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A322/02

GENERAL CERTIFICATE OF SECONDARY EDUCATION

TWENTY FIRST CENTURY SCIENCE

CHEMISTRY A

Unit 2 Modules C4 C5 C6 (Higher Tier)

FRIDAY 25 JANUARY 2008

Morning
Time: 40 minutes

Candidates answer on the question paper.
Additional materials (enclosed):
None

Calculators may be used.
Additional materials: Pencil
Ruler (cm/mm)

CUP/T43547

Candidate Forename		Candidate Surname	
Centre Number		Candidate Number	

INSTRUCTIONS TO CANDIDATES

- Write your name in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use blue or black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- Do **not** write outside the box bordering each page.
- Write your answer to each question in the space provided.

INFORMATION FOR CANDIDATES

- The number of marks for each question is given in brackets [ ] at the end of each question or part question.
- The total number of marks for this paper is **42**.
- The Periodic Table is printed on the back page.

FOR EXAMINER'S USE		
Qu.	**Max.**	**Mark**
1	6	
2	9	
3	6	
4	4	
5	5	
6	6	
7	6	
TOTAL	42	

This document consists of **15** printed pages and **1** blank page.

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[Turn over

Answer **all** the questions.

1 Elements in Group 7 are called the halogens. The table gives some information about the physical properties of three of the halogens.

halogen	proton number	melting point in °C	boiling point in °C	state at 25 °C	colour
chlorine	17	–101	–35	gas	pale green
bromine	35	–7	59		deep red
iodine	53	114	184		dark grey

(a) (i) Finish the table by writing the **state** for bromine **and** iodine in the empty boxes. [1]

(ii) The halogens show trends in physical properties with increasing proton number.

Finish this sentence about the trend in melting point.

Use information from the table to help you answer this question.

As the proton number …… the melting point …… . [1]

(b) The halogens also show a trend in reactivity.

This can be shown by the displacement reactions when halogens are added to solutions of halides.

A student made the following observations.

- When chlorine is added to potassium bromide solution, red bromine appears.
- When bromine is added to potassium iodide solution, brown iodine appears.
- When bromine is added to potassium chloride solution, there is no displacement.

(i) Use this information to place these three halogens in order of reactivity.

most reactive .....

.....

least reactive ..... [2]

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(ii) Fluorine is a halogen with proton number 9.

Which statement describes the displacement reactions of fluorine?

Put a tick (✓) in the box next to the correct answer.

Fluorine displaces chlorine, bromine and iodine. ☐

Fluorine displaces iodine but not chlorine or bromine. ☐

Fluorine displaces chlorine and bromine but not iodine. ☐

Fluorine displaces bromine and iodine but not chlorine. ☐

[1]

(c) Bromine forms ions with the formula Br^-.

Bromine reacts with strontium to form strontium bromide, $SrBr_2$.

Use this information to work out the formula of a strontium ion.

..... [1]

[Total: 6]

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2 This diagram shows part of the Periodic Table.

						He
Li	Be		C			Ne
Na	Mg				Cl	Ar
K	Ca				Br	

(a) (i) Write down the symbol **and** name of an element in the same **period** as calcium.

symbol ..... name ..... [1]

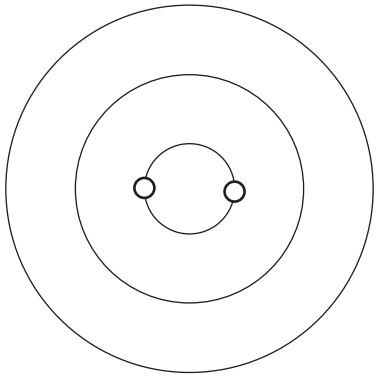
(ii) Write down the symbol **and** name of an element in the same **group** as neon.

symbol ..... name ..... [1]

(iii) Finish the diagram to show the arrangement of electrons in an atom of **argon**.

Use a circle ○ to show the position of each electron.

The positions of two electrons have already been drawn on the diagram to help you.



[1]

(b) The elements sodium and chlorine react to form the compound sodium chloride, NaCl.

(i) Write a balanced symbol equation for the reaction between sodium and chlorine.

Include state symbols in your equation.

..... [3]

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(ii) Sodium chloride is made of sodium ions, Na^+, and chloride ions, Cl^-.

Which statement describes evidence that sodium chloride is made of ions?

Put a tick (✓) in the box next to the correct answer.

Sodium chloride is a solid. ☐

Sodium chloride is made of crystals. ☐

Sodium chloride has a high melting point. ☐

Molten sodium chloride conducts electricity. ☐

[1]

(iii) The table shows the arrangement of electrons in sodium atoms and chlorine atoms.

Complete the table to show the arrangement of electrons in sodium ions and chloride ions.

sodium atom Na	**sodium ion Na^+**	**chlorine atom Cl**	**chloride ion Cl^-**
2.8.1		2.8.7	

[2]

[Total: 9]

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3 The table gives information about ions dissolved in sea water.

ion	symbol	percentage by mass of the total dissolved solids (%)
chloride	Cl^-	55
sodium	Na^+	30
sulfate	SO_4^{2-}	8
magnesium	Mg^{2+}	4
calcium	Ca^{2+}	1
potassium	K^+	1
carbonate	CO_3^{2-}	0.5
bromide	Br^-	0.2

These ions enter the sea water when crystals of ionic compounds in rocks dissolve.

Each of these ionic compounds is made up of one type of positive ion and one type of negative ion shown in the table.

(a) (i) One compound that dissolved from the rocks into the water is magnesium sulfate.

Suggest the name and formula of one **other** ionic compound that dissolved from the rocks into the water.

Use information from the table to help you.

name ..... formula ..... [2]

(ii) When a sample of sea water is evaporated to dryness, a white solid is left. This is a mixture of several ionic compounds.

Look at the **percentage by mass of the total dissolved solids** column in the table.

Use the information to name the ionic compound that makes up **most** of the white solid.

..... [1]

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(b) Sea water conducts electricity.

Which statements give the best explanation for this?

Put a tick (✓) in the box next to **each** correct explanation.

Ions are able to move around in the sea water.	☐
Electrons can pass from ion to ion in the sea water.	☐
The sea water contains more ions with positive charges than ions with negative charges.	☐
The sea water contains ions that have positive charges and ions that have negative charges.	☐

[1]

(c) Solid ionic compounds form crystals.

Finish the sentence about these crystals by choosing words from the list.

atoms **attraction** **ions** **molecules**

opposite **positive** **repulsion** **similar**

In the crystals of solid ionic compounds, particles called …… are held together by the force of …… between particles with …… charges. [1]

(d) Solid ionic compounds have giant, three-dimensional structures.

Which of the following properties are shown by most **solid** ionic compounds?

Put a tick (✓) in the box next to **each** correct answer.

low density	☐
high flexibility	☐
high reactivity	☐
highly coloured	☐
high melting point	☐
low electrical conductivity	☐

[1]

[Total: 6]

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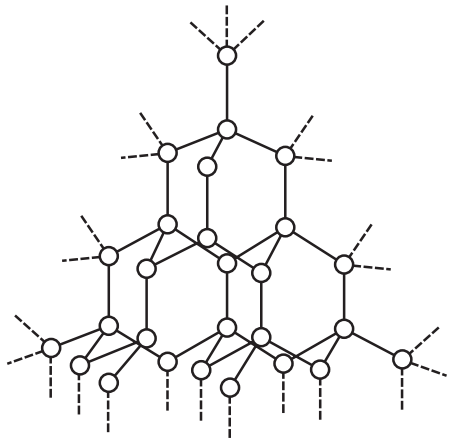
4 Diamond is a giant structure of carbon atoms with bonding similar to that in silicon dioxide.



(a) Here are some sentences about **diamond**.

Finish these sentences by putting a tick (✓) in the box next to the correct word in each pair.

The carbon atoms are joined by

ionic	
covalent	

bonds.

Each carbon atom is joined to

four	
three	

others.

This structure gives diamond a very

low	
high	

melting point,

low	
high	

solubility in water and

low	
high	

electrical conductivity.

[3]

(b) Living things are made up from compounds **mainly** containing four elements.

One of these elements is **carbon**.

What are the names of the **other three** elements?

1.....

2.....

3..... [1]

[Total: 4]

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5 The ore haematite contains iron(III) oxide. Iron is extracted from this ore by reaction with carbon.

The products of this reaction are iron and carbon dioxide.

(a) Finish this **symbol** equation for the reaction.

..... Fe_2O_3 + ... C $\rightarrow$ ..... + ... [2]

(b) A haematite ore contains 80% by mass of iron(III) oxide.

Calculate the maximum mass of iron that can be extracted from each tonne of this ore.

Show each step of your calculation as indicated below.

(1 tonne = 1000 kg)

(relative atomic mass, A_r: Fe = 56, O = 16)

mass of iron(III) oxide in 1 tonne of haematite = ... kg

formula mass of iron(III) oxide = ...

mass of iron in 1 tonne of haematite = ... kg [3]

[Total: 5]

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6 An acid and an alkali react to form a salt and water.

$$\text{acid} + \text{alkali} \longrightarrow \text{salt} + \text{water}$$

(a) Draw straight lines to join up the boxes to show which **acid** reacts with which **alkali** to make each **salt**.

acid	**alkali**	**salt**
sulfuric acid	potassium hydroxide	
		sodium sulfate
hydrochloric acid	ammonium hydroxide	
		potassium chloride
nitric acid	sodium hydroxide	
		magnesium nitrate
phosphoric acid	magnesium hydroxide	

[3]

(b) (i) What is the formula of the **ion** produced when any **acid** dissolves in water?

..... [1]

(ii) What is the formula of the **ion** produced when any **alkali** dissolves in water?

..... [1]

(iii) Write the equation for the neutralisation reaction between these two ions.

..... [1]

[Total: 6]

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7 Magnesium sulfate is one of the chemicals in detergent powder.

Mary makes some magnesium sulfate using this reaction.

magnesium carbonate + sulfuric acid → magnesium sulfate + water + carbon dioxide

$MgCO_3 + H_2SO_4 \rightarrow MgSO_4 + H_2O + CO_2$

(a) (i) The theoretical yield for Mary's experiment is 12.0 g.

Mary dries and weighs the magnesium sulfate she makes. This is her actual yield.

Actual yield = 10.8 g.

Work out the percentage yield for Mary's experiment.

percentage yield = ... [1]

(ii) The relative formula mass of magnesium carbonate is 84.

The relative formula mass of magnesium sulfate is 120.

Calculate the mass of magnesium carbonate that must react with sulfuric acid to make the theoretical yield of 12.0 g of magnesium sulfate.

mass of magnesium carbonate = ... g [1]

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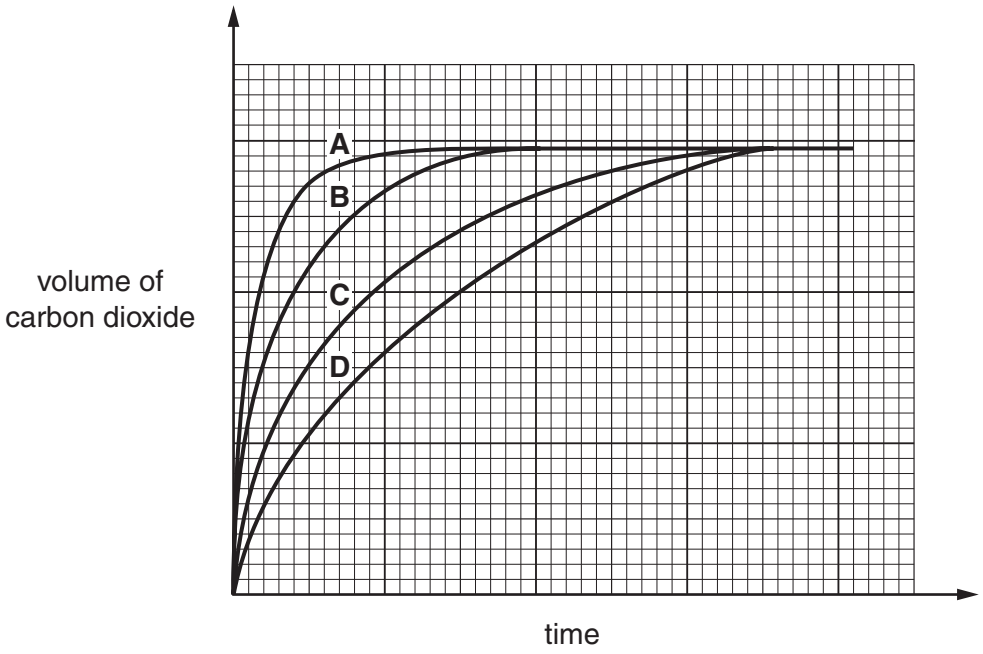
(b) Mary investigates the rate of this reaction with different sized lumps of magnesium carbonate. She keeps all other conditions constant.

She measures the volume of carbon dioxide given off at time intervals and plots her results on a grid.



(i) Which line, **A**, **B**, **C** or **D**, shows results from:

the fastest rate of reaction?

answer .....

the largest lumps of magnesium carbonate?

answer .....[1]

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(ii) In each of the four experiments Mary used 100 cm^3 of solution containing 1.0 g sulfuric acid.

Mary now repeats the experiments, but changes the amount of sulfuric acid.

For each change put a tick (✓) in the correct box to show whether the reaction would be slower, the same speed, or faster.

	slower	**same speed**	**faster**
100 cm^3 solution containing 2.0 g sulfuric acid	☐	☐	☐
100 cm^3 solution containing 0.5 g sulfuric acid	☐	☐	☐
200 cm^3 solution containing 2.0 g sulfuric acid	☐	☐	☐
200 cm^3 solution containing 1.0 g sulfuric acid	☐	☐	☐
50 cm^3 solution containing 0.5 g sulfuric acid	☐	☐	☐

[3]

[Total: 6]

END OF QUESTION PAPER

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The Periodic Table of the Elements

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	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
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	[209] **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	Elements with atomic numbers 112-116 have been reported but not fully authenticated						

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

**** The lanthanoids (atomic numbers 58-71) and the actinoids (atomic numbers 90-103) have been omitted.***

The relative atomic masses of copper and chlorine have not been rounded to the nearest whole number