Surname	Centre Number	Candidate Number
Other Names		0

GCSE – NEW

C410U10-1

S18-C410U10-1

CHEMISTRY – Component 1:
Concepts in Chemistry

FOUNDATION TIER

THURSDAY, 17 MAY 2018 – MORNING

2 hours 15 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**8**	
2.	**12**	
3.	**12**	
4.	**12**	
5.	**8**	
6.	**14**	
7.	**6**	
8.	**12**	
9.	**6**	
10.	**10**	
11.	**10**	
12.	**10**	
Total	**120**	

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01

ADDITIONAL MATERIALS

In addition to this paper you will need 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 **6***(c)* 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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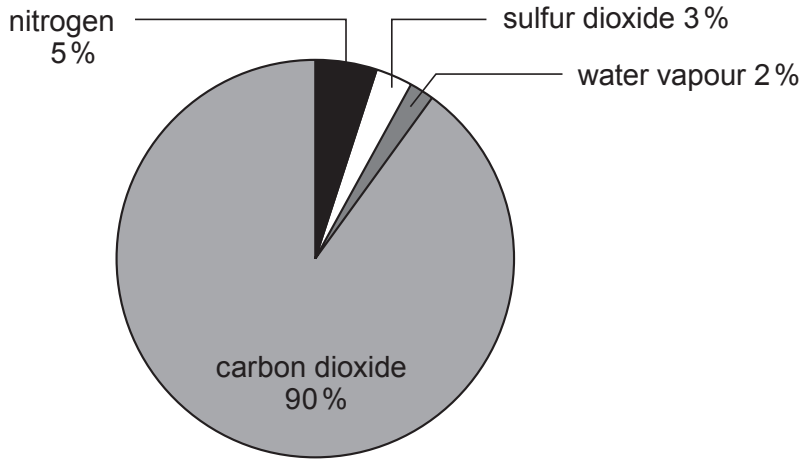
Answer **all** *questions*.

1. *(a)* Draw a line to match each gas to its percentage in the atmosphere. [2]

Gas	Percentage in the atmosphere
oxygen	78 %
nitrogen	21 %
carbon dioxide	0.9 %
argon	0.04 %

(b) The pie chart shows the approximate percentage of gases in the atmosphere that existed **before** green plants evolved on Earth.



Put a tick (✓) next to the statement which describes how green plants affected the amounts of carbon dioxide and oxygen in the atmosphere. [1]

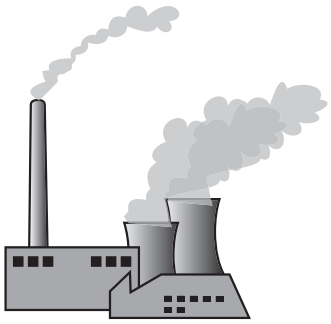
carbon dioxide increased and oxygen decreased ☐

both carbon dioxide and oxygen increased ☐

carbon dioxide decreased and oxygen increased ☐

Examiner only

(c) Coal contains sulfur impurities. Burning coal in power stations is a major source of acid rain.



Describe the **two** steps that lead to acid rain being formed from coal. Give **one** problem which is caused by acid rain. [3]

Step 1 .....

.....

Step 2 .....

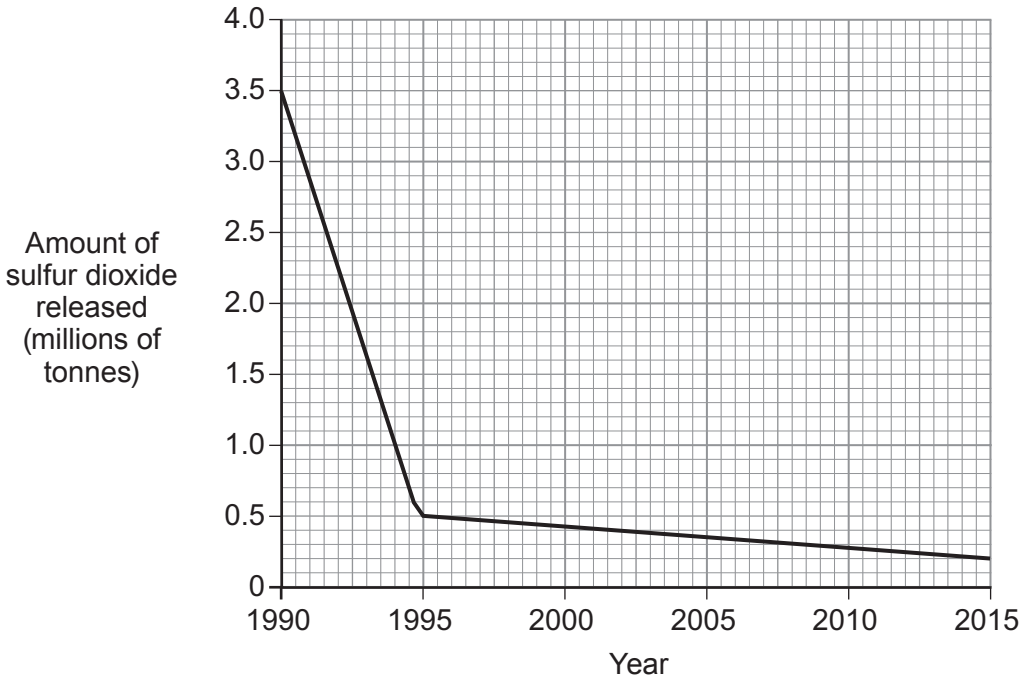
.....

Problem .....

.....

Examiner only

(d) The graph shows the amount of sulfur dioxide released into the atmosphere each year between 1990 and 2015.



What does this graph show? Put ticks (✓) in the boxes next to the **two** correct statements. [2]

the amount of sulfur dioxide released has decreased steadily over 25 years ☐

since 1995 there has been a small decrease in the amount of sulfur dioxide released ☐

there has been no decrease in the amount of sulfur dioxide released over the last 25 years ☐

the amount of sulfur dioxide released decreased rapidly between 1990 and 1995 ☐

8

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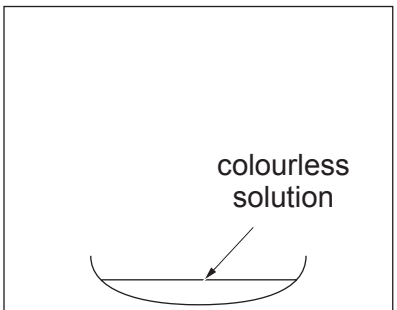
2. *(a)* The diagrams below show the three steps needed to prepare a sample of zinc chloride in the laboratory.

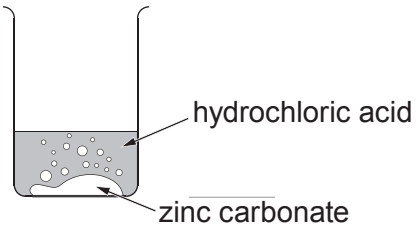
The steps are **not** in the correct order.

zinc carbonate + hydrochloric acid ⟶ zinc chloride + water + carbon dioxide



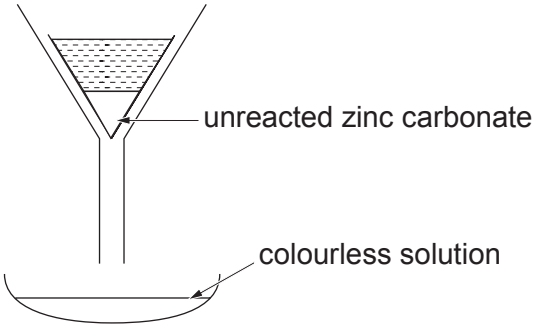
colourless solution is left in an evaporating basin at room temperature

Step A



excess zinc carbonate is added to dilute hydrochloric acid

Step B



the reaction mixture is filtered

Step C

(i) Complete the table.

I Put steps **A**, **B** and **C** in the order they are carried out. [2]

II Describe the **purpose** of each step. [3]

Step	Letter	Purpose
First step	.....	.....
Second step	.....	.....
Last step	.....	.....

(ii) Put a tick (✓) in the box next to the formula of zinc chloride. [1]

ZnCl ☐

Zn_2Cl ☐

$ZnCl_2$ ☐

Zn_2Cl_2 ☐

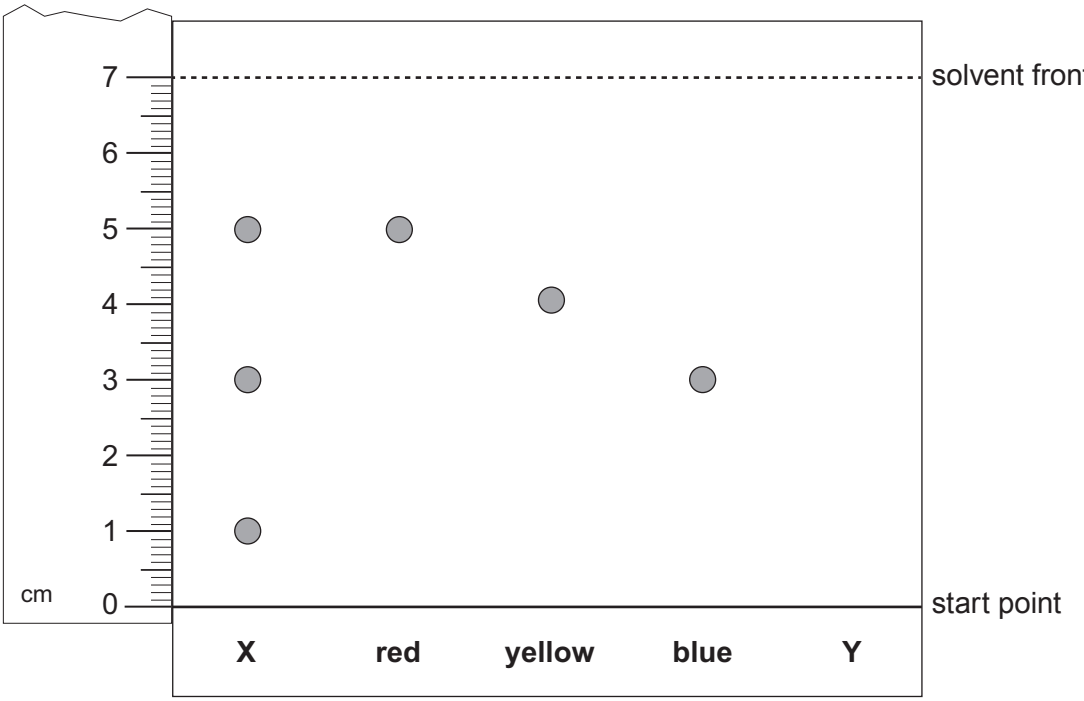
(iii) Give the **name** of another substance which reacts with dilute hydrochloric acid to make zinc chloride. [1]

.....

Examiner only

(b) Food colourings often contain more than one dye mixed together to give the required colour. Food scientists use chromatography to separate the dyes in food colourings.

The diagram shows a paper chromatogram used to investigate an unknown food colouring, **X**, and three known dyes.



(i) How many dyes does **X** contain? ..... [1]

(ii) Which of the known dyes are present in **X**? ..... [1]

(iii) The R_f value of a substance can be used to identify that substance.

The R_f value is given by the formula:

$$R_f = \frac{\text{distance moved by the substance}}{\text{distance moved by the solvent front}}$$

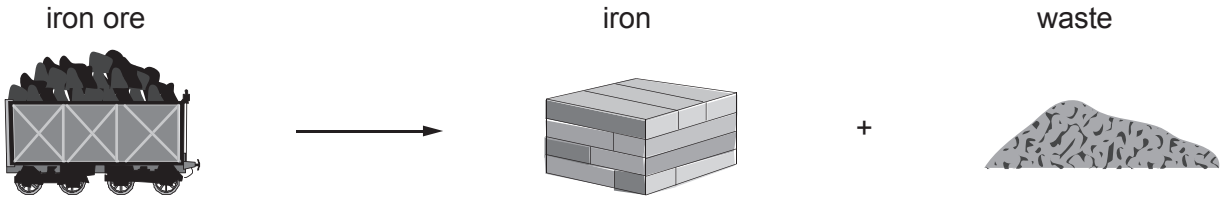
Calculate the R_f value of the blue dye. [2]

R_f = ...

(iv) Another unknown food colouring, **Y**, contains the red and yellow dyes.
On the diagram, draw the chromatogram for **Y**. [1]

Examiner only

3. *(a)* Different iron ores contain different amounts of iron. A scientist tests four iron ores, **A**, **B**, **C** and **D**, to find out how much iron they might expect to extract from each ore.



The table shows the scientist's results.

Ore	Mass of ore tested (g)	Mass of iron extracted from the ore (g)	Mass of iron extracted **per gram** of ore (g)	Mass of iron extracted **per kilogram** of ore (g)
A	100	7	0.07	70
B	100	4	0.04	40
C	100	12	0.12	120
D	100	10	.....	.....

(i) Complete the table. [2]

(ii) Give the **letter** of the ore which produces the least amount of waste. Explain your choice. [2]

.....

.....

(iii) When 500 tonnes of ore **A** are used in the blast furnace the predicted yield is 35 tonnes. In practice the actual yield is 29 tonnes.

Use the following equation to calculate the percentage yield. Give your answer to **two** significant figures. [2]

$$\text{percentage yield} = \frac{\text{actual yield}}{\text{predicted yield}} \times 100$$

Percentage yield = ... %

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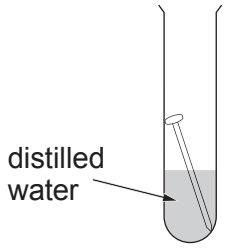
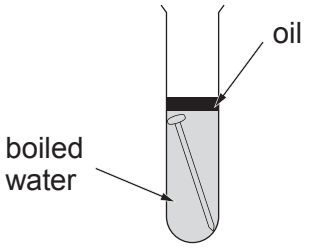
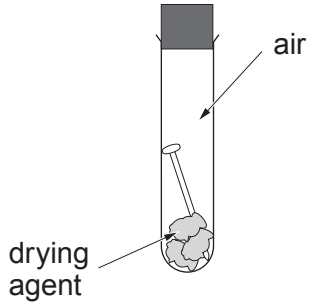
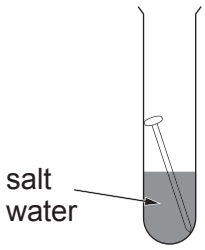
Examiner only

(b) A student investigated the rusting of iron. The table shows the apparatus used and the observations made.

Test tube 1	Test tube 2
	
water and air present	water only present
nail is rusty after 2 weeks	nail still shiny after 2 weeks

Test tube 3	Test tube 4
	
air only present	water, air and salt present
nail still shiny after 2 weeks	nail is rusty after 2 days

What **conclusions** can be drawn from these observations? [2]

.....

.....

.....

Examiner only

(c) The photographs show two methods of preventing ships from rusting.

Painting

www.chem.info

Sacrificial protection

www.tis-gdv.de

Explain how each method protects iron from rusting. [3]

.....

.....

.....

.....

(d) When iron rusts it reacts with oxygen to form iron(III) oxide. Iron(III) oxide contains the ions Fe^{3+} and O^{2-}.

Write the chemical formula for iron(III) oxide. ..... [1]

12

Turn over.

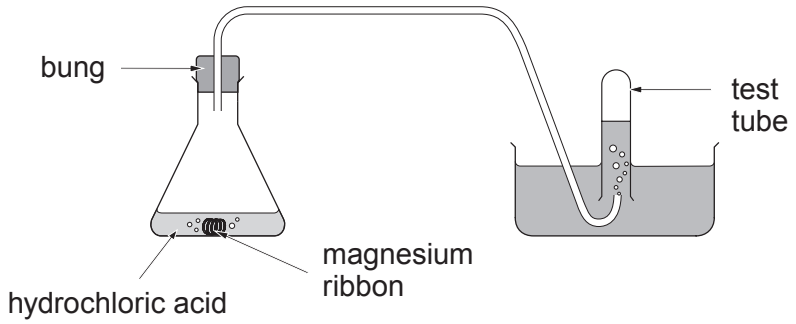
Examiner only

4. An experiment was carried out to investigate the rate of the reaction between magnesium ribbon and dilute hydrochloric acid.

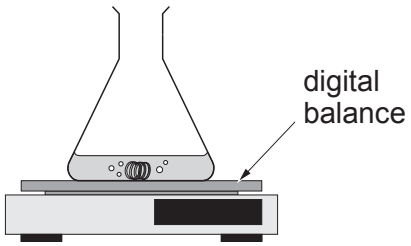
magnesium + hydrochloric acid ⟶ magnesium chloride + hydrogen

The volume of hydrogen formed every 10 seconds was recorded.

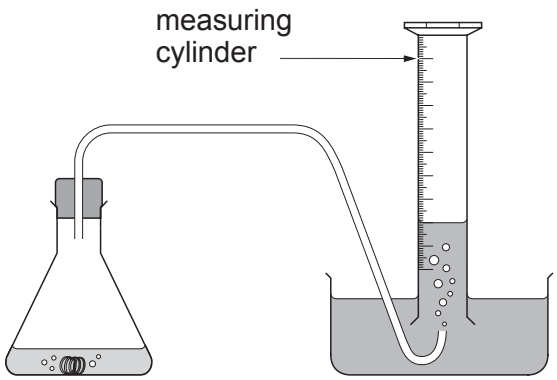
(a) Give the **letter** of the apparatus which would be used to **accurately** record the **volume** of hydrogen formed. Give a reason for your choice. [2]



A



B



C

Letter .....

Reason .....

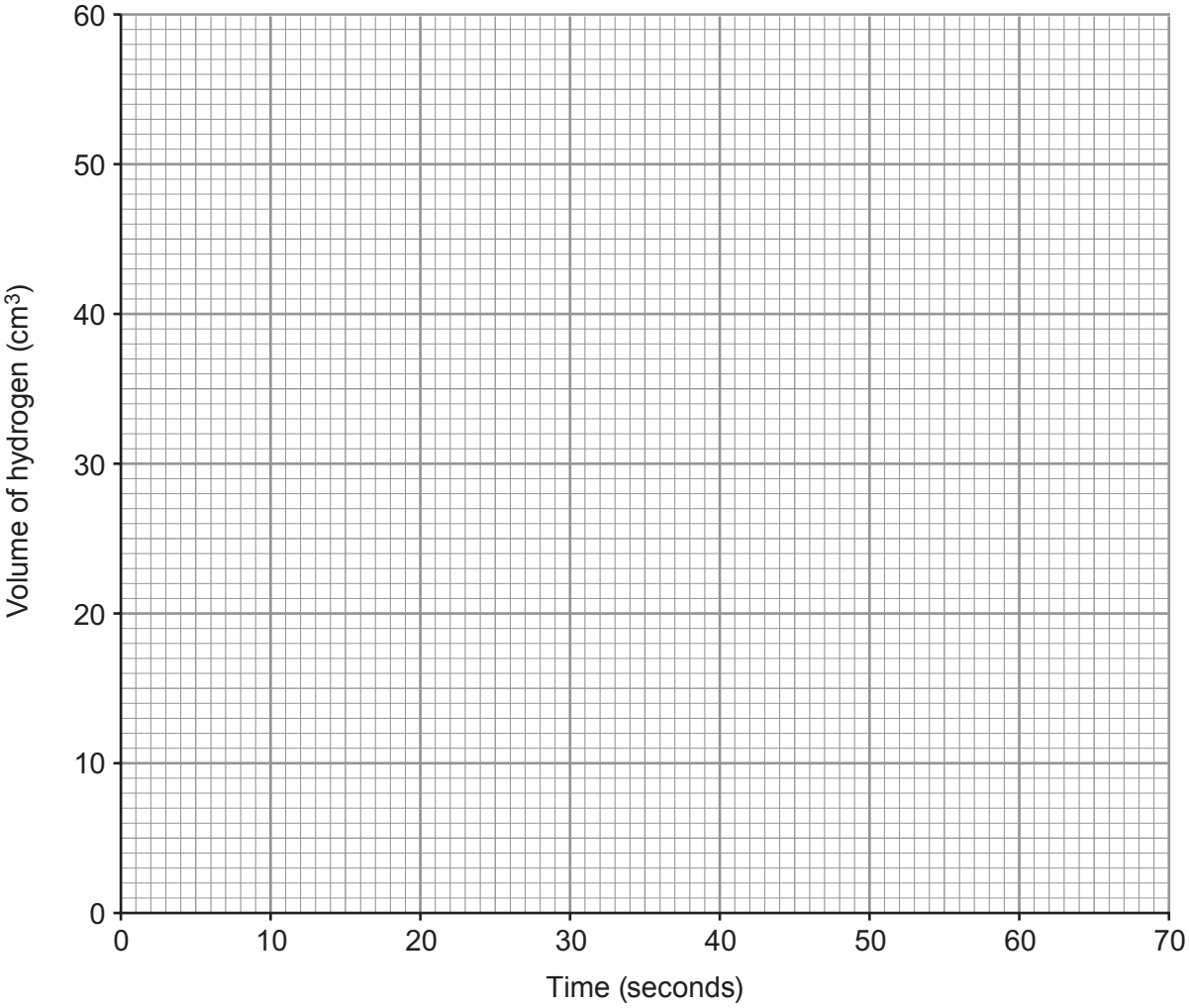
.....

Examiner only

(b) The table shows the volume of hydrogen formed during the reaction between magnesium ribbon and excess dilute hydrochloric acid at 20 °C.

Time (seconds)	0	10	20	30	40	50	60	70
Volume of hydrogen (cm^3)	0	16	30	42	52	55	55	55

(i) Plot the results on the grid and draw a suitable line. [3]



(ii) I Use the graph to find the volume of hydrogen formed after 25 seconds. [1]

..... cm^3

II Use the graph to find the time taken to form 5 cm^3 of hydrogen. [1]

..... s

Examiner only

(c) The rate of this reaction can be changed by replacing the magnesium ribbon with powdered magnesium.

State and explain, in terms of the particle model, how this change affects the rate. [3]

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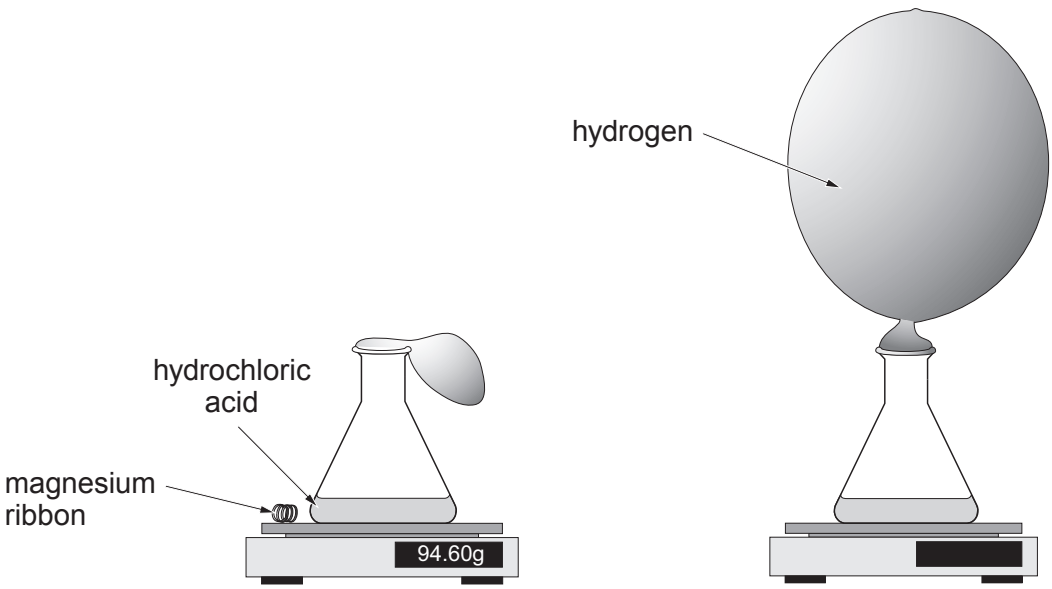
(d) The same reaction was repeated and a balloon used to collect **all** the gas given off. The apparatus was set up as shown below. The mass was recorded at the start and again after 1 minute.



After 1 minute

Put a tick (✓) in the box next to the statement which gives the total mass after 1 minute.

< 94.60 g ☐

= 94.60 g ☐

> 94.60 g ☐

= 47.30 g ☐

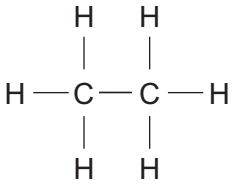
Give a reason for your choice. [2]

.....

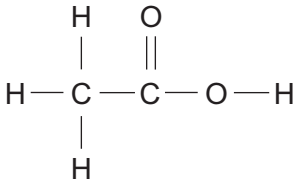
.....

Examiner only

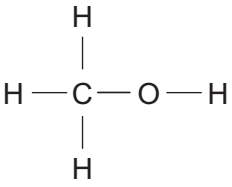
5. The structural formulae of five carbon compounds are shown.



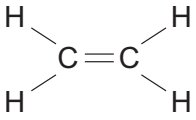
ethane



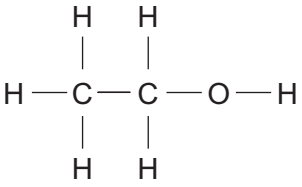
ethanoic acid



methanol



ethene



ethanol

Use only these compounds in your answers to parts *(a)-(d)*.

(a) Give the **names** of the two hydrocarbons. Give the reason for your choice. [2]

Names ..... and .....

Reason .....

.....

(b) Give the **names** of the two compounds which belong to the same homologous series. Name the homologous series. [2]

Names ..... and .....

Homologous series .....

(c) Give the **name** of the compound which reacts with oxygen to form ethanoic acid. [1]

Name .....

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(d) Give the **name** of the compound used to make polythene. Explain how polythene is formed. [3]

Name .....

Explanation .....

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8

Examiner only

6. *(a)* A group of students used simple chemical tests to identify unknown substances.

(i) Samantha tested three colourless gases **A**, **B** and **C**.

She was told that the gases were three of the following.

ammonia	**carbon dioxide**	**chlorine**	**hydrogen**	**oxygen**

The table shows her results.

Test	Observations		
	Gas **A**	Gas **B**	Gas **C**
Damp red litmus paper	no change	bleached white	turns blue
Using a pipette, bubble some of the gas into limewater	turns milky	no change	no change
Damp blue litmus paper	turns red	turns red, and then bleached white	no change

Name the three gases. [3]

A .....

B .....

C .....

(ii) Jack was given three solutions **D**, **E** and **F** in unlabelled bottles.

He was told the solutions were either **metal carbonates** or **metal halides**.

The table shows his results.

Test	Observations		
	Compound D	Compound E	Compound F
Flame test	yellow	lilac	brick-red
Add silver nitrate solution	white precipitate	no reaction	yellow precipitate
Add dilute hydrochloric acid	no reaction	fizzes	no reaction

Name the three compounds. [3]

D .....

E .....

F .....

(b) Barium chloride solution is used to test for sulfate ions. When barium chloride solution is added to sodium sulfate solution a white precipitate is formed.

barium chloride + sodium sulfate ⟶ sodium chloride + barium sulfate

Complete and balance the symbol equation for this reaction. [2]

$BaCl_2$ + Na_2SO_4 ⟶ ..... + ...

Examiner only

(c) Emily carried out a series of experiments to find the relative positions of copper, magnesium and zinc in the reactivity series. Each metal was added to separate solutions of the other two metals. The table shows her results.

Metal	Metal sulfate solution		
	copper(II) sulfate	magnesium sulfate	zinc sulfate
copper		no reaction	no reaction
magnesium	brown solid forms and blue solution turns colourless		silvery-grey solid forms
zinc	brown solid forms and blue solution turns colourless	no reaction	

Use the information in the table to place these metals in order of reactivity. Explain your reasoning and include equations to show the type of reaction taking place. [6 QER]

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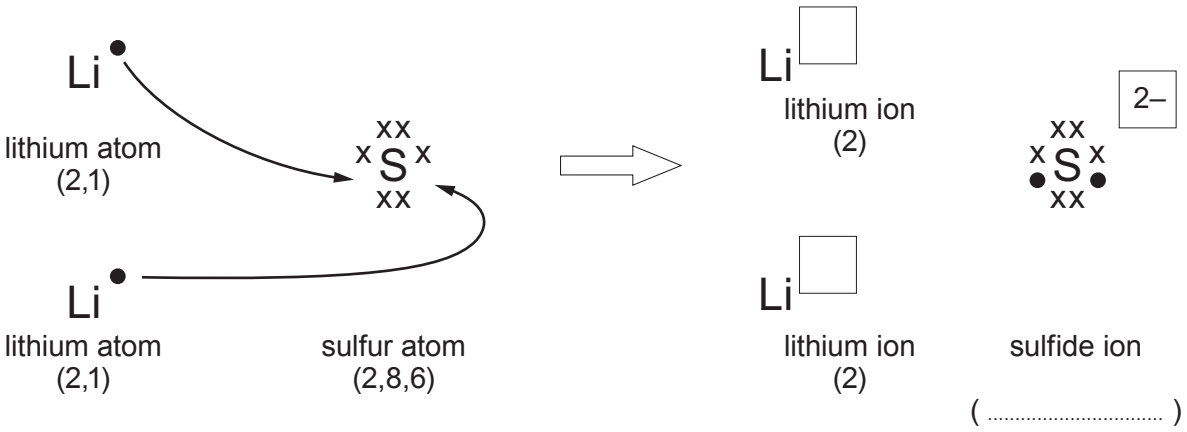
14

Turn over.

Examiner only

7. *(a)* The diagrams show the electronic changes that occur when lithium reacts with sulfur to form lithium sulfide.

The ● and x symbols are **outer** shell electrons.



(i) **Complete the diagram** by putting in the charge on each lithium ion and the electronic structure of the sulfide ion. [2]

(ii) Underline the name of the force holding the ions together in lithium sulfide. [1]

gravity **electrostatic** **magnetic** **friction**

(iii) Write the chemical formula of lithium sulfide. [1]

.....

Examiner only

(b) The table shows the electronic structures of the elements present in hydrogen sulfide.

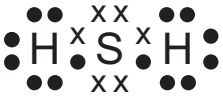
Element	Electronic structure
hydrogen	1
sulfur	2,8,6

(i) Use this information to choose the diagram **A**-**D** which shows the bonding in a hydrogen sulfide molecule. [1]

A

B

C



D

Letter .....

(ii) Name the type of bonding found in hydrogen sulfide.

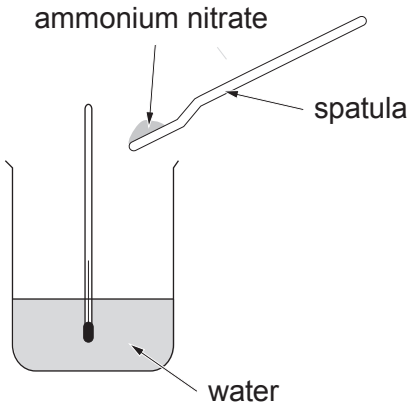
.....

[1]

6

Examiner only

8. *(a)* A teacher demonstrated an experiment to show the temperature change when ammonium nitrate dissolves in water.



Different amounts of ammonium nitrate were added separately to 100 cm^3 of water. The results are shown in the table.

Spatulas of ammonium nitrate	Initial temperature (°C)	Final temperature (°C)
1	21	19
2	21	16
4	21	9

(i) What conclusions can be drawn from the results? [2]

.....

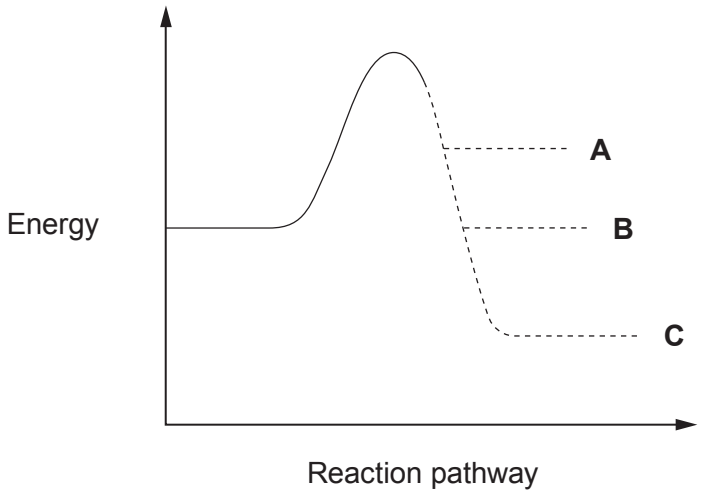
.....

.....

.....

Examiner only

(ii) An energy profile diagram can be drawn for the dissolving of ammonium nitrate in water.



Give the **letter** which shows the energy of the product. [1]

Letter .....

(iii) The teacher repeated the experiment using accurate masses of ammonium nitrate.

Give the name of the apparatus used to measure mass. [1]

.....

(b) Ammonium nitrate and potassium nitrate are two important chemicals used in NPK fertilisers.

(i) Calculate the relative formula mass (M_r) of ammonium nitrate, NH_4NO_3 [2]

A_r(H) = 1 A_r(N) = 14 A_r(O) = 16

M_r = ...

(ii) Calculate the percentage by mass of nitrogen in ammonium nitrate. [2]

Percentage = ... %

Examiner only

(c) The atom economy of a reaction is an important factor when planning an industrial process.

One method of manufacturing potassium nitrate is by reacting potassium hydroxide with nitric acid.

$$KOH + HNO_3 \longrightarrow KNO_3 + H_2O$$

The tables show the relative formula masses (M_r) of the reactants and products of the reaction.

Reactants	M_r
potassium hydroxide	56
nitric acid	63

Products	M_r
potassium nitrate	101
water	18

The atom economy for a reaction can be calculated using the following formula.

$$\text{atom economy} = \frac{\text{mass of atoms in desired product}}{\text{mass of atoms in reactants}} \times 100$$

(i) Calculate the atom economy for the production of potassium nitrate. Give your answer to an **appropriate** number of significant figures. [2]

Atom economy = ... %

(ii) Put a tick (✓) next to **two** statements which describe the advantages of a reaction with a high atom economy. [2]

uses less natural resources ☐

forms more waste ☐

only uses renewable natural resources ☐

forms less waste ☐

forms biodegradable waste ☐

12

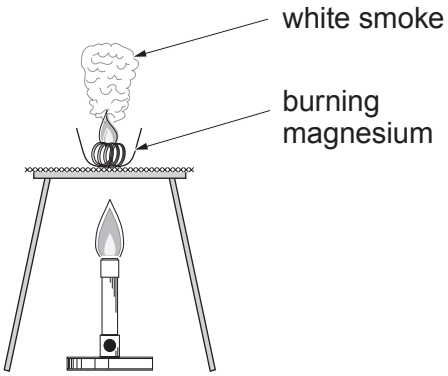
Examiner only

9. Four students investigated the burning of magnesium in air.

magnesium + oxygen ⟶ magnesium oxide

They wanted to show that 0.24 g of magnesium always joins with the same mass of oxygen. Each student followed the same method.

Method
1. Weigh a crucible.
2. Weigh the crucible and 0.24 g of magnesium ribbon.
3. Heat the magnesium until the reaction stops.
4. Allow the apparatus to cool.
5. Weigh the crucible and magnesium oxide.
6. Calculate the mass of oxygen gained.



The table shows the mass of oxygen gained in each student's experiment.

Student	1	2	3	4
Mass of oxygen gained (g)	0.11	0.05	0.07	0.09

(a) (i) Use all **four** of the students results to calculate the mean mass of oxygen which reacts with 0.24 g of magnesium. [2]

Mean mass of oxygen = ... g

(ii) 0.24 g of magnesium should join with 0.16 g of oxygen.

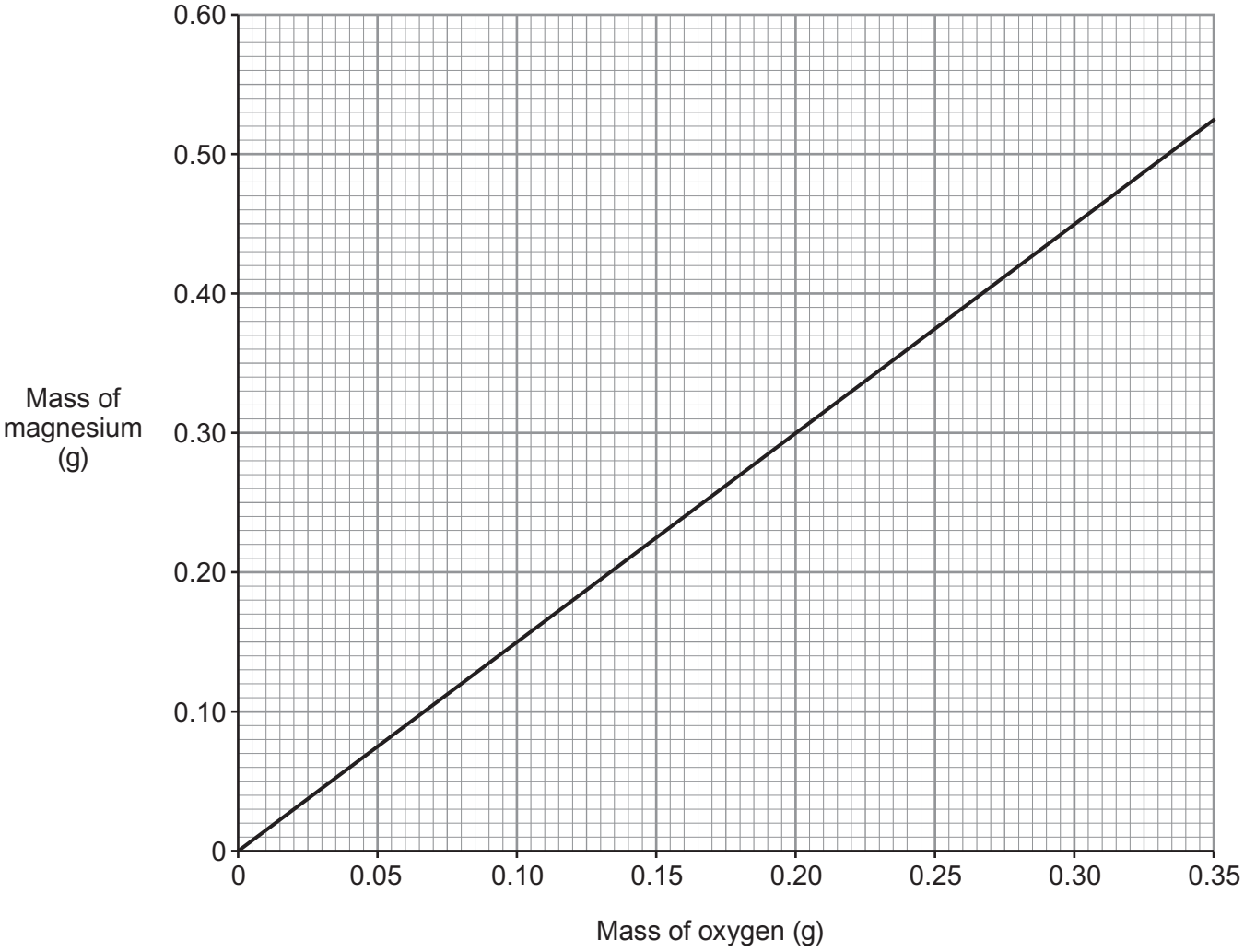
Suggest **one** reason why the results obtained by all the students were lower than 0.16 g. [1]

.....

.....

Examiner only

(b) The graph shows the relationship between the mass of magnesium and the mass of oxygen present in magnesium oxide.



(i) Calculate the gradient of the line. You **must** show your working. [2]

Gradient of line = ...

(ii) Use the graph to predict the mass of oxygen that reacts with 0.6 g of magnesium. [1]

Mass of oxygen = ... g

6

Examiner only

10. *(a)* The table shows some information about particles found in atoms. Complete the table. [2]

Particle	Relative mass	Relative charge
proton	.....	+1
electron	negligible	.....
neutron	1	0

(b) Complete the following table that shows information about atoms of some elements. [3]

Element	Mass number	Atomic number	Number of protons	Number of neutrons	Number of electrons
fluorine	19	9	9	10	.....
potassium	39	19	.....	20	19
argon	.....	18	18	22	18

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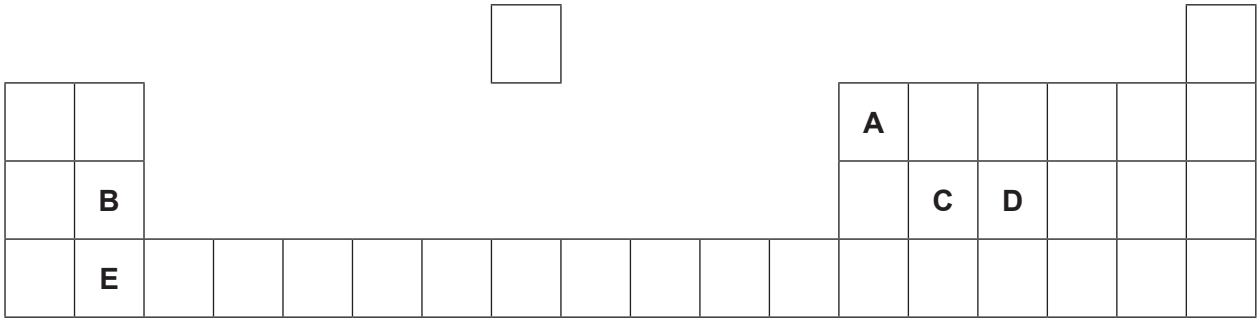
(c) The following diagram shows an outline of part of the Periodic Table.

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



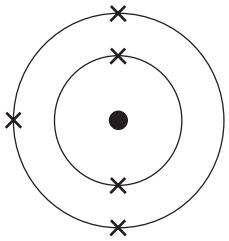
(i) Give the **letter** of the element in Group 2 and Period 3. [1]

.....

(ii) Give the **letter** of the element which has 14 protons in its nucleus. [1]

.....

(d) The diagram shows the electronic structure of an element in the Periodic Table.



Draw the diagram which shows the electronic structure of the element which lies directly **below** it. [1]

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(e) The definition of an element is:

> *"a substance that cannot be broken down into simpler substances by chemical methods".*

In the 1700s a chemist named Antoine Lavoisier attempted to arrange substances in a pattern. The table shows some of the 'substances' which Lavoisier thought were elements. He divided the 'substances' into four groups. He published these groups in 1789. The modern names of some of the 'substances' are given in brackets.

Acid-making elements	Gas-like elements	Metallic elements	Earthy elements
sulfur	light	mercury	lime (calcium oxide)
phosphorus	caloric (heat)	copper	magnesia (magnesium oxide)
charcoal (carbon)	oxygen	nickel	barites (barium sulfate)
	azote (nitrogen)	gold	silex (silicon dioxide)
	hydrogen	iron	
		zinc	

(i) Name **one** 'substance' in the table which is **not** a chemical element or compound. [1]

.....

(ii) The 'earthy elements' are now known as compounds. Suggest why Lavoisier thought they were elements. [1]

.....

10

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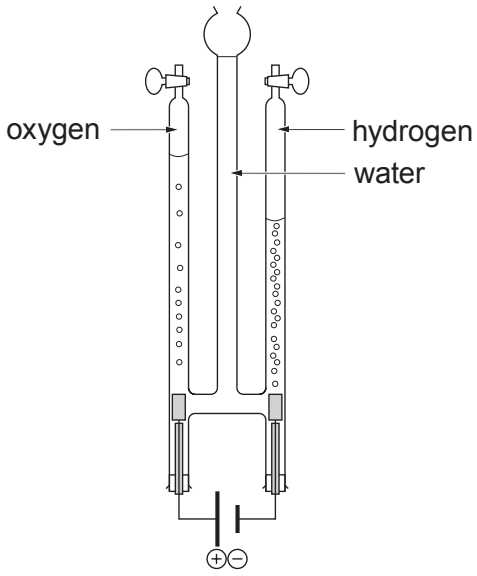
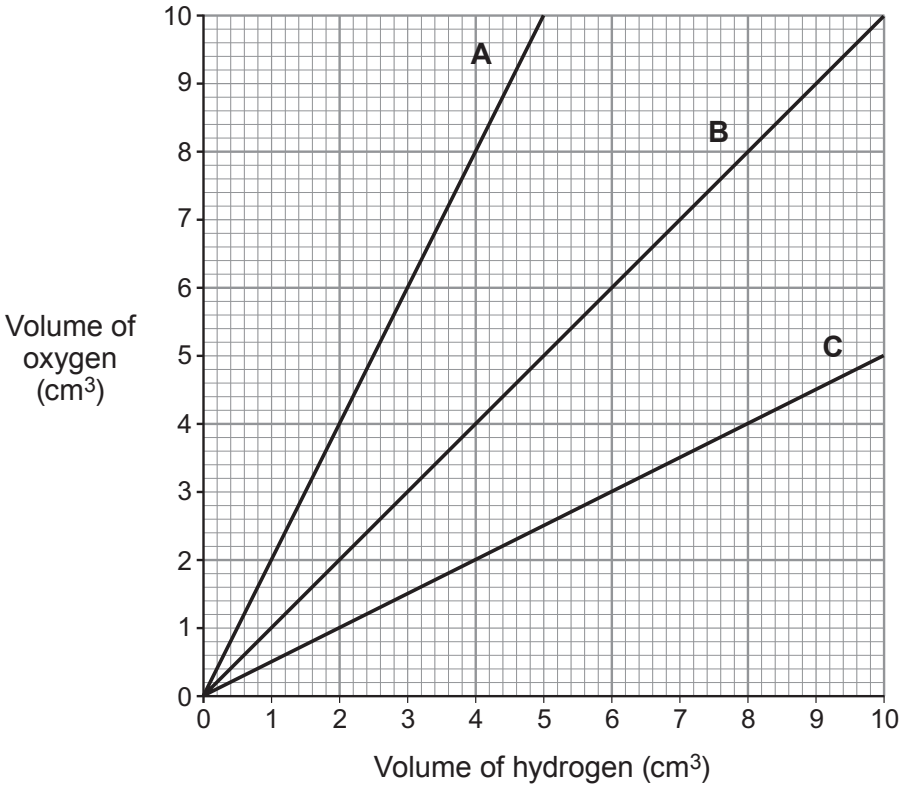
11. *(a)* The following apparatus is used to show the electrolysis of water.



(i) Choose the **letter** of the graph which shows the relationship between the volume of hydrogen and the volume of oxygen formed during the process. Give the reason for your choice. [2]



Letter .....

Reason .....

.....

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(ii) Explain the **movement** of H^+ ions and OH^- ions during the process. [2]

.....

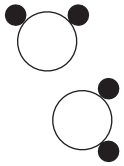
.....

.....

.....

(iii) Complete the equation by drawing diagrams to represent **all** the molecules formed. [2]

water ⟶ hydrogen + oxygen



⟶ +

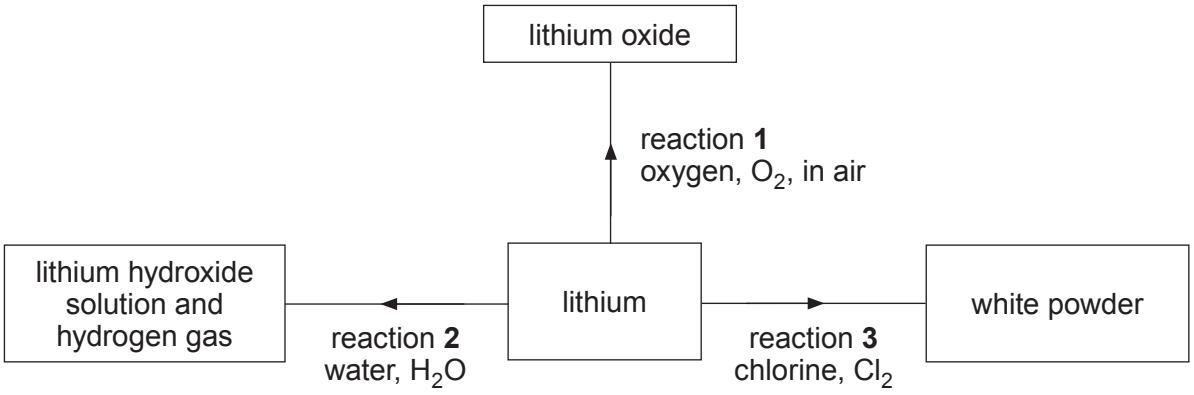
(b) The table below shows the symbols of the ions present in three electrolytes and the products formed during their electrolysis. **Complete the table.** [4]

Electrolyte	**Symbol** of ions present in electrolyte		**Name** of product formed	
	Positive ion(s)	Negative ion(s)	At the cathode (−)	At the anode (+)
molten lead(II) iodide	.....	.....	lead	iodine
aqueous copper(II) sulfate	Cu^{2+} H^+	SO_4^{2-} OH^-	.....	oxygen
aqueous lithium chloride	Li^+ H^+	Cl^- OH^-	hydrogen	.....

10

Examiner only

12. *(a)* The diagram shows three reactions of lithium.



(i) I Balance the symbol equation for reaction **1**. [1]

$$\square\ Li + O_2 \longrightarrow \square\ Li_2O$$

II Calculate the relative formula mass (M_r) of lithium oxide. [1]

A_r(Li) = 7 A_r(O) = 16

M_r = ...

III Describe how reaction **1** is prevented from happening when storing lithium in the laboratory. [1]

.....

.....

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(ii) I Complete and balance the symbol equation for reaction **2**. [2]

$2Li + 2H_2O \longrightarrow$ ..... + ...

II Explain the colour seen when a few drops of universal indicator are added to the solution formed in reaction **2**. [2]

.....

.....

(iii) Write a balanced symbol equation for reaction **3**. [2]

.....

(b) Give the chemical formula of lithium carbonate. [1]

.....

10

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+}		

Turn over.

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