



Rewarding Learning

General Certificate of Secondary Education  
2022–2023

Centre Number

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Candidate Number

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# 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 <sup>-</sup>	
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 /%
$^{46}\text{Ti}$	8.3
$^{47}\text{Ti}$	7.4
$^{48}\text{Ti}$	73.7
$^{49}\text{Ti}$	5.4
$^{50}\text{Ti}$	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]

[Turn over



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]

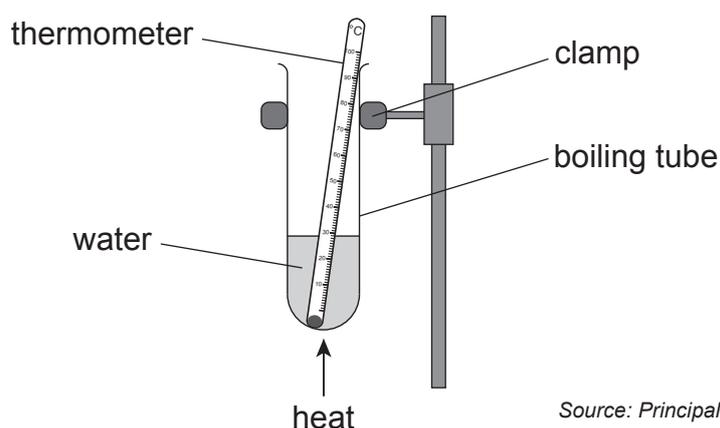


(iii) Using the information in (a), complete the table below by placing a tick (✓) for **all** the terms which apply to each substance.

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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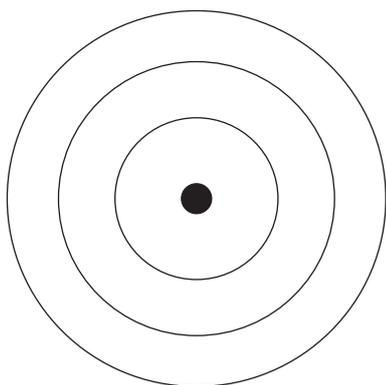
4 Magnesium reacts with chlorine and with oxygen.

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

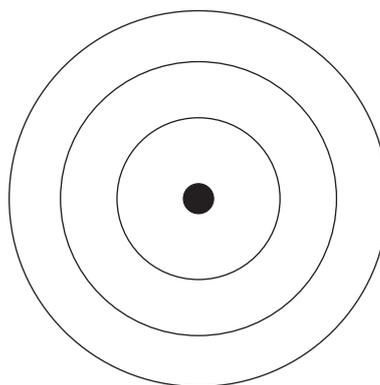
\_\_\_\_\_ [1]

(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]

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[Turn over



\*20GDW2211\*

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.



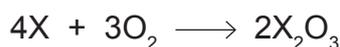
(b) Name the compound which has the formula  $\text{K}_2\text{Cr}_2\text{O}_7$ .  
\_\_\_\_\_ [1]

(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.



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



(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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[Turn over



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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,  $\text{Na}_3\text{PO}_4$

relative formula mass ( $M_r$ ) \_\_\_\_\_

lead(II) nitrate,  $\text{Pb}(\text{NO}_3)_2$

relative formula mass ( $M_r$ ) \_\_\_\_\_ [2]

(b) Calculate the percentage of carbon, by mass, in magnesium butanoate,  $(\text{C}_3\text{H}_7\text{COO})_2\text{Mg}$ . 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 tetroxide ( $\text{N}_2\text{O}_4$ ) with water to form nitric acid ( $\text{HNO}_3$ ) and nitrogen monoxide ( $\text{NO}$ ).



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

(Relative formula mass ( $M_r$ ):  $\text{HNO}_3 = 63$ )

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.

$\text{H}^+$	$\text{Cu}^{2+}$	$\text{H}^-$
$\text{Zn}^{2+}$	$\text{CO}_3^{2-}$	$\text{OH}^-$
$\text{K}^+$	$\text{Ca}^{2+}$	$\text{O}^{2-}$
$\text{CH}_3\text{COO}^-$	$\text{NH}_4^+$	$\text{SO}_4^{2-}$

(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.

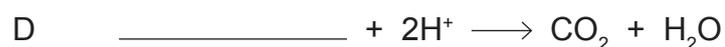
\_\_\_\_\_  
\_\_\_\_\_ [2]

(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.



(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:

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

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

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

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Question Number	Marks
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Examiner Number

<b>Total Marks</b>	
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## SYMBOLS OF SELECTED IONS

### Positive ions

Name	Symbol
Ammonium	$\text{NH}_4^+$
Chromium(III)	$\text{Cr}^{3+}$
Copper(II)	$\text{Cu}^{2+}$
Iron(II)	$\text{Fe}^{2+}$
Iron(III)	$\text{Fe}^{3+}$
Lead(II)	$\text{Pb}^{2+}$
Silver	$\text{Ag}^+$
Zinc	$\text{Zn}^{2+}$

### Negative ions

Name	Symbol
Butanoate	$\text{C}_3\text{H}_7\text{COO}^-$
Carbonate	$\text{CO}_3^{2-}$
Dichromate	$\text{Cr}_2\text{O}_7^{2-}$
Ethanoate	$\text{CH}_3\text{COO}^-$
Hydrogencarbonate	$\text{HCO}_3^-$
Hydroxide	$\text{OH}^-$
Methanoate	$\text{HCOO}^-$
Nitrate	$\text{NO}_3^-$
Propanoate	$\text{C}_2\text{H}_5\text{COO}^-$
Sulfate	$\text{SO}_4^{2-}$
Sulfite	$\text{SO}_3^{2-}$



## Data Leaflet

### Including the Periodic Table of the Elements

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

### 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

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

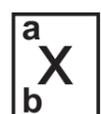
# gcse examinations chemistry

# THE PERIODIC TABLE OF ELEMENTS

## Group

												1 <b>H</b> Hydrogen 1							4 <b>He</b> Helium 2
1	2											3	4	5	6	7	0		
7 <b>Li</b> Lithium 3	9 <b>Be</b> Beryllium 4											11 <b>B</b> Boron 5	12 <b>C</b> Carbon 6	14 <b>N</b> Nitrogen 7	16 <b>O</b> Oxygen 8	19 <b>F</b> Fluorine 9	20 <b>Ne</b> Neon 10		
23 <b>Na</b> Sodium 11	24 <b>Mg</b> Magnesium 12											27 <b>Al</b> Aluminium 13	28 <b>Si</b> Silicon 14	31 <b>P</b> Phosphorus 15	32 <b>S</b> Sulfur 16	35.5 <b>Cl</b> Chlorine 17	40 <b>Ar</b> Argon 18		
39 <b>K</b> Potassium 19	40 <b>Ca</b> Calcium 20	45 <b>Sc</b> Scandium 21	48 <b>Ti</b> Titanium 22	51 <b>V</b> Vanadium 23	52 <b>Cr</b> Chromium 24	55 <b>Mn</b> Manganese 25	56 <b>Fe</b> Iron 26	59 <b>Co</b> Cobalt 27	59 <b>Ni</b> Nickel 28	64 <b>Cu</b> Copper 29	65 <b>Zn</b> Zinc 30	70 <b>Ga</b> Gallium 31	73 <b>Ge</b> Germanium 32	75 <b>As</b> Arsenic 33	79 <b>Se</b> Selenium 34	80 <b>Br</b> Bromine 35	84 <b>Kr</b> Krypton 36		
85 <b>Rb</b> Rubidium 37	88 <b>Sr</b> Strontium 38	89 <b>Y</b> Yttrium 39	91 <b>Zr</b> Zirconium 40	93 <b>Nb</b> Niobium 41	96 <b>Mo</b> Molybdenum 42	98 <b>Tc</b> Technetium 43	101 <b>Ru</b> Ruthenium 44	103 <b>Rh</b> Rhodium 45	106 <b>Pd</b> Palladium 46	108 <b>Ag</b> Silver 47	112 <b>Cd</b> Cadmium 48	115 <b>In</b> Indium 49	119 <b>Sn</b> Tin 50	122 <b>Sb</b> Antimony 51	128 <b>Te</b> Tellurium 52	127 <b>I</b> Iodine 53	131 <b>Xe</b> Xenon 54		
133 <b>Cs</b> Caesium 55	137 <b>Ba</b> Barium 56	139 <b>La</b> <sup>*</sup> Lanthanum 57	178 <b>Hf</b> Hafnium 72	181 <b>Ta</b> Tantalum 73	184 <b>W</b> Tungsten 74	186 <b>Re</b> Rhenium 75	190 <b>Os</b> Osmium 76	192 <b>Ir</b> Iridium 77	195 <b>Pt</b> Platinum 78	197 <b>Au</b> Gold 79	201 <b>Hg</b> Mercury 80	204 <b>Tl</b> Thallium 81	207 <b>Pb</b> Lead 82	209 <b>Bi</b> Bismuth 83	210 <b>Po</b> Polonium 84	210 <b>At</b> Astatine 85	222 <b>Rn</b> Radon 86		
223 <b>Fr</b> Francium 87	226 <b>Ra</b> Radium 88	227 <b>Ac</b> <sup>†</sup> Actinium 89	261 <b>Rf</b> Rutherfordium 104	262 <b>Db</b> Dubnium 105	266 <b>Sg</b> Seaborgium 106	264 <b>Bh</b> Bohrium 107	277 <b>Hs</b> Hassium 108	268 <b>Mt</b> Meitnerium 109	271 <b>Ds</b> Darmstadtium 110	272 <b>Rg</b> Roentgenium 111	285 <b>Cn</b> Copernicium 112								

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



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

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