Surname	Centre Number	Candidate Number
First name(s)		0

GCSE

S24-3430UB0-1

3430UB0-1

THURSDAY, 13 JUNE 2024 – MORNING

SCIENCE (Double Award)

Unit 2: CHEMISTRY 1
HIGHER TIER

1 hour 15 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**7**	
2.	**4**	
3.	**4**	
4.	**10**	
5.	**6**	
6.	**6**	
7.	**9**	
8.	**7**	
9.	**7**	
Total	**60**	

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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. (a) The table shows information about some Group 1 elements. The melting point of rubidium is missing.

Element	Melting point (°C)	Boiling point (°C)	Density (g/cm^3)
lithium	181	1330	0.53
sodium	98	883	0.99
potassium	64	759	0.86
rubidium		688	1.53
caesium	29	671	1.93

(i) State which of the elements **lithium**, **sodium** or **potassium**, is a liquid over the greatest temperature range. [1]

.....

(ii) Estimate a value for the melting point of rubidium. [1]

.....

(iii) Group 1 elements are stored in paraffin oil to prevent reactions with oxygen.

The density of paraffin oil is $0.80\,g/cm^3$.

State which of the Group 1 elements would float on paraffin oil. [1]

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(b) When a small piece of **sodium** is added to water, it fizzes, melts and moves around on the surface of the water.

Give **another** observation that you would expect to make when **potassium** is added to water. State the reason for the difference. [2]

Observation .....

Reason .....

.....

(c) Lithium reacts with oxygen to give lithium oxide.

Complete the equation for the reaction by

- giving the formula for lithium oxide
- putting numbers in the boxes to balance the equation [2]

$$\square\ Li + O_2 \longrightarrow \square\ .....$$

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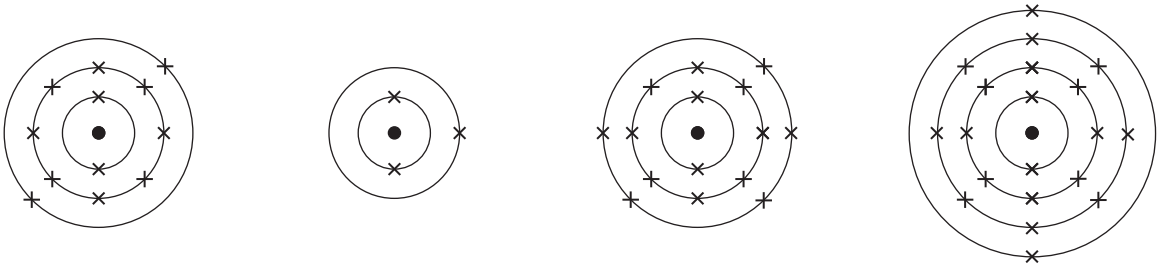
2. The diagrams below show the electronic structures of four elements, **A**, **B**, **C** and **D**.

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



A **B** **C** **D**

(a) Give the **letters** of **two** elements which are in the same period in the Periodic Table. [1]

..... and .....

(b) Give the atomic number and the name of element **D**. [2]

Atomic number .....

Name .....

(c) Draw the electronic structure of the element directly **above** element **C** in the Periodic Table. [1]

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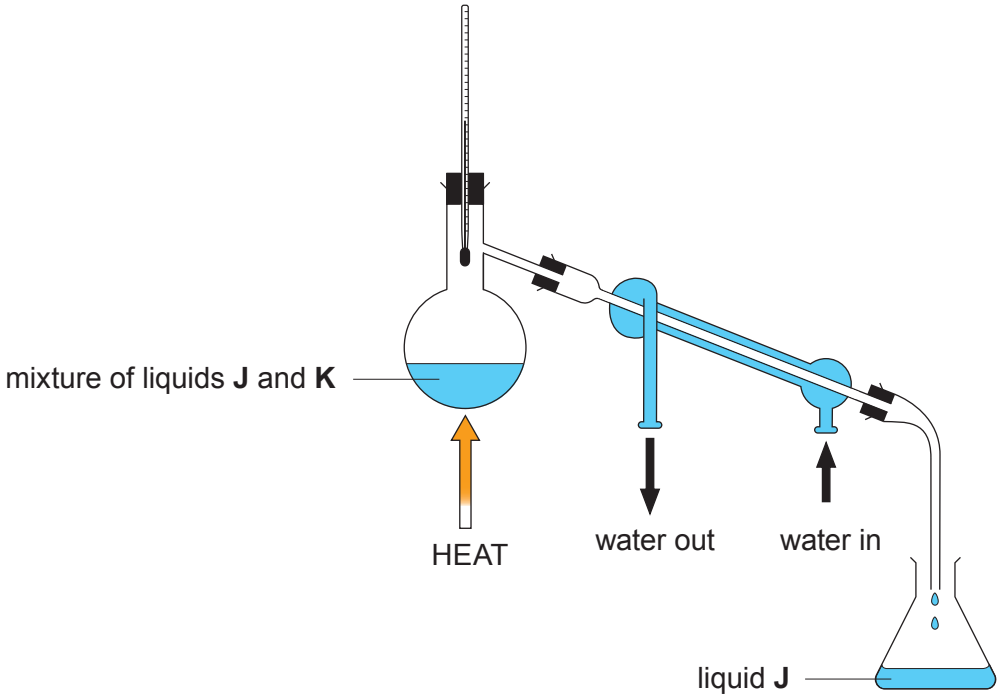
3. The diagram shows the separation of a mixture of liquids **J** and **K**.



- The temperature on the thermometer stays at 56 °C even though the mixture is still being heated
- Drops of liquid **J** fall steadily into the flask

(a) Use the information given above and in the diagram.

State the conclusions that you can draw about the boiling points of liquids **J** and **K**. [2]

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(b) **K** is a compound with the formula C_4H_8O. The relative formula mass (M_r) of compound **K** is 72.

Calculate the percentage by mass of carbon in compound **K**. [2]

$A_r(C) = 12$

Percentage = ... %

4

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4. (a) A class investigated the reaction between magnesium and nitric acid by measuring the volume of hydrogen gas produced over time.

The table shows their results.

Time (s)	Volume of gas produced (cm^3)
0	0
5	12.0
10	20.5
15	29.0
20	33.5
25	35.0
30	35.0

(i) The reaction between magnesium and nitric acid produces magnesium nitrate and hydrogen gas.

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

Mg + ☐ HNO_3 ⟶ ..... + ...

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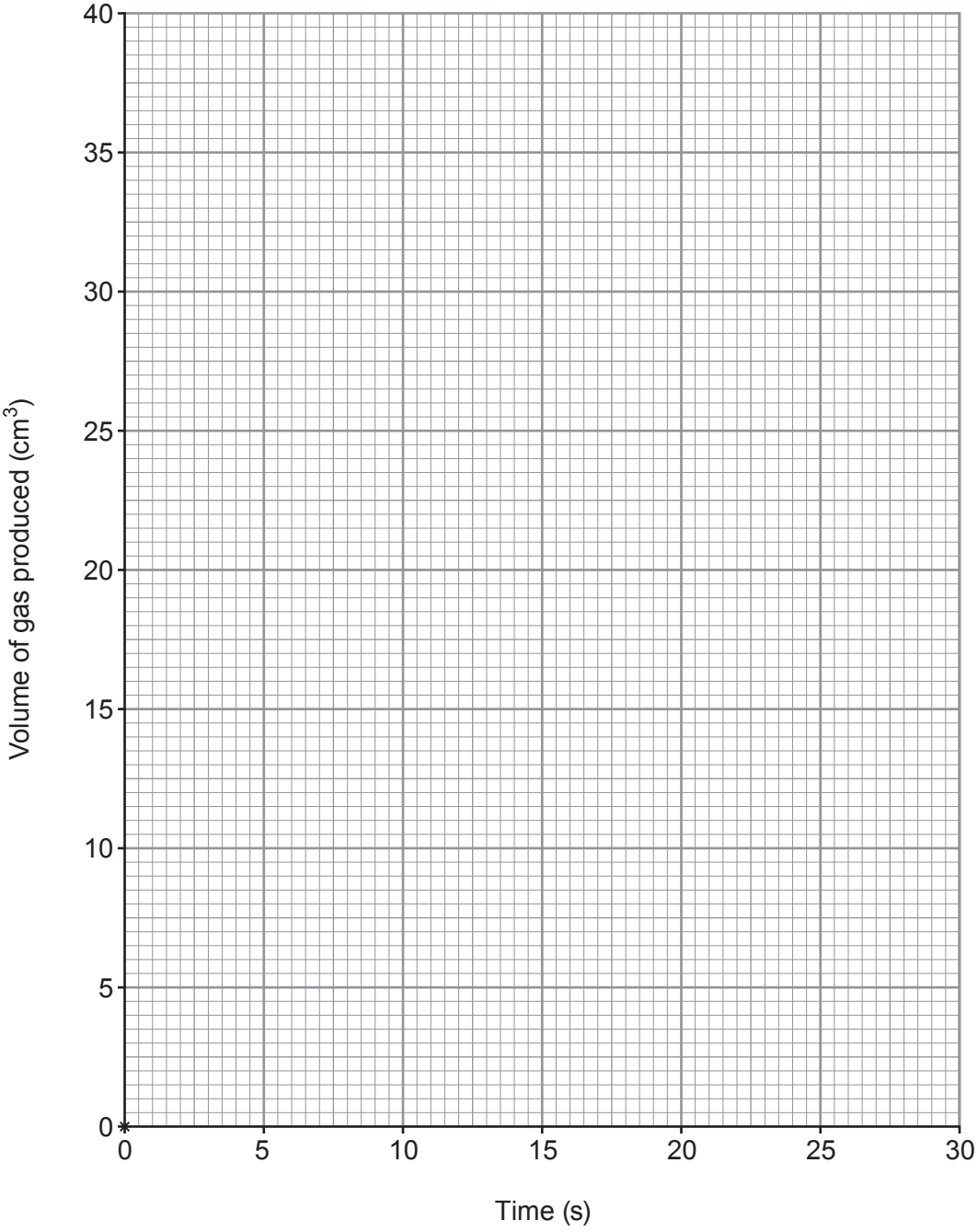
(ii) Plot the results on the grid and draw a suitable line.

The first point has been plotted for you. [3]



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(iii) Use particle theory to explain why the graph becomes less steep over time. [3]

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(b) State why a catalyst is added to a reaction mixture and explain how a catalyst works. [2]

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5. Human activity causes emissions of about 6 billion tonnes of carbon dioxide into the atmosphere each year. Carbon capture effectively traps the emissions from power plants or factory chimneys before they enter the atmosphere and contribute to global warming. There are different ideas regarding what to do with the gas once it has been captured.

Proposal 1

One idea is to pipe the trapped gas to the ocean floor more than 4 km below sea level where the temperature is around 2 °C and the pressure can be up to 750 times atmospheric pressure. The captured carbon dioxide would be stored in a solid-liquid state in huge plastic bags. Each of these bags would hold about two days' worth of global emissions. Some scientists have predicted that we might find a way in the near future to use this 'solid' carbon dioxide as a fuel, possibly by combining it with hydrogen to produce methanoic acid for use in fuel cells.

Proposal 2

Another idea is to refine the carbon emissions to make a high-grade product which will then be used to make sodium hydrogencarbonate, also known as baking soda. Baking soda is in high demand in the pharmaceutical sector to help treat conditions from heartburn to kidney disease. It is found in ear and eye drops. It can also be used to produce components of detergents, sherbet powder and glass. Some manufacturers are even using it to remove acidic gases from factory emissions.

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(a) (i) Tick (✓) the **two** correct statements which explain why carbon dioxide would be in a solid-liquid state when in plastic bags at the deep ocean floor. [2]

the pressure is higher than at sea level and the temperature is lower	☐
the pressure and temperature are both lower than at sea level	☐
particles are closer together at a higher pressure	☐
carbon dioxide is not a gas at any temperature or pressure	☐
particles are closer together at a higher temperature	☐

(ii) Suggest **two** reasons why **proposal 2** might be viewed as a better solution than **proposal 1**. [2]

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(b) Sodium hydrogencarbonate contains the HCO_3^- ion.

Sodium hydrogencarbonate is the **only product** made when captured carbon dioxide reacts with sodium hydroxide.

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

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6

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6. Hard water can be softened by boiling or by passing through an ion exchange column.

Describe how each method softens hard water and compare the advantages and disadvantages of each method. [6 QER]

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7. (a) The table shows some tests carried out to identify the ions contained in salts **A**, **B** and **C** and the observations made.

Salt	Flame test	Silver nitrate test	Name of salt
A	lilac flame	yellow precipitate	.....
B	.....	no change	calcium nitrate
C	.....	.....	barium bromide

Complete the table by giving the name of salt **A** and the observations expected for salts **B** and **C**. [3]

(b) Give the numbers of protons and electrons in a calcium ion, Ca^{2+}, and a bromide ion, Br^{-}. [2]

Ion	Number of protons	Number of electrons
Ca^{2+}	.....	.....
Br^{-}	.....	.....

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(c) Calcium nitrate solution reacts with sodium carbonate solution to form a precipitate of calcium carbonate.

$$Ca(NO_3)_2(aq) + Na_2CO_3(aq) \longrightarrow CaCO_3(s) + 2NaNO_3(aq)$$

Write an **ionic** equation for the formation of the calcium carbonate precipitate. [2]

.....

(d) The solubility of barium bromide at different temperatures is shown in the table.

Temperature (°C)	Solubility (g / 100 cm^3 of water)
0	91
20	98
40	106
60	116
80	128
100	132

Calculate the mass of barium bromide that would crystallise when 500 cm^3 of a saturated solution is cooled from 80 °C to 40 °C. [2]

Mass = ... g

9

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8. (a) Chlorine, bromine and iodine are Group 7 elements.

(i) Describe and explain the trend in reactivity within the group. [2]

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(ii) **X**, **Y** and **Z** are known to be chlorine, bromine and iodine but not necessarily in that order.

A student identifies **X**, **Y** and **Z** by mixing them with solutions of halide salts.

The table shows the observations made.

Element	Sodium bromide	Sodium iodide	Sodium chloride
X	solution turns orange	solution turns brown	no change
Y	no change	no change	no change
Z	no change	solution turns brown	no change

Use the observations to identify elements **X**, **Y** and **Z**.

Explain your reasoning. [2]

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(b) Iron reacts with chlorine gas to form iron(III) chloride according to the equation shown.

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

Calculate the mass of iron(III) chloride that could be produced using 22.4 g of iron. [2]

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

Mass = ... g

(c) White phosphorus has the formula P_4. It reacts with chlorine to form phosphorus trichloride, PCl_3.

Put a number in each box to balance the equation for this reaction. [1]

$$P_4 + \square\ Cl_2 \longrightarrow \square\ PCl_3$$

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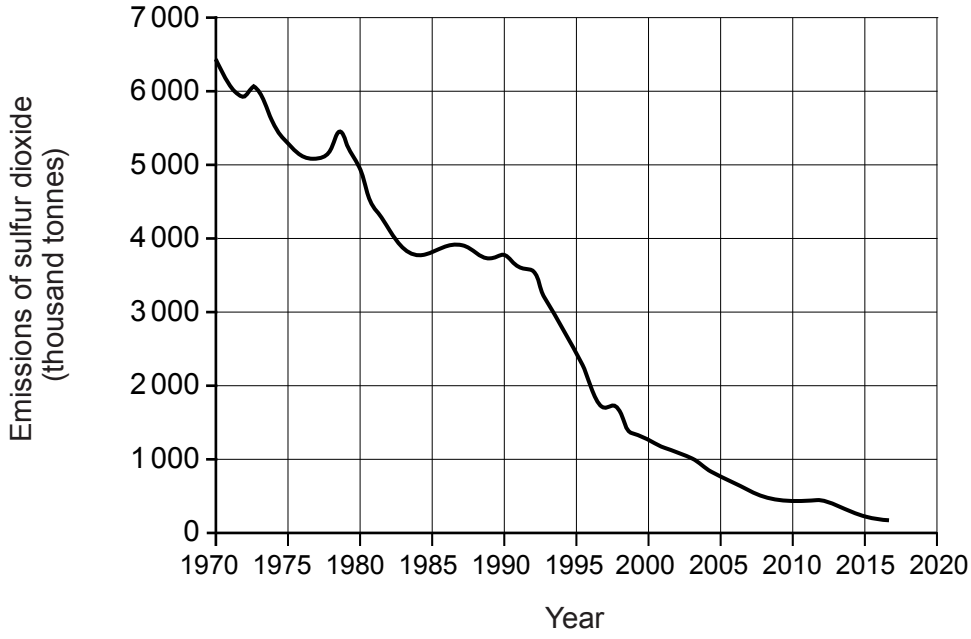
9. (a) The graph shows the annual emissions of sulfur dioxide in the UK between 1970 and 2017.



(i) From 1970 to 2017, the level of sulfur dioxide emissions decreased by 97%.

Suggest **two** reasons why sulfur dioxide levels decreased over this period. [2]

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(ii) Explain the likely benefit of such a decrease on natural habitats. [2]

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(b) A sample of an oxide of nitrogen contains 1.4 g of nitrogen and 4.0 g of oxygen.

Find the simplest formula of this oxide. You **must** show your working. [3]

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

Simplest formula .....

7

END OF PAPER

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

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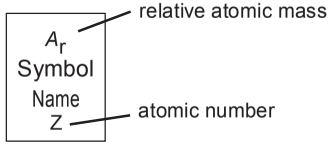
FORMULAE FOR SOME COMMON IONS

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



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