Rewarding Learning

Centre Number

Candidate Number

General Certificate of Secondary Education
2021–2022

Double Award Science: Chemistry

Unit C1

Higher Tier

[GDW22]

GDW22

FRIDAY 27 MAY 2022, 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 **4**.
A Data Leaflet, which includes a Periodic Table of the elements is provided.

13753

1 This question is about atomic structure.

(a) Complete the table below to show the relative charges and relative masses of the subatomic particles.

particle	relative charge	relative mass
proton	+1	
neutron		1
electron		$\frac{1}{1840}$

[3]

(b) The table below gives information about some atoms and ions. Complete the table by filling in all the blank spaces.

atom/ion	mass number	number of protons	number of electrons	number of neutrons
O		8		10
Cl^-	37		18	
Al^{3+}	27	13		

[3]

(c) The oxygen atom represented in the table (part (b)) is one of the three stable forms of oxygen. There are other oxygen atoms which have the same number of protons but a different number of neutrons.

What name is given to atoms of an element which have the same number of protons but a different number of neutrons?

_____ [1]

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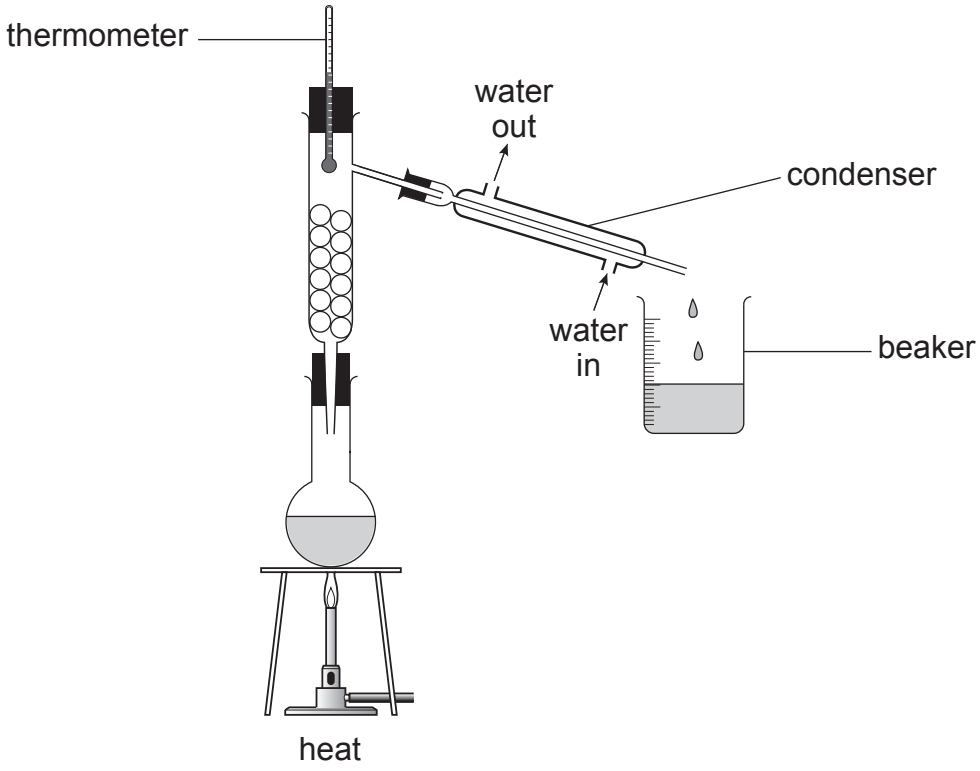
(Questions continue overleaf)

[Turn over

2 The diagram below shows the apparatus used to separate ethanol from water.



Source: Principal Examiner

(a) What name is given to this separation technique?

_____ [1]

(b) Why is the thermometer placed so high in the apparatus?

_____ [1]

(c) Why does cold water circulate in the condenser?

_____ [1]

(d) Ethanol and water are miscible liquids. Explain the meaning of the word miscible.

_____ [1]

(e) What general name is given to the liquid which collects in the beaker during this separation?

_____ [1]

(f) How could you prove that the substance collected is a pure substance?

_____

_____ [1]

[Turn over

3 Read the information about atoms of elements X and Y and then answer the questions that follow.

An atom of X has an electronic configuration of 2,8,2
An atom of Y has an electronic configuration of 2,8,7
X forms an ionic bond with Y

(a) (i) How many electrons need to be transferred from an atom of element X when it bonds with element Y?

_____ [1]

(ii) How many electrons does an atom of element Y need to gain in order to become stable?

_____ [1]

(iii) Write a formula, using the symbols X and Y, for the compound formed when X and Y bond ionically.

_____ [1]

(iv) Ionic bonding involves cations and anions.
Write the formula for the **cation** in the compound formed from X and Y.

_____ [1]

(b) Draw a dot and cross diagram of a molecule of phosphine, PH_3. Show outer electrons only.

[3]

(c) Draw a dot and cross diagram of a molecule of nitrogen, N_2.
All electrons should be shown. Label the multiple bond.

[3]

[Turn over

4 The element carbon exists as allotropes including diamond and graphite.

Use your knowledge and understanding of the term allotropes and of the structure and bonding of carbon to:

- Define what is meant by the term allotrope
- Describe the bonding and structure of diamond
- Describe ways in which the bonding and structure of graphite is similar to and different from that of diamond

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

Definition of allotrope:

Description of the bonding and structure of diamond:

Description of ways in which the bonding and structure of graphite is similar to and different from that of diamond:

similarities:

differences:

[6]

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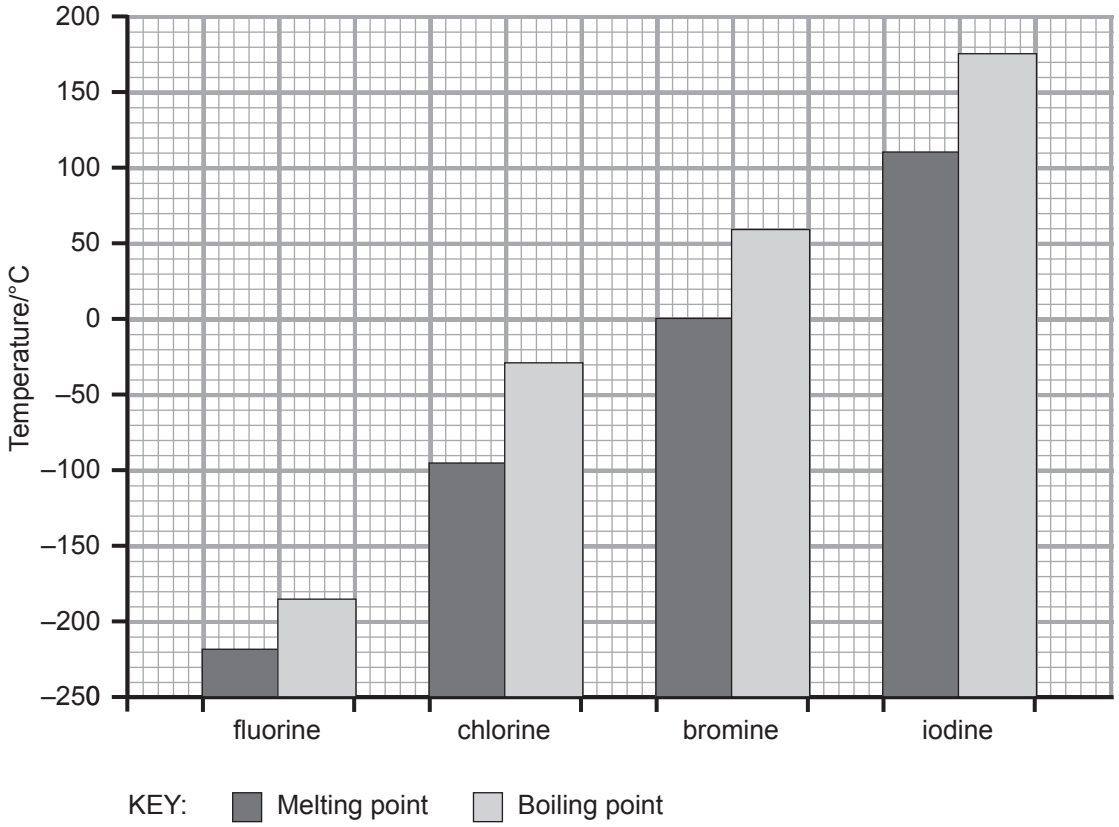
5 The graph below shows the approximate melting points and boiling points of the first four elements in Group 7 of the Periodic Table.



(a) (i) What name is given to this group of elements?

_____ [1]

(ii) What happens to the melting points as you move down the group?

_____ [1]

(iii) What is the physical state of chlorine at room temperature?

_____ [1]

(iv) Astatine is the fifth member of this group.

Give the chemical symbol for astatine and predict its physical state at room temperature.

chemical symbol: _____

physical state at room temperature: _____ [2]

(b) Iodine sublimes on heating. What is meant by the term sublimation?

_____ [1]

(c) The table below gives information on the boiling points of the noble gases.

noble gas	symbol	relative atomic mass	boiling point/°C
helium	He	4	–269
neon	Ne	20	–246
argon	Ar	40	–186
krypton	Kr	84	–153
xenon	Xe	131	–108

(i) Use your knowledge of the electronic configuration of the noble gases to explain why they are so unreactive and stable.

_____

_____ [2]

(ii) What is the trend in boiling points as the relative atomic mass increases?

_____

_____ [1]

(iii) Use the difference between the boiling points of krypton and xenon to estimate the boiling point of radon which has a relative atomic mass of 222.

_____ [1]

[Turn over

6 **(a)** Four different solutions labelled A, B, C and D were tested using a pH meter, red and blue litmus papers and universal indicator paper. Some of the results are given in the table below.

test	results			
	A	**B**	**C**	**D**
pH meter	5.3	13.7		1.4
red litmus paper	red	blue	red	red
blue litmus paper	red	blue	blue	red
universal indicator paper		purple		red

(All solutions tested had a concentration of 1.0 mol/dm^3)

(i) Which solution A, B, C or D has the highest concentration of hydrogen ions?

_____ [1]

(ii) Identify the colour of universal indicator paper with solution A.

_____ [1]

(iii) Suggest a reading on the pH meter for solution C.

_____ [1]

(iv) Which of the solutions A, B, C or D is a **strong alkali**? Explain your answer.

_____

_____ [1]

(b) The table below gives some information about metal compounds and their reactions to produce salts.
Use your knowledge and the Data Leaflet to complete the table by filling in the blank spaces.

metal compound	metal compound soluble in water	acid used	formula of salt produced
potassium carbonate	yes	sulfuric acid	
copper(II) oxide			$CuCl_2$
magnesium oxide	no	nitric acid	

[4]

[Turn over

7 **(a)** Some properties of four different substances are given in the table below. Complete the table by filling in all the blank spaces.

type of structure	substance	melting point/ °C	boiling point/ °C	solubility in water	electrical conductivity as solid	electrical conductivity as liquid
	aluminium	660	2470	low		good
giant ionic	potassium iodide	681	1330		poor	
	sodium sulfate	884	1429			good
	bromine	–7	59	low	poor	

[5]

(b) Explain fully, in terms of particles, why potassium hydroxide can be described as both **strong** and as an **alkali**.

_____

_____

_____ [2]

(c) Complete the definition of a salt by filling in the missing words.

A salt is a _____ formed when some or all of the hydrogen ions in an acid are replaced by metal ions or

_____ ions. [2]

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

_____ [3]

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[Turn over

8 **(a)** Complete the definition below:

Relative atomic mass is _____

_____

_____

_____ [3]

(b) Calculate the relative formula mass (M_r) of each of the following substances.
(relative atomic masses: H = 1, C = 12, O = 16, Al = 27, S = 32, Cu = 64)

Copper(II) sulfate $CuSO_4$

_____

Aluminium hydrogencarbonate $Al(HCO_3)_3$

_____ [2]

(c) Sodium sulfate may be prepared by the reaction of sodium hydrogencarbonate and magnesium sulfate.

$$MgSO_4 + 2NaHCO_3 \longrightarrow Na_2SO_4 + Mg(OH)_2 + 2CO_2$$

(relative formula masses (M_r): $MgSO_4$ = 120; $NaHCO_3$ = 84; Na_2SO_4 = 142; $Mg(OH)_2$ = 74; CO_2 = 44)

(i) Calculate the mass of magnesium sulfate needed to react with 0.4 moles of sodium hydrogencarbonate.

mass = _____ g [1]

(ii) What is the maximum mass of carbon dioxide formed when 0.1 moles of magnesium sulfate are mixed with excess sodium hydrogencarbonate?

mass = _____ g [2]

[Turn over

(d) Cadmium can be formed from the reaction between iron and cadmium (II) nitrate.

$$Fe + Cd(NO_3)_2 \longrightarrow Fe(NO_3)_2 + Cd$$

(relative atomic masses (A_r): Fe = 56; Cd = 112)
(relative formula masses (M_r): $Cd(NO_3)_2$ = 236; $Fe(NO_3)_2$ = 180)

(i) Calculate the maximum mass of cadmium formed if 0.15 moles of both reactants are used.

mass = _____ g [1]

(ii) Use your answer from (d)(i) to calculate, to one decimal place, the percentage yield if 13.8 g of cadmium was formed from 0.15 moles of both reactants.

Percentage yield = _____ % [2]

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For Examiner's use only	
Question Number	Marks
1	
2	
3	
4	
5	
6	
7	
8	
Total Marks	

Examiner Number

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

11984.02

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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