Rewarding Learning

Centre Number

Candidate Number

General Certificate of Secondary Education
2022–2023

Double Award Science: Chemistry

Unit C1

Higher Tier

[GDW22]

GDW22

MONDAY 22 MAY, MORNING

TIME

1 hour.

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 in black ink only. **Do not write with a gel pen.**
Answer **all eight** questions.

INFORMATION FOR CANDIDATES

The total mark for this paper is 70.
Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.
Quality of written communication will be assessed in Question **8**.
A Data Leaflet, which includes a Periodic Table of the elements is provided.

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20GDW2201

1 Electronic configurations show the arrangement of electrons in an atom or ion.

(a) Five electronic configurations are given in the table below and are represented by the letters V to Z.

Letter	Electronic configuration
V	2, 4
W	2, 6
X	2, 8
Y	2, 8, 3
Z	2, 8, 8, 2

(i) Write the symbol of an atom of an element which would have the electronic configuration V.

_____ [1]

(ii) Draw a diagram to show the electronic configuration W.

[1]

(iii) The ions below all have the electronic configuration of X (2, 8). Complete the table.

Charge on ion	Formula of ion	Name of ion
Single negative charge	F^-	
Single positive charge		sodium
Double negative charge		

[4]

(iv) Y represents the electronic configuration of an atom. How many protons does the atom have?

_____ [1]

(v) Which one of the letters (V, W, X, Y, Z) represents the electronic configuration of an atom of an element in Period 4 of the Periodic Table?

_____ [1]

[Turn over

(b) The mass number and the percentage abundance of each of the five stable isotopes of titanium are shown in the table below.

Isotope	Percentage abundance /%
^{46}Ti	8.3
^{47}Ti	7.4
^{48}Ti	73.7
^{49}Ti	5.4
^{50}Ti	5.2

Use the information in the table to calculate the relative atomic mass (A_r) of titanium. Give your answer to 1 decimal place.

Show your working out.

relative atomic mass (A_r) _____ [3]

2 **(a)** Complete the table below about two Group 7 elements.

Element	Colour	Physical state at room temperature
chlorine		
	red-brown	

[2]

(b) What name is given to Group 7 of the Periodic Table?

_____ [1]

(c) A displacement reaction occurs when bromine is added to a solution of lithium iodide.

(i) Write a balanced symbol equation for the reaction between bromine and lithium iodide.

_____ [3]

(ii) During the reaction bromine molecules react to form bromide ions. Write a half equation for this reaction.

_____ [2]

(iii) State the colour of lithium iodide solution before bromine is added.

_____ [1]

(iv) What colour is the solution after the reaction?

_____ [1]

3 Many different terms can be used to describe substances such as pure, mixture, formulation and alloy.

(a) Information on several substances is shown in the table below.

Substance	Composition	Percentage composition /%
Brass	copper	63
	zinc	37
Air	nitrogen	approximately 78
	oxygen	approximately 20
	carbon dioxide	approximately 0.04
	noble gases	approximately 1
	water vapour	approximately 1
Baking soda	sodium hydrogencarbonate	100
Stainless steel	iron	67
	silicon	1
	manganese	2
	nickel	10
	chromium	20

(i) Name one **compound** from the table which will react with hydrochloric acid.

_____ [1]

(ii) Name one **element** from the table which is a solid non-metal at room temperature.

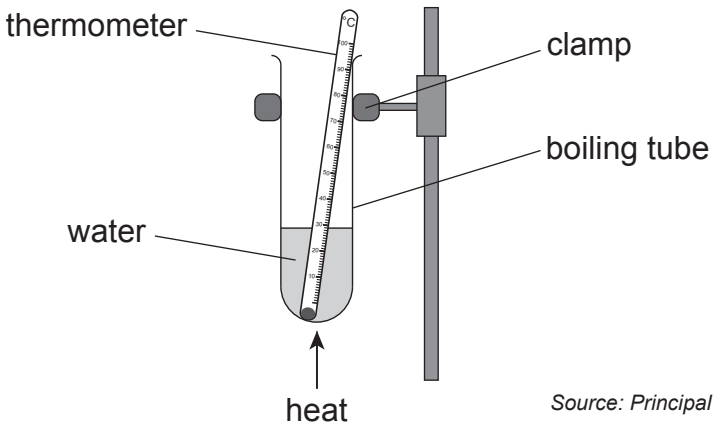
_____ [1]

(iii) Using the information in **(a)**, complete the table below by placing a tick (✓) for **all** the terms which apply to each substance.

Substance	Pure substance	Mixture	Formulation	Alloy
Brass				
Air				
Baking soda				
Stainless steel				

[4]

(b) The diagram below shows the apparatus used in an experiment to determine the boiling point of pure water.



Source: Principal Examiner

(i) State the boiling point of pure water. Include the units.

_____ [1]

(ii) State the change, if any, to the boiling point of water if the volume of water was increased.

_____ [1]

[Turn over

(iii) Name the chemical used to test for water and state the colour change observed for a positive test.

Name of chemical _____

Colour change from _____ to _____ [2]

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(Questions continue overleaf)

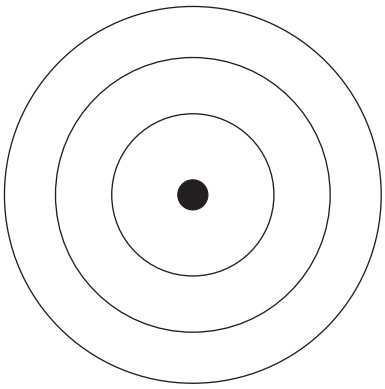
4 Magnesium reacts with chlorine and with oxygen.

(a) Name the type of bonding present in solid magnesium.

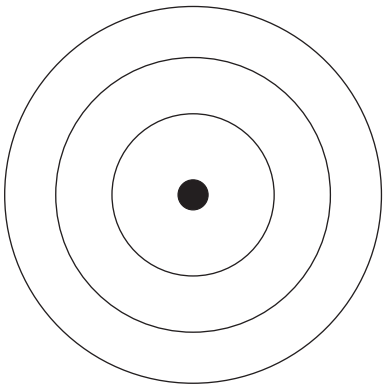
_____ [1]

(b) **(i)** Complete the diagrams below to show the electronic configuration of a magnesium atom and of a chlorine atom.

magnesium atom



chlorine atom



[2]

(ii) Explain in terms of changes to electronic configuration how magnesium atoms and chlorine atoms react to form the ionic compound magnesium chloride.

_____

_____

_____

_____ [3]

(iii) Explain why a magnesium ion is more stable than a magnesium atom.

_____ [1]

(c) Draw a dot and cross diagram to show the bonding in a molecule of oxygen. Only outer shell electrons should be shown.

[3]

5 Compounds can be represented by formulae and reactions by different types of equations.

(a) Which one of the following is the formula for the compound magnesium nitrate? Circle the correct answer.

Mg_2NO_3 $MgNO_3$ Mg_3NO_2 $Mg(NO_3)_2$ $Mg_3(NO)_2$

[1]

(b) Name the compound which has the formula $K_2Cr_2O_7$.

_____ [1]

(c) Solid calcium carbonate reacts with water and carbon dioxide to form a solution of calcium hydrogencarbonate.

Complete the balanced symbol equation for this reaction including state symbols.

$$\quad + \quad + \quad \longrightarrow \quad Ca(HCO_3)_2(aq)$$

[2]

(d) Element X is an unknown element. X reacts with oxygen according to the equation below.

$$4X + 3O_2 \longrightarrow 2X_2O_3$$

(i) Suggest one element which could be element X.

_____ [1]

(ii) Write the formula of the compound formed when element X reacts with fluorine.

_____ [1]

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(Questions continue overleaf)

6 The relative formula mass of a compound can be calculated from the relative atomic masses of the elements it contains.

(a) Calculate the relative formula mass (M_r) of the following compounds.

(Relative atomic masses (A_r): N = 14; O = 16; Na = 23; P = 31; Pb = 207)

sodium phosphate, Na_3PO_4

relative formula mass (M_r) _____

lead(II) nitrate, $Pb(NO_3)_2$

relative formula mass (M_r) _____ [2]

(b) Calculate the percentage of carbon, by mass, in magnesium butanoate, $(C_3H_7COO)_2Mg$. The relative formula mass (M_r) of magnesium butanoate is 198.

Give your answer to 1 decimal place.

percentage of carbon _____ % [2]

(c) The equation below shows the reaction of dinitrogen tetraoxide (N_2O_4) with water to form nitric acid (HNO_3) and nitrogen monoxide (NO).

$$3N_2O_4 + 2H_2O \longrightarrow 4HNO_3 + 2NO$$

(i) Calculate the theoretical yield of nitric acid, in grams, which can be produced when 45 moles of dinitrogen tetraoxide reacts with excess water.

(Relative formula mass (M_r): HNO_3 = 63)

theoretical yield _____ g [2]

(ii) The percentage yield was found to be 85%. Calculate the actual yield, in grams, of nitric acid obtained.

actual yield _____ g [2]

[Turn over

7 The table below shows the formulae of several ions.

H^+	Cu^{2+}	H^-
Zn^{2+}	CO_3^{2-}	OH^-
K^+	Ca^{2+}	O^{2-}
CH_3COO^-	NH_4^+	SO_4^{2-}

(a) Answer the questions below using only the ions from the table above.

(i) Write the formula of an ion which could cause a solution to be blue in colour.

_____ [1]

(ii) Write the formula of two ions which are present in sulfuric acid.

_____

_____ [2]

(iii) Write the formula of a green solid compound formed from two of the ions above.

_____ [1]

(b) Four ionic equations (A, B, C and D) are shown below. An ion is missing in each equation.

A $H^+ + _____ \longrightarrow H_2O$

B $_____ + H^- \longrightarrow H_2$

C $NH_4^+ + _____ \longrightarrow NH_3 + H_2O$

D $_____ + 2H^+ \longrightarrow CO_2 + H_2O$

(i) Complete the blanks in the ionic equations above by choosing the most appropriate ion from the table on the page opposite.
Each ion may be used once, more than once or not at all. [4]

(ii) Name the type of reaction represented by equation A.

_____ [1]

8 Potassium reacts with iodine to form potassium iodide. State the colour and physical state of iodine and potassium iodide at room temperature and name and describe the structure and bonding in each.

In your answer you should include:

- the colour and physical state of iodine at room temperature
- the colour and physical state of potassium iodide at room temperature
- the name and description of the structure and bonding of iodine at room temperature
- the name and description of the structure and bonding of potassium iodide at room temperature

In this question you will be assessed on your written communication skills including the use of specialist scientific terms.

The colour and physical state of iodine at room temperature:

The colour and physical state of potassium iodide at room temperature:

The name and description of the structure and bonding of iodine at room temperature:

The name and description of the structure and bonding of potassium iodide at room temperature:

[6]

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For Examiner's use only	
Question Number	Marks
1	
2	
3	
4	
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6	
7	
8	
Total Marks	

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	$C_3H_7COO^-$
Carbonate	CO_3^{2-}
Dichromate	$Cr_2O_7^{2-}$
Ethanoate	CH_3COO^-
Hydrogencarbonate	HCO_3^-
Hydroxide	OH^-
Methanoate	$HCOO^-$
Nitrate	NO_3^-
Propanoate	$C_2H_5COO^-$
Sulfate	SO_4^{2-}
Sulfite	SO_3^{2-}

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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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

gcse examinations

chemistry

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THE PERIODIC TABLE OF ELEMENTS

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	64 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
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	98 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	178 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	261 Rf Rutherfordium 104	262 Db Dubnium 105	266 Sg Seaborgium 106	264 Bh Bohrium 107	277 Hs Hassium 108	268 Mt Meitnerium 109	271 Ds Darmstadtium 110	272 Rg Roentgenium 111	285 Cn Copernicium 112						

140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	145 Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
232 Th Thorium 90	231 Pa Protactinium 91	238 U Uranium 92	237 Np Neptunium 93	242 Pu Plutonium 94	243 Am Americium 95	247 Cm Curium 96	245 Bk Berkelium 97	251 Cf Californium 98	254 Es Einsteinium 99	253 Fm Fermium 100	256 Md Mendelevium 101	254 No Nobelium 102	257 Lr Lawrencium 103

* 58 – 71 Lanthanum series
† 90 – 103 Actinium series

a X b

a = relative atomic mass (approx)
x = atomic symbol
b = atomic number

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