OCR
Oxford Cambridge and RSA

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Wednesday 14 June 2017 – Morning

GCSE TWENTY FIRST CENTURY SCIENCE CHEMISTRY A/ADDITIONAL SCIENCE A

A172/01 Modules C4 C5 C6 (Foundation 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

* A 1 7 2 0 1 *

* 6 7 1 7 4 5 9 3 6 9 *

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

PLEASE DO NOT WRITE ON THIS PAGE

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 formulae of some salts in seawater.

Formula
NaF
KBr
$CaCl_2$
Na_2SO_4

(i) Which salt contains the most atoms in its formula?

Put a (ring) around the correct answer.

NaF **KBr** **$CaCl_2$** **Na_2SO_4** **[1]**

(ii) Which salt contains calcium?

Put a (ring) around the correct answer.

NaF **KBr** **$CaCl_2$** **Na_2SO_4** **[1]**

(b) Liz works for a company that extracts salts from seawater.

She wants to work out the mass of the salts in some seawater.

She uses this information.

Element	Relative atomic mass
Na	23
Ca	40
F	19
Cl	35.5

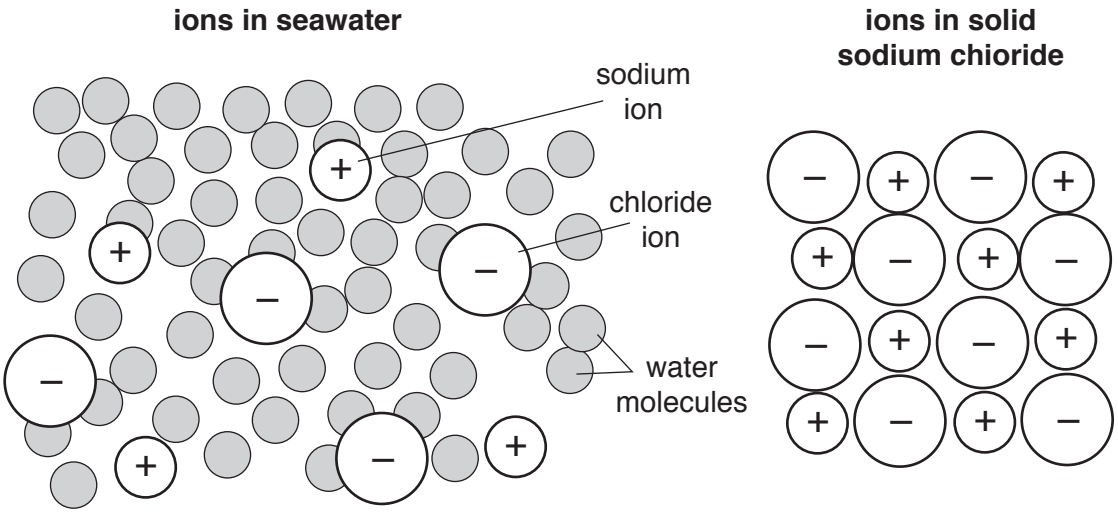
Calculate the relative formula mass of NaF and $CaCl_2$.

NaF .....

$CaCl_2$ ..... **[2]**

(c) Sodium chloride can be extracted from seawater.

The diagrams show the arrangement of ions in seawater and in solid sodium chloride.



Solid sodium chloride forms when seawater evaporates.

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

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

(d) Magnesium is a very valuable metal.

Magnesium is usually extracted from solid ores which are mined on land.

A new process has been developed which extracts magnesium from seawater.

Suggest one **advantage** and one **disadvantage** to the environment of extracting magnesium from seawater rather than by mining.

advantage .....

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disadvantage .....

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[2]

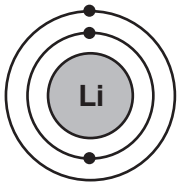
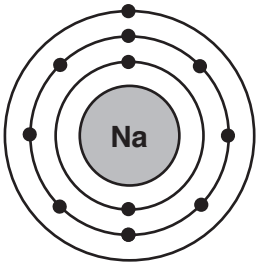
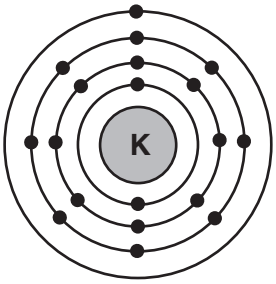
[Total: 9]

2 Lithium, sodium and potassium are all elements in Group 1 of the Periodic Table.

Group 1

Li lithium
Na sodium
K potassium

The table shows information about the atoms of lithium, sodium and potassium.

	Lithium	**Sodium**	**Potassium**
Diagram of atom			
Electron arrangement	2.1	2.8.1	2.8.8.1
Number of protons	3	11	19
Number of neutrons	4	12	20

7

Explain how the information shows that all three elements belong in Group 1 and describe how the structures of the atoms are different down the group.

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

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

[Total: 6]

3 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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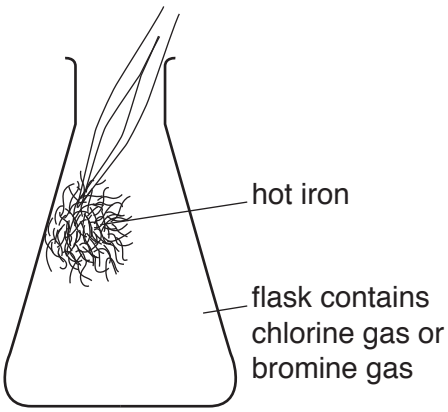
..... **[2]**

(b) Ben does an experiment to show that chlorine is more reactive than bromine.

He puts some hot iron wool into a flask which contains chlorine gas.

He repeats the experiment using hot iron wool and bromine gas.



How will Ben's observations show that the reactivity of chlorine is different to the reactivity of bromine?

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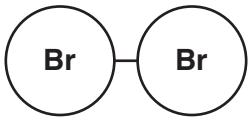
..... **[2]**

(c) The diagram shows the structure of a bromine molecule.



Bromine is an element which has diatomic molecules.

Draw straight lines to connect each **word** with its correct **meaning**.

word	**meaning**
	all of the atoms in bromine are the same
element	bromine is in Group 7
diatomic	bromine is a gas
	every molecule of bromine contains two atoms

[2]

[Total: 6]

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

He called the groups 'triads'.

(a) One of Döbereiner's triads contained carbon, nitrogen and oxygen.

Döbereiner put these elements together because he thought they were similar.

How are these three elements similar?

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

They are all solids. ☐

They all conduct electricity. ☐

They are all non-metals. ☐

They all react vigorously with water. ☐

[1]

(b) Döbereiner had an idea 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.

The table shows some of the masses in a triad.

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

(i) Work out the mean relative atomic mass of carbon and oxygen.

Show your working.

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

(ii) What is the relative atomic mass of nitrogen?

Use the Periodic Table to help you to answer.

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

(iii) Do your values support Döbereiner's idea for this triad?

Explain your answer.

.....

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

(c) The elements in some of Döbereiner's triads fit into groups of the modern Periodic Table.

Which groups contain these triads of elements?

Draw straight lines to connect each **group** with the correct triad.

Use the Periodic Table to help you.

group	**triad**		
2	calcium Ca	strontium Sr	barium Ba
5	sulfur S	selenium Se	tellurium Te
6	nitrogen N	phosphorus P	arsenic As

[2]

(d) Other scientists rejected Döbereiner's idea about triads.

Why did they do this?

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

- Data about some elements did not fit his idea. ☐
- The Periodic Table had not yet been developed. ☐
- Other scientists had better ideas about organising elements. ☐
- Some elements had not been discovered. ☐

[2]

[Total: 9]

5 Nikesh buys a bottle of fizzy water. The label shows what ions are in the water.

Contents:
calcium
sodium
chloride
sulfate

(a) Nikesh adds test solutions to the water to identify some of the ions in the water.

Write down the test solutions that Nikesh needs to use and the observations he should expect to identify each ion in the water and state which ion **cannot** be identified from his tests.

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

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

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

(b) Nikesh uses some other techniques to test the water.

Which two other techniques can be used to identify the ions in the water?

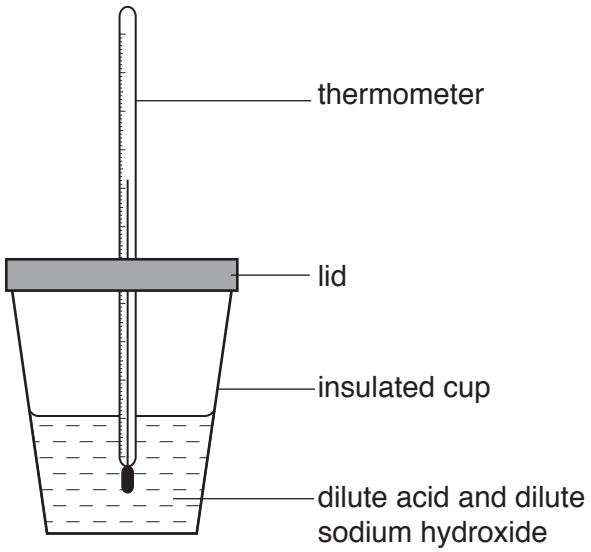
Put ticks (✓) in the boxes next to the **two** correct answers.

flame tests	☐
crystallisation	☐
testing pH	☐
looking at line spectra	☐
filtration	☐

[2]

[Total: 8]

6 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 wants to find out if his idea fits all acids.

He knows that he cannot test all acids.

Describe the experiments he could do to increase confidence in his idea.

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

(b) Which words can be used to describe the reactions between the acids 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.

hydrogen ion + hydroxide ion ⟶ water

Draw straight lines to join each ion or molecule to its correct formula.

ion or molecule	**formula**
	$H_2(g)$
hydrogen ion	$H^+(aq)$
	$OH^-(aq)$
hydroxide ion	
	$O^{2-}(aq)$
water	$H_2O(s)$
	$H_2O(l)$

[2]

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

The formula for every reactant or product in the reaction contains **three** different elements.

Complete the table by filling in the missing information.

Use the Periodic Table to help you.

	Name	**Formula**	**Elements in formula**
Acid used	sulfuric acid	H_2SO_4	hydrogen sulfur oxygen
Alkali used	sodium hydroxide	NaOH	sodium ....
Salt formed		Na_2SO_4	....

[3]

[Total: 13]

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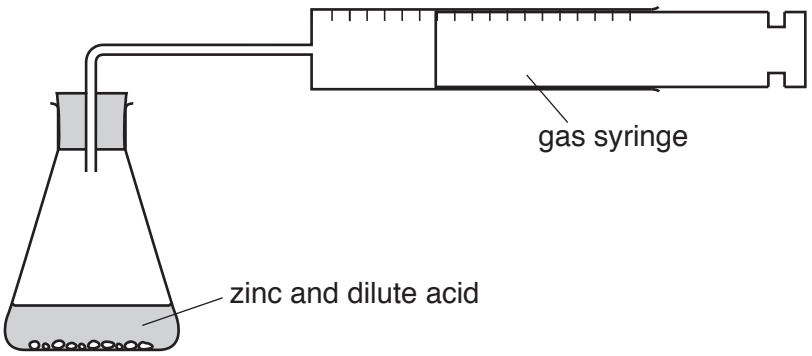
7 Jay does some experiments to investigate the rate of the reaction between zinc and a dilute acid.

He uses this apparatus to measure the volume of gas given off after 10 s.



He varies the concentrations of 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) What is the name of the gas made in the reaction between zinc and the dilute acid?

Put a (ring) around the correct answer.

chlorine **hydrogen** **oxygen** **nitrogen** **[1]**

(b) These are Jay's results.

Without a catalyst	
Concentration of acid in mol/dm^3	**Volume of gas given off after 10 s in cm^3**
0.1	4
0.5	15
1.0	24
2.0	45

With a catalyst	
Concentration of acid in mol/dm^3	**Volume of gas given off after 10 s in cm^3**
0.1	9
0.5	27
1.0	49
2.0	92

What conclusions can you make about the effects of changing the concentration and using a catalyst on the rate of this reaction? Use examples 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.