Surname	Centre Number	Candidate Number
First name(s)		0

GCSE

3430UB0-1

Z22-3430UB0-1

FRIDAY, 17 JUNE 2022 – AFTERNOON

SCIENCE (Double Award)

Unit 2 – CHEMISTRY 1
HIGHER TIER

1 hour 15 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**9**	
2.	**6**	
3.	**6**	
4.	**10**	
5.	**6**	
6.	**6**	
7.	**8**	
8.	**9**	
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 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 **5** 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) (i) State why sodium is stored in oil in the laboratory. [1]

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(ii) Describe the change in appearance when a piece of freshly cut sodium is left for a few minutes. [1]

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(iii) Give the formula of the compound formed when sodium reacts with oxygen. [1]

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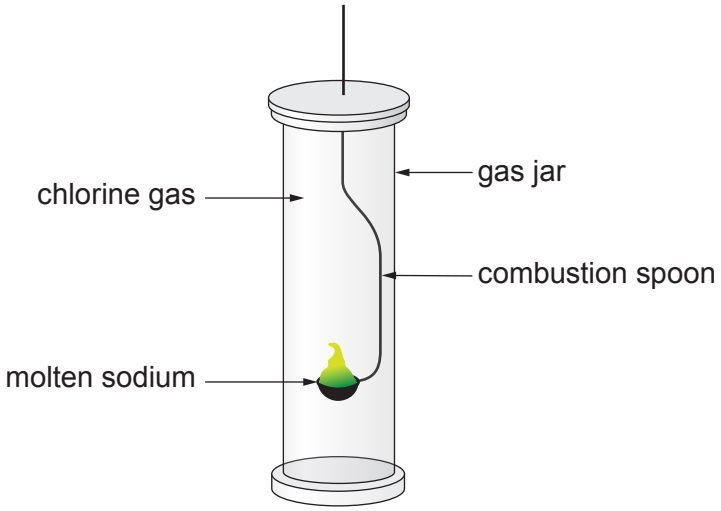
(b) The diagram shows the reaction of sodium with chlorine.



(i) State why it is necessary to carry out this reaction in a fume cupboard. [1]

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(ii) Complete and balance the equation for the reaction of sodium and chlorine. [2]

$\square$ Na + Cl_2 $\longrightarrow$ $\square$ .....

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(c) The table shows some properties of Group 7 elements.

Element	Melting point (°C)	Boiling point (°C)	Reaction with hot iron
fluorine	–220	–188	explosive
chlorine	–101	–34	very fast
bromine	–7	59	quite fast
iodine	114		slow

(i) Put a tick (✓) in the box next to the most likely boiling point for iodine. [1]

–25 °C ☐ 25 °C ☐ 100 °C ☐ 150 °C ☐

(ii) Astatine lies below iodine in Group 7. State how you would expect astatine to react with hot iron.

Give a reason for your answer. [2]

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2. (a) In 1915 Alfred Wegener suggested that the Earth's continents were once joined together as one large land mass.

(i) State **three** pieces of evidence that Alfred Wegener used to support his theory. [3]

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(ii) Explain why Wegener's theory was not originally accepted by other scientists, but it is today. [2]

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(b) What type of destructive event is likely to happen at a **conservative** plate boundary? [1]

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3. The table shows the electronic structures of atoms of the elements **A–F**.

A–F are not the chemical symbols for the elements.

Element	Electronic structure
A	2
B	2,6
C	2,8,1
D	2,8,7
E	2,8
F	2,8,6

(a) Which of elements **A–F** is found in Group 6 and Period 3 of the Periodic Table?

Explain your choice, referring to electronic structure. [2]

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(b) Which **two** of elements **A–F** are chemically inert?

Explain your choice, referring to electronic structure. [2]

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(c) Element **D** has two isotopes. Isotope **1** has 18 neutrons and isotope **2** has 20 neutrons.

Complete the table by giving the atomic number and mass number of both isotopes. [2]

Isotope	Atomic number	Mass number
1		
2		

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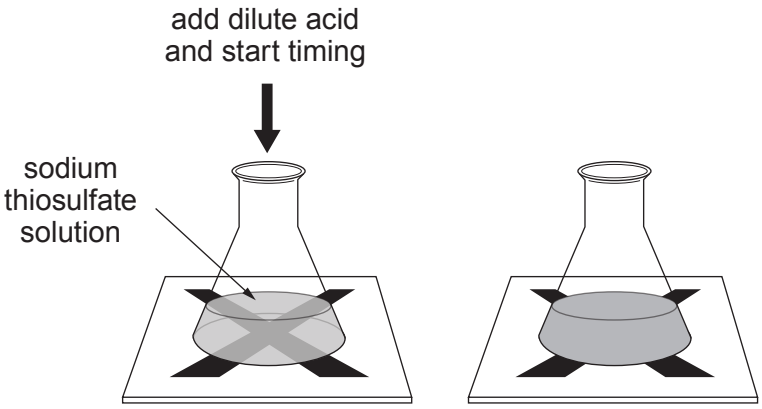
4. Sodium thiosulfate solution reacts with dilute hydrochloric acid to form a precipitate. The precipitate causes the solution to go cloudy.

The rate of the reaction can be measured by placing a cross beneath the flask and measuring the time taken for the cross to disappear.



Gareth and Sion studied the effect of sodium thiosulfate concentration by carrying out the reaction with thiosulfate of five different concentrations. They tested each concentration three times.

Their results are shown in the table below.

Concentration of sodium thiosulfate (g/dm^3)	Time 1 (s)	Time 2 (s)	Time 3 (s)	Mean time (s)
0.2	114	113	112	113
0.4	74	70	72	72
0.6	40	38	57	39
0.8	21	23	22	22
1.0	14	16	15	15

(a) When calculating the mean times, they ignored one of the values recorded.

Circle this value in the table. [1]

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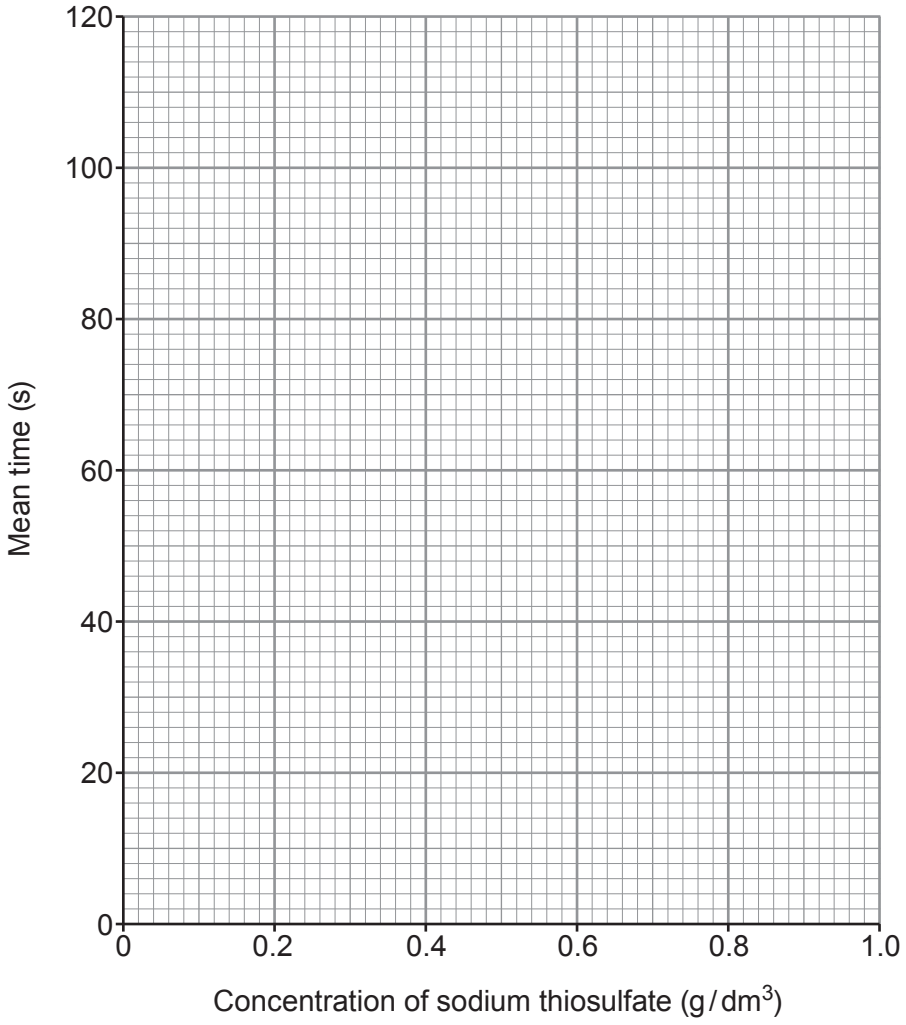
(b) Plot the mean time against sodium thiosulfate concentration on the grid below. Draw a suitable line. [3]



(c) Explain the results in terms of particle theory. [3]

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(d) A second group of students carried out the same experiment with sodium thiosulfate solution at a higher temperature.

On the grid above, sketch a line to show the results you would expect them to record. [1]

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(e) The stock solution of sodium thiosulfate used in both experiments was made by dissolving 1.0 g of the solid in 1 dm^3 of water.

Calculate the number of moles of sodium thiosulfate ($Na_2S_2O_3$) in 1.0 g.

Give your answer to **two** significant figures. [2]

A_r(Na) = 23 A_r(S) = 32 A_r(O) = 16

Number of moles = ... mol

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5. Calcium ions (Ca^{2+}) and magnesium ions (Mg^{2+}) both cause hardness in water. Both can be present in temporary hard water and permanent hard water. It is the other ions present which cause hardness to be temporary or permanent.

State the difference between the composition of temporary hard water and permanent hard water. Describe a method to distinguish between them in the laboratory. Explain how this method works. [6 QER]

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6. Levels of oxygen and carbon dioxide in the atmosphere are maintained at approximately constant values.

(a) Identify the natural processes that help maintain the balance of oxygen and carbon dioxide levels in the atmosphere. Describe briefly how this is achieved. [3]

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(b) The table shows the amount of carbon dioxide produced by the United States of America and India between 1955 and 2015.

Year	Carbon dioxide emissions (million tonnes)	
	USA	India
1955	700	100
1965	800	250
1975	1150	250
1985	1150	450
1995	1150	600
2005	1400	900
2015	1300	1850

Use the information in the table to compare the increase in carbon dioxide emissions in the United States of America and India between 1955 and 2015. [2]

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(c) The combustion of the fossil fuel propane (C_3H_8) produces carbon dioxide and water.

Balance the equation for this reaction. [1]

$$C_3H_8 + \square\, O_2 \longrightarrow \square\, CO_2 + \square\, H_2O$$

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7. The table shows some properties of elements in Period 3 of the Periodic Table.

Element	Melting point (°C)	Boiling point (°C)	Density (g/cm^3)	Appearance	Malleability	Conductivity
Na	98	882	1.00	shiny solid	malleable	good
Mg	650	1091	1.75	shiny solid	malleable	good
Al	660	2470	2.70	shiny solid	malleable	good
Si	1410	3265	2.35	shiny solid	brittle	semiconductor
P	44	281	1.80	red solid	brittle	poor
S	113	444	2.05	yellow solid	brittle	poor
Cl	–101	–34	0.003	green gas	n/a	poor

(a) One of the elements is difficult to classify as a metal or non-metal.

Identify this element and give your reasoning. [2]

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(b) Tick (✓) **two** boxes which correctly describe the change in density and boiling point for the elements across Period 3. [2]

The density of metals and non-metals increases	☐
The boiling point of metals increases but the boiling point of non-metals shows no trend	☐
The density of metals shows no trend but the density of non-metals decreases	☐
The boiling point of metals and non-metals shows no trend	☐
The density of metals increases but the density of non-metals shows no trend	☐
The boiling point of metals shows no trend but the boiling point of non-metals decreases	☐
The density of metals decreases but the density of non-metals shows no trend	☐

(c) Argon is the next element in Period 3 after chlorine, Cl.

State why it is not possible to predict a melting point for argon using the information in the table. [1]

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(d) Phosphorus is found in phosphoric acid, H_3PO_4.

(i) During the production of phosphoric acid, phosphorus is heated to 60 °C.

Give the state of phosphorus at 60 °C. Explain your choice. [2]

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(ii) Phosphoric acid reacts with zinc to produce zinc phosphate and hydrogen.

Balance the equation for this reaction. [1]

$$\square\ Zn + \square\ H_3PO_4 \longrightarrow Zn_3(PO_4)_2 + \square\ H_2$$

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8. The tables show the electronic structures of some Group 1 and Group 2 elements.

Group 1 metal	Electronic structure
sodium	2,8,1
potassium	2,8,8,1

Group 2 metal	Electronic structure
magnesium	2,8,2
calcium	2,8,8,2

(a) (i) Use the information to explain the trend in reactivity down Group 1. [2]

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(ii) Use the information to explain the difference in reactivity of Group 1 and Group 2 elements. [2]

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(b) Sodium reacts with water to produce sodium hydroxide and hydrogen. The equation for this reaction is shown.

$$2Na(s) + 2H_2O(l) \longrightarrow 2NaOH(aq) + H_2(g)$$

Calculate the mass of sodium needed to produce 11.2 g of hydrogen gas. [3]

A_r(Na) = 23 A_r(H) = 1

Mass of sodium = ... g

(c) Group 2 metals react in a similar way with water as Group 1 metals.

The word equation for the reaction of calcium and water is shown.

calcium + water ⟶ calcium hydroxide + hydrogen

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

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END OF PAPER

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

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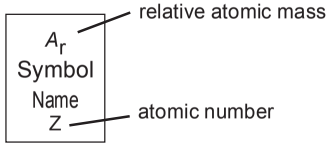
FORMULAE FOR SOME COMMON IONS

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

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



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