



Rewarding Learning

General Certificate of Secondary Education
2025

Centre Number

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Candidate Number

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GCSE Chemistry

Unit 1

Higher Tier



[GCM12]

GCM12

MONDAY 19 MAY, MORNING

TIME

1 hour 15 minutes.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.

You must answer the questions in the spaces provided.

Do not write outside the boxed area on each page or on blank pages.

Complete questions in black ink and use a dark HB pencil for drawings and graphs.

Do not write with a gel pen.

Answer **all five** questions.

INFORMATION FOR CANDIDATES

The total mark for this paper is 80.

Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.

You may use a scientific calculator.

Quality of written communication will be assessed in Question **2(b)**.

A Data Leaflet, which includes a Periodic Table of the Elements, is included in this question paper.

14542



20GCM1201

1 Magnesium reacts with oxygen to form magnesium oxide.

(a) Write a balanced symbol equation for this reaction.

_____ [3]

(b) The table below shows some properties of magnesium, oxygen and magnesium oxide.

Physical property	Magnesium	Oxygen	Magnesium oxide
Melting point /°C	650	-218	2852
Boiling point /°C	1090	-183	3600
State at room temperature (25°C)	solid	gas	
Colour at room temperature (25°C)	grey	colourless	
Structure			giant lattice
Bonding		covalent	ionic

(i) Complete the table above. [5]

(ii) Complete the following for a **molecule** of oxygen.

Total number of electrons: _____

Number of lone pairs of electrons: _____

Number of electrons in covalent bonds: _____ [3]

(iii) Explain why oxygen has a low boiling point.

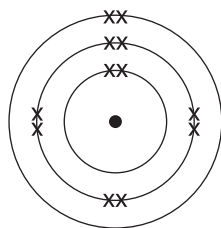
_____ [2]



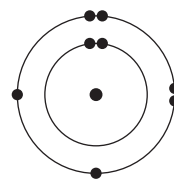
(iv) Explain what is meant by ionic bonding.

[1]

(v) Complete the dot and cross diagram below by drawing the electronic configurations of the ions formed and write the formulae of the ions.



magnesium atom



oxygen atom

magnesium ion

oxide ion

Formula _____

Formula _____ [4]



(c) Magnesium oxide is also formed when magnesium reacts with carbon dioxide. The other product is carbon.

(i) Write a balanced symbol equation for this reaction.

[3]

(ii) Draw a dot and cross diagram to show the bonding in a molecule of carbon dioxide.

[1]





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[Turn over



20GCM1205

- 2 A version of the Periodic Table devised by Dmitri Mendeleev is shown below. Some elements, such as zinc, are in different positions in Mendeleev's Periodic Table compared to the modern Periodic Table.

H 1										
Li 7	Be 9	B 11	C 12	N 14	O 16	F 19				
Na 23	Mg 24	Al 27	Si 28	P 31	S 32	Cl 35.5				
K 39	Ca 40		Ti 48	V 51	Cr 52	Mn 55	Fe 56	Co 59	Ni 59	
Cu 64	Zn 65			As 75	Se 79	Br 80				
Rb 86	Sr 88	Y 89	Zr 91	Nb 93	Mo 96		Ru 101	Rh 103	Pd 106	
Ag 108	Cd 112	In 115	Sn 119	Sb 122	Te 128	I 127				

- (a) Suggest one reason why Mendeleev placed zinc in the same group as calcium and magnesium.

[1]



(c) Using the Periodic Table in your Data Leaflet, identify the elements below from the information given.

(i) A transition metal which forms a black oxide and a green carbonate.

_____ [1]

(ii) The most reactive halogen.

_____ [1]

(iii) The element in Period 4 and Group 5.

_____ [1]

(iv) The element with atomic number 32.

_____ [1]

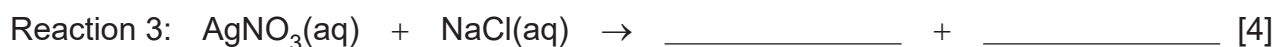
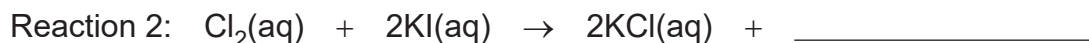


(d) Group 1 and Group 7 elements and their compounds undergo a range of chemical reactions.

(i) State the name given to Group 1.

_____ [1]

(ii) Complete the balanced symbol equations below for the three reactions shown. Include state symbols.



(iii) When potassium reacts with water in Reaction 1, heat is released and the potassium eventually disappears with a crackle forming a colourless solution.

State three other observations made when potassium reacts with water.

1. _____

2. _____

3. _____ [3]

(iv) State the colour change observed in the solution in Reaction 2.

_____ [1]

(v) State what is observed in Reaction 3.

_____ [1]

[Turn over



3 Acids react with alkalis and with metal carbonates to form salts.

(a) The reactions of acids occur because of the presence of hydrogen ions in solution.

(i) Write the formula of a hydrogen ion.

_____ [1]

(ii) Name the ion present in all alkalis.

_____ [1]

(iii) Sulfuric acid is a strong acid. What is meant by the term **strong acid**?

_____ [1]



(b) The table below shows some acidic and alkaline solutions.

	Solution	Concentration /mol/dm ³
A	Ethanoic acid	0.1
B	Hydrochloric acid	0.05
C	Hydrochloric acid	0.1
D	Sodium hydroxide	0.1
E	Sulfuric acid	0.2

(i) Which one of the solutions (**A**, **B**, **C**, **D** or **E**) would have the highest pH?

_____ [1]

(ii) Which one of the solutions (**A**, **B**, **C**, **D** or **E**) would have the lowest pH?

_____ [1]

(iii) What colour is observed when phenolphthalein is added to solution **D**?

_____ [1]

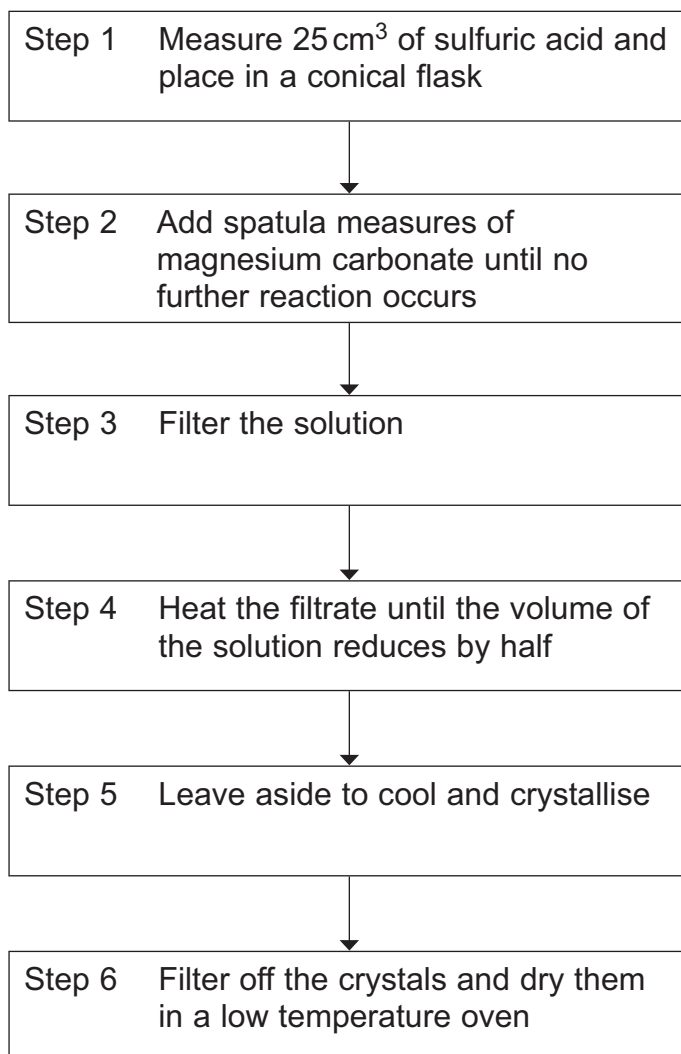
(iv) Write a balanced symbol equation for the reaction which occurs between solution **C** and solution **D**.

_____ [2]

[Turn over



(c) The salt, magnesium sulfate, may be prepared using the steps shown in the flow scheme below.



(i) Write a balanced symbol equation for the reaction of magnesium carbonate with sulfuric acid.

_____ [2]

(ii) What is meant by the term salt?

_____ [2]



(iii) What piece of apparatus is used to measure out 25 cm³ of sulfuric acid in Step 1?

_____ [1]

(iv) How would you know that no further reaction was occurring in Step 2?

_____ [1]

(v) Name the three pieces of apparatus required to filter the solution in Step 3.

1. _____
2. _____
3. _____ [1]

(vi) Explain why the solution is heated to half volume in Step 4.

_____ [1]

(vii) State two other methods which could be used to dry the crystals in Step 6.

1. _____
2. _____ [2]

[Turn over



4 Aluminium forms a variety of compounds with non-metals.

(a) In an experiment to determine the empirical formula of an aluminium compound, 0.81 g of aluminium reacted with sulfur and formed 2.09 g of a sulfide of aluminium.

(i) Calculate the mass of sulfur which reacted.

mass of sulfur = _____ g [1]

(ii) Calculate the number of moles of sulfur which reacted.

moles of sulfur = _____ [1]

(iii) Calculate the number of moles of aluminium which reacted.

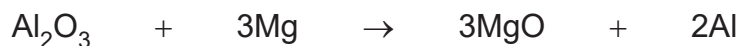
moles of aluminium = _____ [1]

(iv) Using your answers to (a)(ii) and (iii), determine the empirical formula of the sulfide of aluminium.

empirical formula _____ [1]



(b) Aluminium oxide reacts with magnesium according to the equation:



459 g of aluminium oxide are mixed with 288 g of magnesium. The mixture is allowed to react.

(i) Complete the table below.

	Aluminium oxide	Magnesium
Mass /g	459	288
Relative formula mass (M_r)	102	24
Number of moles	4.5	

[1]

(ii) Which reactant is the limiting reactant?

[1]

(iii) Calculate the mass of aluminium formed.

mass of aluminium = _____ g [2]

[Turn over



(c) A sample of 1.5g of hydrated aluminium nitrate, $\text{Al}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$ was heated to remove all of the water of crystallisation.

(i) What is meant by the term water of crystallisation?

_____ [1]

(ii) How could you ensure that all of the water of crystallisation was removed?

_____ [1]

(iii) Calculate the loss in mass.

loss in mass = _____ g [3]





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20GCM1217

- 5 (a) The table below gives information about the atomic structure of five different atoms and ions.

Complete the table below.

Atom/ Ion	Atomic number	Mass number	Number of protons	Number of neutrons	Number of electrons	Electronic configuration
Li	3	7				
F ⁻		19			10	2, 8
	1	1				2
Ca ²⁺				20		
	7			7		2, 8

[5]



(b) Some elements exist as isotopes.

A sample of zinc contains 3 isotopes, details of which are shown in the table below.

Isotope	Abundance /%
^{64}Zn	50
^{66}Zn	25
^{68}Zn	25

Calculate the relative atomic mass (A_r) of zinc. Give your answer to 1 decimal place.

relative atomic mass = _____ [1]

THIS IS THE END OF THE QUESTION PAPER



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Question Number	Marks
1	
2	
3	
4	
5	

Total Marks	
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Examiner Number

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SYMBOLS OF SELECTED IONS

Positive ions

Name	Symbol
Ammonium	NH_4^+
Chromium(III)	Cr^{3+}
Copper(II)	Cu^{2+}
Iron(II)	Fe^{2+}
Iron(III)	Fe^{3+}
Lead(II)	Pb^{2+}
Silver	Ag^+
Zinc	Zn^{2+}

Negative ions

Name	Symbol
Butanoate	$\text{C}_3\text{H}_7\text{COO}^-$
Carbonate	CO_3^{2-}
Dichromate	$\text{Cr}_2\text{O}_7^{2-}$
Ethanoate	CH_3COO^-
Hydrogencarbonate	HCO_3^-
Hydroxide	OH^-
Methanoate	HCOO^-
Nitrate	NO_3^-
Propanoate	$\text{C}_2\text{H}_5\text{COO}^-$
Sulfate	SO_4^{2-}
Sulfite	SO_3^{2-}



Data Leaflet

Including the Periodic Table of the Elements

For the use of candidates taking
 Science: Chemistry,
 Science: Double Award
 or Science: Single Award

Copies must be free from notes or additions of any kind. No other type of data booklet or information sheet is authorised for use in the examinations

SOLUBILITY IN COLD WATER OF COMMON SALTS, HYDROXIDES AND OXIDES

Soluble
All sodium, potassium and ammonium salts
All nitrates
Most chlorides, bromides and iodides EXCEPT silver and lead chlorides, bromides and iodides
Most sulfates EXCEPT lead and barium sulfates Calcium sulfate is slightly soluble
Insoluble
Most carbonates EXCEPT sodium, potassium and ammonium carbonates
Most hydroxides EXCEPT sodium, potassium and ammonium hydroxides
Most oxides EXCEPT sodium, potassium and calcium oxides which react with water

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