OCR
Oxford Cambridge and RSA

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Wednesday 14 June 2017 – Morning

GCSE TWENTY FIRST CENTURY SCIENCE CHEMISTRY A/ADDITIONAL SCIENCE A

A172/02 Modules C4 C5 C6 (Higher Tier)

Candidates answer on the Question Paper.
A calculator may be used for this paper.

OCR supplied materials:
None

Other materials required:
- Pencil
- Ruler (cm/mm)

Duration: 1 hour

A172/02

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the barcodes.

INFORMATION FOR CANDIDATES

- The quality of written communication is assessed in questions marked with a pencil ( ).
- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- The total number of marks for this paper is **60**.
- This document consists of **24** pages. Any blank pages are indicated.
- A list of qualitative tests for ions is printed on page **2**.
- The Periodic Table is printed on the back page.

TWENTY FIRST CENTURY SCIENCE DATA SHEET

Qualitative analysis

Tests for ions with a positive charge

Ion	Test	Observation
calcium Ca^{2+}	add dilute sodium hydroxide	a white precipitate forms; the precipitate does not dissolve in excess sodium hydroxide
copper Cu^{2+}	add dilute sodium hydroxide	a light blue precipitate forms; the precipitate does not dissolve in excess sodium hydroxide
iron(II) Fe^{2+}	add dilute sodium hydroxide	a green precipitate forms; the precipitate does not dissolve in excess sodium hydroxide
iron(III) Fe^{3+}	add dilute sodium hydroxide	a red-brown precipitate forms; the precipitate does not dissolve in excess sodium hydroxide
zinc Zn^{2+}	add dilute sodium hydroxide	a white precipitate forms; the precipitate dissolves in excess sodium hydroxide

Tests for ions with a negative charge

Ion	Test	Observation
carbonate CO_3^{2-}	add dilute acid	the solution effervesces; carbon dioxide gas is produced (the gas turns lime water from colourless to milky)
chloride Cl^-	add dilute nitric acid, then add silver nitrate	a white precipitate forms
bromide Br^-	add dilute nitric acid, then add silver nitrate	a cream precipitate forms
iodide I^-	add dilute nitric acid, then add silver nitrate	a yellow precipitate forms
sulfate SO_4^{2-}	add dilute acid, then add barium chloride or barium nitrate	a white precipitate forms

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Question 1 begins on page 4

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Answer **all** the questions.

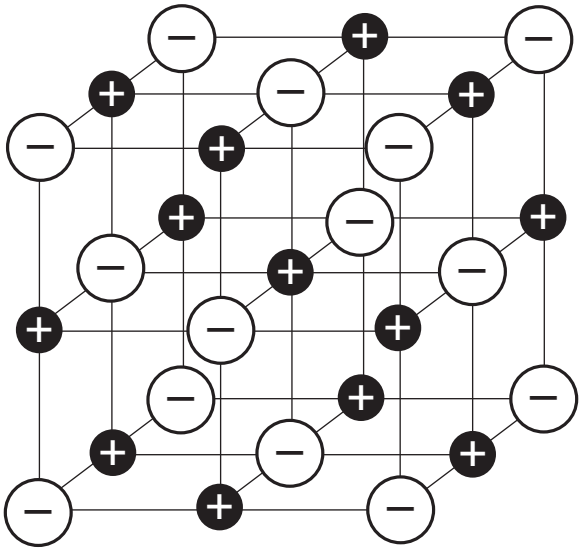
1 Seawater contains water and dissolved salts.

(a) Salts can be extracted from seawater by evaporating the water to leave solid salts.

The table shows the names and formulae of some salts in seawater.

Name of salt	**Formula**
lithium fluoride	LiF
calcium chloride	$CaCl_2$
sodium sulfate	Na_2SO_4

(i) The diagram represents the three dimensional arrangement of ions in one of the salts.



The diagram can only be used to represent **one** of the salts in the table.

Which one? Explain your answer.

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..... **[3]**

(ii) The solid salt forms when seawater evaporates.

Describe the differences between the movement and arrangement of ions in the seawater and the movement and arrangement of the ions in the solid salt.

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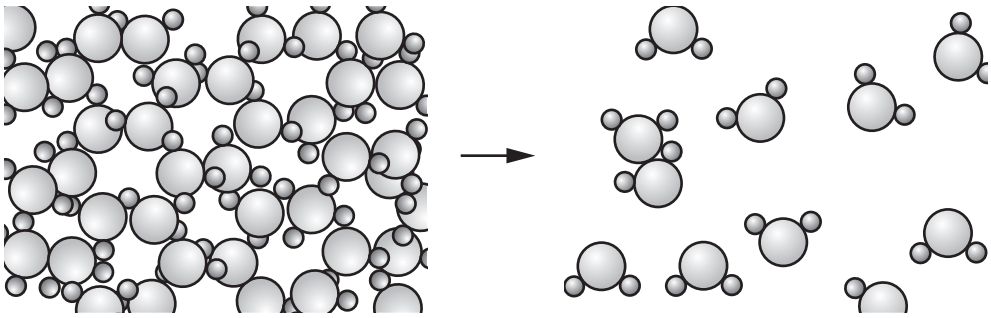
..... **[3]**

(b) When seawater evaporates, water changes from a liquid to a gas.

(i) Complete the equation to show what happens when water evaporates by filling in the missing state symbols.

H_2O(.....) → H_2O(.....) **[1]**

(ii) The diagrams show what happens to the molecules when water evaporates.



liquid **gas**

Describe and explain what happens to the **bonds between atoms** and the **forces between molecules** when water evaporates.

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..... **[2]**

[Total: 9]

2 Ben investigates the reactivity of the Group 7 elements.

(a) Ben adds bromine water to dilute potassium iodide.

This is the equation for the reaction.

$$Br_2(aq) + 2KI(aq) \rightarrow I_2(aq) + 2KBr(aq)$$

How does the equation show that bromine is more reactive than iodine?

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..... **[2]**

(b) The diagrams show the structure of bromine and iodine molecules.

(i) How do the diagrams show that both bromine and iodine are **elements**?

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..... **[1]**

(ii) How do the diagrams show that both bromine and iodine have **diatomic** molecules?

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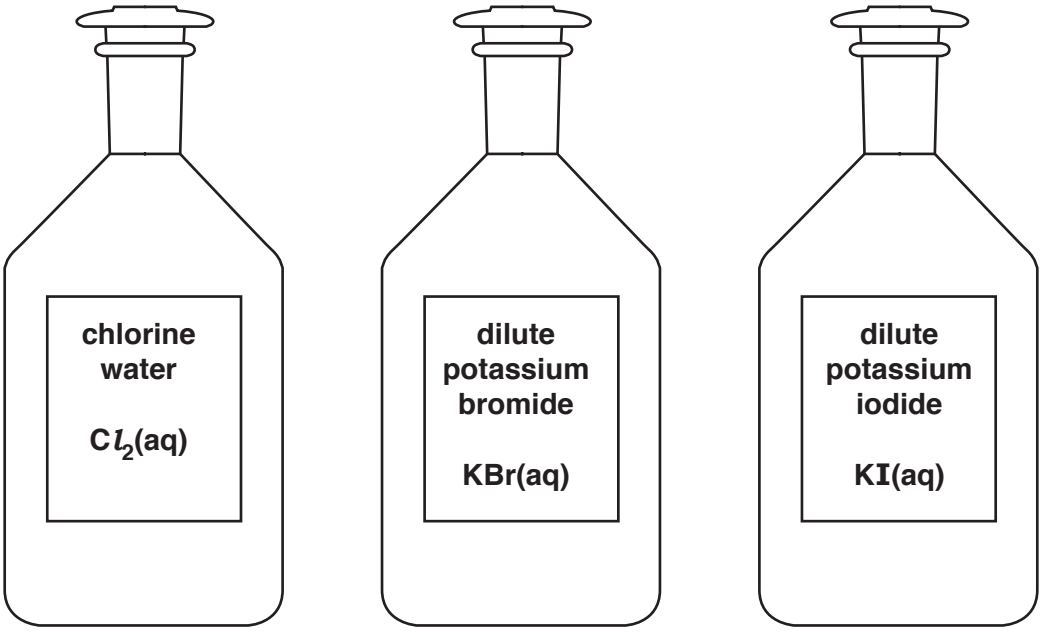
..... **[1]**

(c) Ben wants to show that chlorine is more reactive than bromine and iodine.

He has these solutions.



Describe what experiments Ben should do to show that chlorine is more reactive than bromine and iodine, and predict his observations. Include equations for any reactions that you expect to happen.

The quality of written communication will be assessed in your answer.

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[Total: 10]

3 Döbereiner was a chemist who had the idea that elements with similar properties could be arranged in groups of three.

He called the groups 'triads'.

Döbereiner's idea was that the mean relative atomic mass of the first and last element in each triad was close to the relative atomic mass of the element in the middle.

This is an example of a triad.

relative atomic mass of selenium = 79

Element	**Sulfur**	**Selenium**	**Tellurium**
Symbol	S	Se	Te
Relative atomic mass	32	79	128

mean relative atomic mass of sulfur and tellurium = 80

(a) Sulfur, selenium and tellurium are in the same group of the modern Periodic Table.

(i) Which group of the Periodic Table contains sulfur, selenium and tellurium?

..... **[1]**

(ii) Suggest why these three elements are in the same group of the Periodic Table.

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..... **[1]**

(b) Döbereiner suggested two other triads.

Element	**Carbon**	**Nitrogen**	**Oxygen**
Relative atomic mass	12		16

Element	**Chlorine**	**Bromine**	**Iodine**
Relative atomic mass	35.5		127

(i) Use Döbereiner's idea about relative atomic masses to predict the relative atomic masses of nitrogen and bromine.

Show your working.

Döbereiner's predicted relative atomic mass of nitrogen:

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Döbereiner's predicted relative atomic mass of bromine:

..... **[3]**

(ii) The atomic number of nitrogen is 7.

The atomic number of bromine is 35.

Use the Periodic Table to find the actual relative atomic masses of nitrogen and bromine.

relative atomic mass of nitrogen .....

relative atomic mass of bromine ..... **[2]**

(iii) Does Döbereiner's idea work for nitrogen and bromine?

Explain your answer.

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..... **[2]**

(c) Döbereiner published his idea over 200 years ago.

Scientists who worked after Döbereiner rejected his idea.

Suggest reasons why they did this.

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..... **[2]**

[Total: 11]

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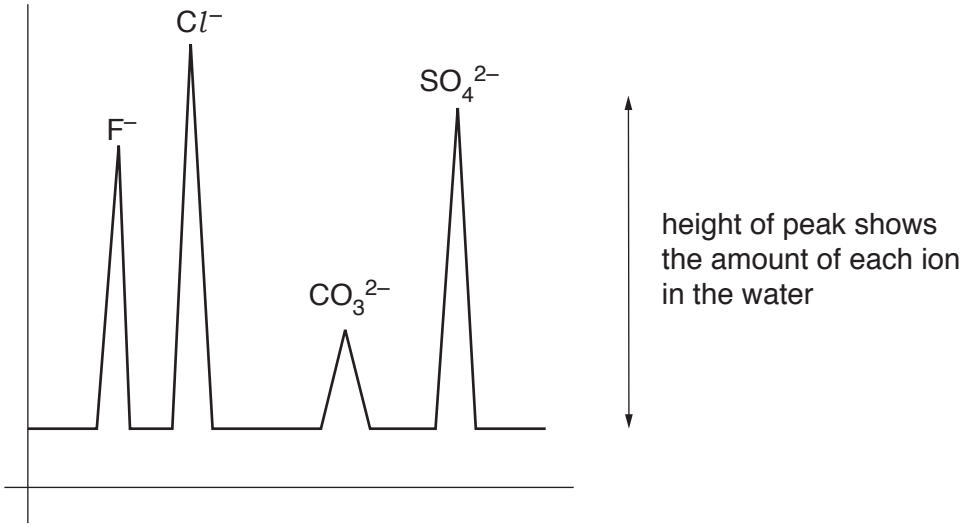
4 Nikesh tests some bottled fizzy water to find out what ions it contains.

(a) He has a new machine called an ion chromatography machine.

The machine gives a printout to show the negative ions in the water.

The position of each peak identifies the ion and the height of each peak shows the amounts of each ion.

This is the printout for the fizzy water.



He also uses test-tube tests to identify the ions in the water.

These are his results.

Test-tube test	**Result**
add dilute acid	fizzing, gas turns lime water milky
add silver nitrate	white precipitate
add barium nitrate	white precipitate

Describe and explain how each test-tube test supports the ion chromatography results and describe what extra information the ion chromatography gives.

Use the data sheet on page 2 of this question paper to help you to answer.

The quality of written communication will be assessed in your answer.

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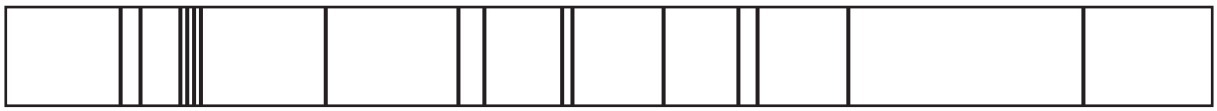
(b) Nikesh wants to find out what positive ions are in the water.

He uses a spectroscopy machine to produce a line spectrum from the water.

This is the line spectrum.



Nikesh uses a reference book to find information to help him to interpret the line spectrum.

Describe the information he needs to find and how he uses it to identify the ions in the water.

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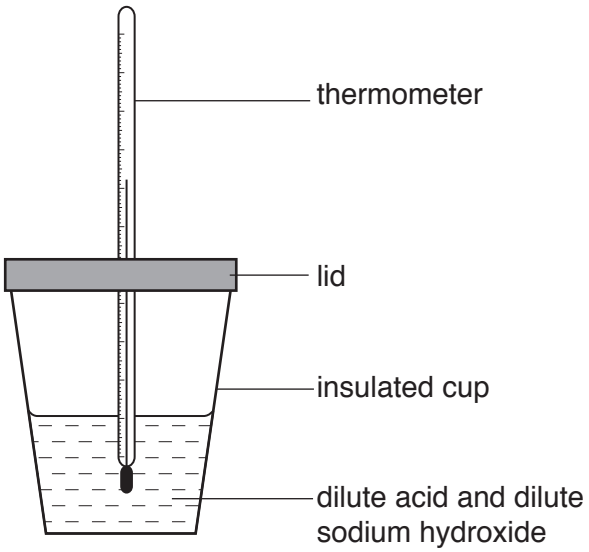
..... **[2]**

[Total: 8]

5 Jack measures the temperature change when different dilute acids react with dilute sodium hydroxide.



He uses the same volume and concentration of the acid and the sodium hydroxide every time.

The table shows his results.

Acid		Temperature change in °C
Name	**Formula**	
hydrochloric acid	HCl	+ 5.0
nitric acid	HNO_3	+ 5.0
sulfuric acid	H_2SO_4	+ 9.5

(a) (i) Jack has an idea about his results.

Jack's Idea: I think that the temperature change is linked to the number of hydrogen atoms in the formula of the acid.

Explain how the results in the table support Jack's idea.

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..... **[3]**

(ii) Jack does an investigation to find out if his idea works for other acids.

He reacts acids with different numbers of hydrogen atoms in their formula with dilute sodium hydroxide. He measures the temperature change.

Identify whether each variable is an **input variable**, an **outcome variable** or a **control variable** in his investigation.

Put a tick (✓) in one box in each row.

Variable	Input variable	Outcome variable	Control variable
Number of hydrogen atoms in formula of acid			
Volume of dilute sodium hydroxide			
Concentration of acid			
Temperature			

[3]

(b) Which words can be used to describe the reactions between any acid and dilute sodium hydroxide?

Put ticks (✓) in the boxes next to the **two** correct answers.

neutralisation ☐

titration ☐

analysis ☐

exothermic ☐

corrosive ☐

[2]

(c) Jack knows that every reaction between an acid and an alkali can be represented by this equation.

$$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$$

Explain why this equation is the same for every reaction between an acid and an alkali.

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..... **[2]**

(d) The table shows some information about the reactants and products in the reaction between sulfuric acid and potassium hydroxide.

Complete the table by filling in the missing information.

	Name	**Formula**	**Formula of positive ion**	**Formula of negative ion**
Acid used	sulfuric acid	H_2SO_4	H^+	SO_4^{2-}
Alkali used	potassium hydroxide		K^+	OH^-
Salt formed			K^+	SO_4^{2-}

[3]

[Total: 13]

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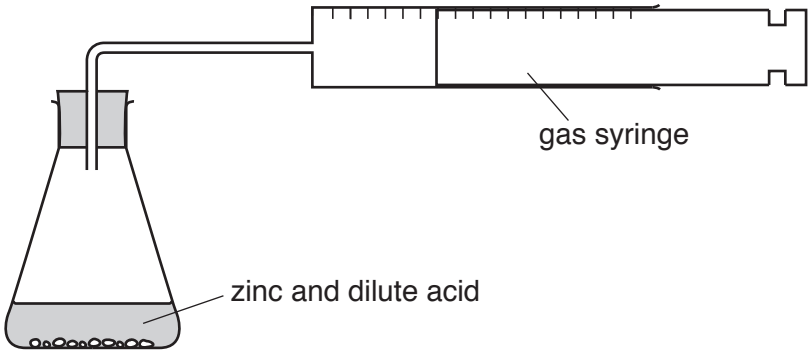
6 Jay does some experiments to investigate the rate of the reaction between zinc and a dilute acid.

He uses this apparatus to measure the time taken to collect 10 cm^3 gas in each experiment.



He varies the concentration of the acid.

He also uses a catalyst in some experiments.

(a) (i) State **two** variables that Jay needs to control in every experiment.

1 .....

2 .....

[2]

(ii) Name the gas that is made in the reaction between zinc and the dilute acid.

..... **[1]**

(b) These are Jay's results.

Concentration of acid in mol/dm^3	Time taken to collect 10 cm^3 gas in s	Catalyst used
0.1	50	no catalyst
0.1	35	catalyst
0.5	25	no catalyst
0.5	18	catalyst
1.0	7	no catalyst
1.0	7	catalyst
2.0	7	no catalyst
2.0	7	catalyst

What conclusions can you make from the data? Use values from the data to support your answer.

The quality of written communication will be assessed in your answer.

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..... **[6]**

[Total: 9]

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).

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.