

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



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

3

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Question 1 begins on page 4

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4

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

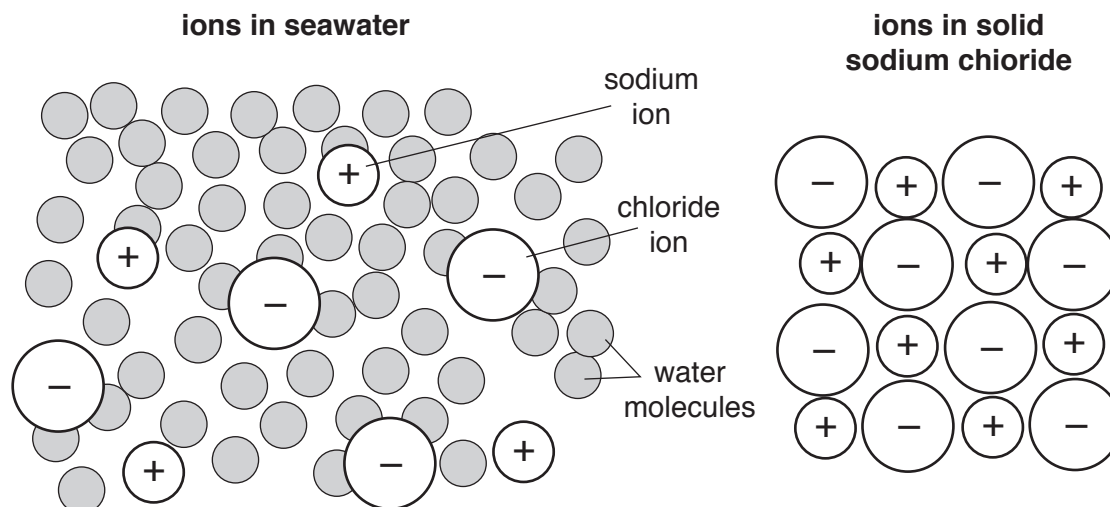
 CaCl_2

[2]

5

- (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

.....

disadvantage

.....

[2]

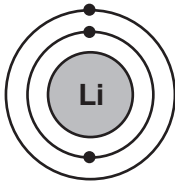
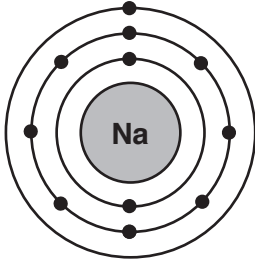
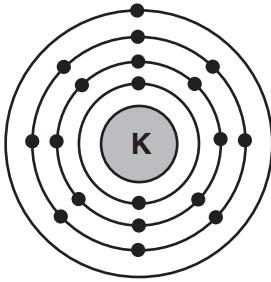
[Total: 9]

- 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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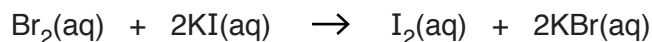
..... [6]

[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.



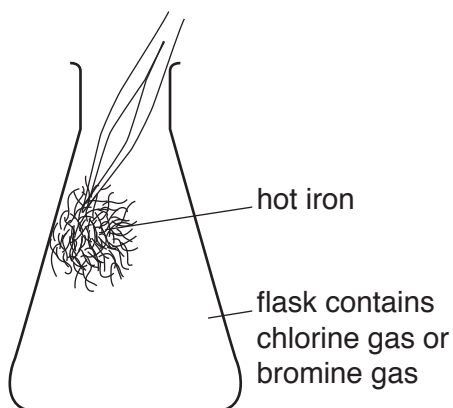
How does the equation show that bromine is more reactive than iodine?

.....
.....
..... [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?

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

9

(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.

..... [6

13

(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

☐

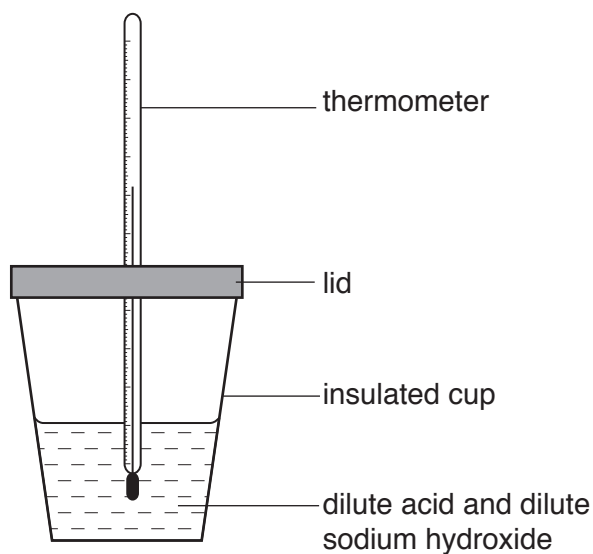
filtration

☐

[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 ₂ SO 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.

.....

.....

.....

.....

..... [3]

15

- (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.

.....

.....

.....

.....

..... [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	<input type="checkbox"/>
titration	<input type="checkbox"/>
analysis	<input type="checkbox"/>
exothermic	<input type="checkbox"/>
corrosive	<input type="checkbox"/>

[2]

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



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

ion or molecule

formula

	<input type="text" value="H<sub>2</sub>(g)"/>
<input type="text" value="hydrogen ion"/>	<input type="text" value="H<sup>+</sup>(aq)"/>
	<input type="text" value="OH<sup>-</sup> (aq)"/>
<input type="text" value="hydroxide ion"/>	<input type="text" value="O<sup>2-</sup> (aq)"/>
	<input type="text" value="H<sub>2</sub>O(s)"/>
<input type="text" value="water"/>	<input type="text" value="H<sub>2</sub>O(l)"/>

[2]

16

- (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

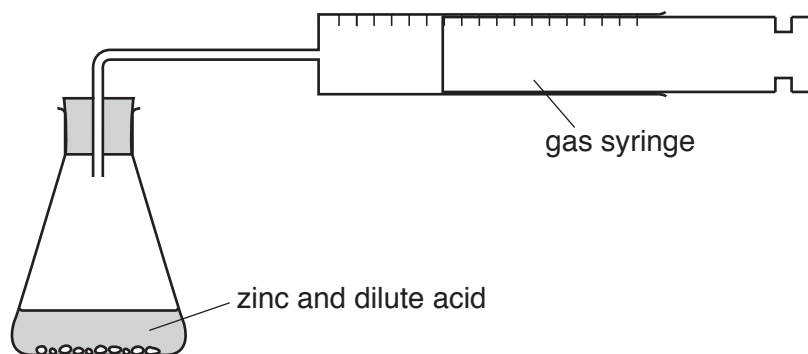
[3]

[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]

[illegible]

[illegible]

[illegible]

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The Periodic Table of the Elements

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1	2	Key										3	4	5	6	7	0
		relative atomic mass atomic symbol name atomic (proton) number															
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						

* 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.