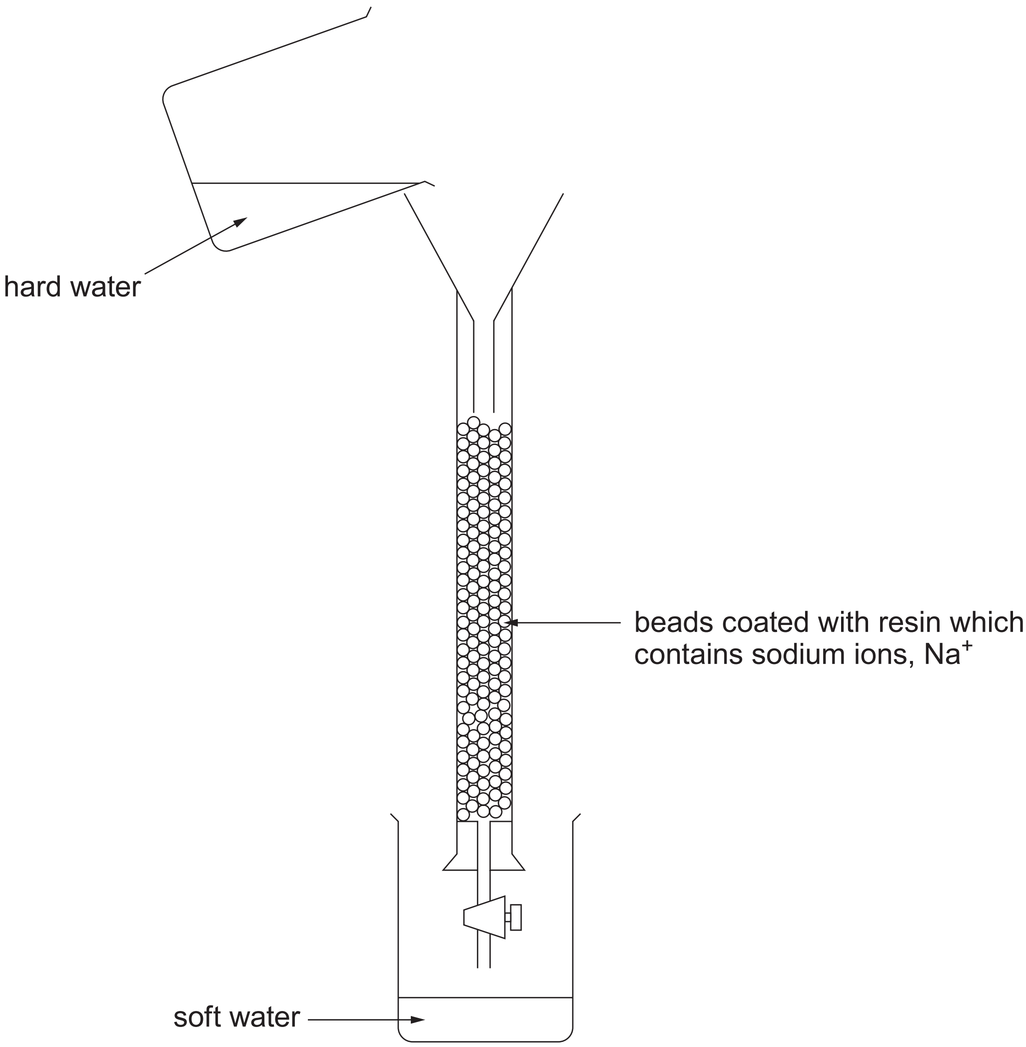
12

7. *(a)* The diagram shows an ion exchange column used for softening permanent hard water.



(i) Explain how ion exchange works. [2]

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(ii) Explain why the ion exchange resin will stop working after continued use. Name a solution which can be passed through the resin to regenerate it. [2]

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Examiner only

(b) Describe and explain a method to test whether a water sample is soft water, temporary hard water or permanent hard water. [4]

(You do **not** need to include reference to fair testing in your answer)

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8

Examiner only

8. *(a)* (i) The table below shows results of tests carried out on three white Group 1 compounds, **A**, **B** and **C**.

The flame tests were carried out on solids and the silver nitrate tests on solutions of the compounds.

Test	Compound **A**	Compound **B**	Compound **C**
Flame test	red	yellow	lilac
Add silver nitrate solution	white precipitate	cream precipitate	yellow precipitate

Use the information in the table to identify the compounds. [2]

Compound **A** ....

Compound **B** ....

Compound **C** ....

(ii) The symbol equation represents the reaction occurring between solutions of silver nitrate and magnesium chloride.

$$2AgNO_3(aq) \;+\; MgCl_2(aq) \longrightarrow Mg(NO_3)_2(aq) \;+\; 2AgCl(s)$$

Write the **ionic** equation for the reaction. Include state symbols in your answer. [3]

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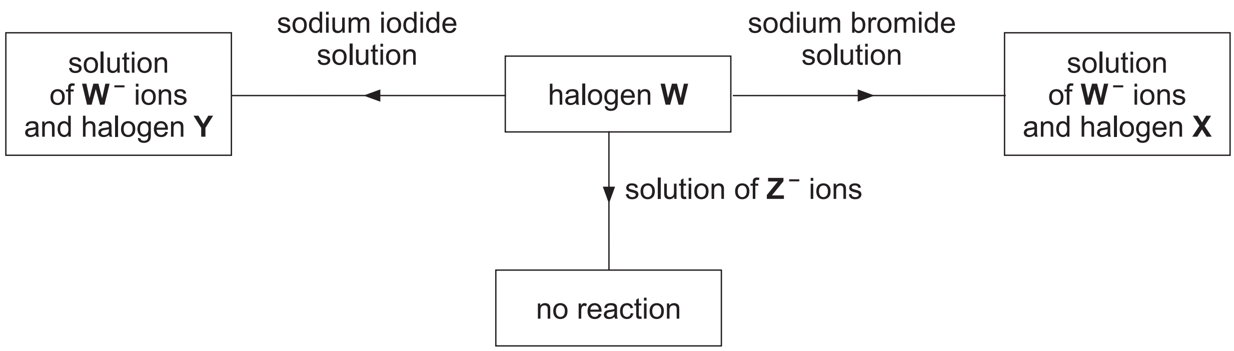
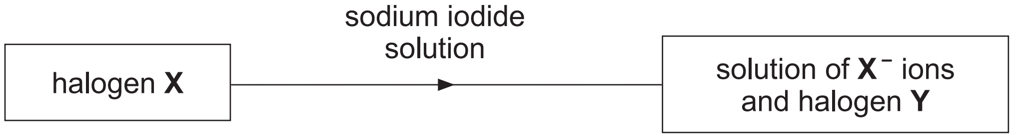
Examiner only

(b) **W**, **X**, **Y** and **Z** represent the halogens fluorine, chlorine, bromine and iodine, but not necessarily in that order.

The diagrams below show some reactions of halogens **W** and **X**.





Use the information to identify halogens **W**, **X**, **Y** and **Z**. [2]

W ....

X ....

Y ....

Z ....

(c) Iron wool burns in fluorine to give iron(III) fluoride.

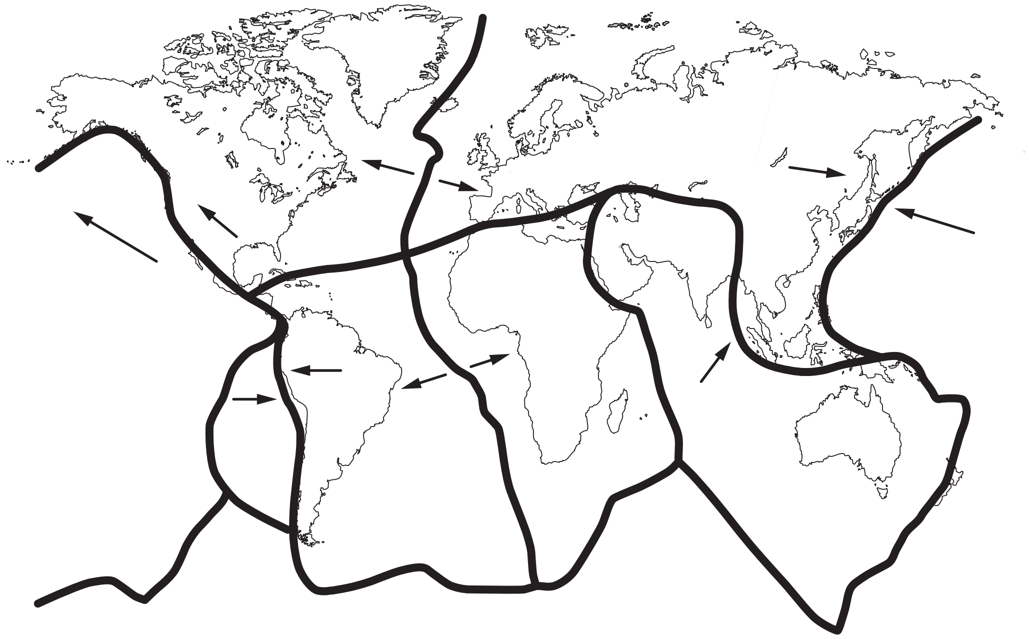
Write a balanced **symbol** equation for this reaction. [2]

....

9

Examiner only

9. The diagram shows the movement of the major tectonic plates.



Explain what happens at destructive and constructive plate boundaries.
Diagrams may be included in your answer. [6 QER]

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6

END OF PAPER

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For continuation only.

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

1	2					Group						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

A_r	relative atomic mass
Symbol	
Name	
Z	atomic number