OCR
Oxford Cambridge and RSA

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Tuesday 7 November 2017 – Afternoon

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

* A 1 7 2 0 2 *

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.
- The Periodic Table is printed on the back page.
- A list of qualitative tests for ions is printed on page 2.

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 Bromine is an element in Group 7.

Joe works for a company that makes bromine.

His job is to test samples of the bromine that the company makes.

(a) These are the hazard symbols for bromine.

Joe wears goggles when he works with bromine.

Explain what these hazard symbols mean and what other safety precautions are needed to avoid these hazards.

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

(b) Joe measures the volume and mass of some samples of bromine.

Sample	Volume of bromine in cm^3	Mass of bromine in g
1	5.0	15.3
2	5.0	15.6
3	5.0	15.0

(i) Calculate the **average** density of the samples of bromine in g/cm^3.

Use the formula: $\text{density} = \frac{\text{mass in g}}{\text{volume in } cm^3}$

Show your working.

density = ... g/cm^3 **[2]**

(ii) Joe tests 20.0 cm^3 samples of bromine from the same batch.

Use your answer to **(i)** to work out the mass of bromine for a 20.0 cm^3 sample.

answer = ... g **[1]**

(c) Joe looks up the densities of some other elements in Group 7 at room temperature.

He finds out that the density of chlorine is **lower** than bromine.

The density of iodine is **higher** than bromine.

Explain why.

Use ideas about the state of the elements at room temperature.

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

[Total: 9]

2 Helium is an element. It is in Group 0 of the Periodic Table.

(a) Use the Periodic Table to answer the following questions.

(i) Give the name of an element in the same **period** as helium.

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

(ii) Helium and fluorine are both very close to neon in the Periodic Table.

Helium and neon have similar properties.

How can you tell from the Periodic Table that fluorine and neon do **not** have similar properties?

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

(b) Helium was discovered when scientists looked at the lines in spectra of light.

Read the information about the evidence collected by the scientists.

Janssen, August 1868

Scientists already know that the spectrum of sodium has lines in the yellow part of the spectrum.

I have looked at part of the spectrum from the Sun. It looks similar to the spectrum of sodium. It has lines like this. They are all close together in the yellow part of the spectrum.

Lockyer, October 1868

I have checked Janssen's work. I have seen the same pattern of lines in the spectrum of the Sun.

I have checked the spectrum from pure sodium in the laboratory. The spectrum from the pure sodium has only lines in the yellow part of the spectrum like this.

Palmeiri, 1882

I looked at the spectrum of light from hot lava from Vesuvius, a volcano in Italy.

The spectrum from the lava also shows the three lines seen by Janssen and Lockyer in the spectrum of the Sun. The spectrum looks like this.

Ramsay, 1895

I found some mineral samples in Norway. I have extracted a gas from them.
The spectrum from the gas also contains all three lines.

Ideas suggested between 1868 and 1895

At first, scientists thought a new line had been found in the spectrum of sodium.

Later, scientists agreed that the new line could not be sodium and must be a new element. They called this new element 'helium'.

This element is found both in the Sun and on Earth.

Explain how the evidence gathered by each scientist led to these ideas.

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

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

(c) Argon is another element in Group 0.

(i) When Mendeleev developed his Periodic Table, he put the elements in order of their relative atomic mass.

In a modern Periodic Table, argon (relative atomic mass 40) comes before potassium (relative atomic mass 39).

Explain why they are this way around.

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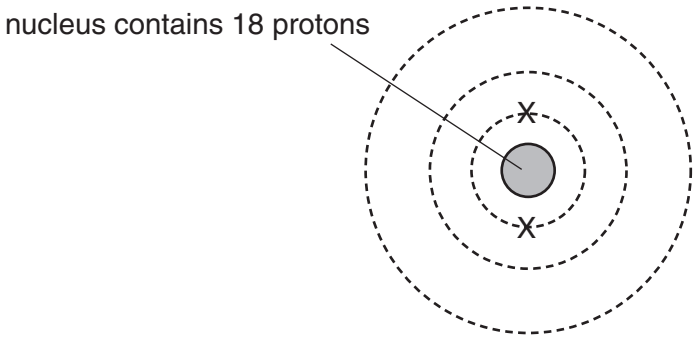
..... **[2]**

(ii) The diagram shows part of the structure of an argon atom.

Complete the diagram to show the arrangement of the rest of the electrons in an argon atom.



[2]

(iii) How many **neutrons** does an atom of argon contain?

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

[Total: 13]

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Question 3 begins on page 10

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3 Silver-coloured coins contain a mixture of copper and nickel.

(a) Copper for making coins can be extracted from several different copper compounds.

The table shows information about some copper compounds.

Compound	Formula of copper compound in the mineral	Relative formula mass of compound	Percentage of copper in the compound
A	**CuO**	79.5	79.9%
B	**CuS**	95.5	66.5%
C	**$CuFeS_2$**		34.6%
D	**$CuCl_2$**		

(i) Complete the table by filling in the boxes.

Use these relative atomic masses to help you.

Atom	Relative atomic mass
copper	63.5
iron	56
sulfur	32
oxygen	16
chlorine	35.5

[3]

(ii) Compounds **B** and **C** both contain copper and sulfur.

Compound **B** has a higher percentage of copper than compound **C**.

Explain how you can tell this from their formulae.

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

(iii) Two compounds found in copper ores have the formulae CuO and Cu_2O.

The formula for the oxide ion in each compound is O^{2-}.

What is the formula for the copper ion in each compound?

Formula for copper ion in CuO .....

Formula for copper ion in Cu_2O .....

[2]

(b) A mining company wants to build a new nickel mine.

The company looks at some different sites for the mine. All of the sites have ore deposits of similar size.

The table shows information about the sites.

Site number	Percentage of nickel in ore	Area where ore is found	Other information
1	1.0	50 m under the ground	limited roads nearby, no local towns
2	2.2	on the deep sea floor	large sea port and town nearby
3	1.8	near an earthquake zone	road and sea transport nearby, town nearby
4	2.2	300 m under the ground	road and sea transport nearby, town nearby

The company decides that site 4 is the best choice because it is likely to have the lowest overall cost of extracting nickel.

Explain why the **cost** of extracting nickel is likely to be higher at each of the other sites than at site 4.

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

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[Total: 13]

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Question 4 begins on page 14

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4 Aluminium is extracted by the electrolysis of molten aluminium oxide.

(a) Most other metals can be extracted by heating their oxides with carbon.

It is **not** possible to extract aluminium by heating aluminium oxide with carbon.

Explain why.

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

(b) Samples of both aluminium metal and molten aluminium oxide conduct electricity.

Complete the table to show which statements are **only true for aluminium metal**, which are **only true for molten aluminium oxide** and which are **true for both**.

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

	Only true for aluminium metal	**Only true for molten aluminium oxide**	**True for both**
The sample contains charged particles.			
Ions are free to move through the sample.			
Electricity flows due to electrons moving through the sample.			
Flow of electricity causes chemical reaction.			

[2]

(c) Aluminium reacts with oxygen in the air. The aluminium becomes covered with a layer of aluminium oxide.

The layer of aluminium oxide affects the conductivity of the aluminium.

The aluminium oxide can be removed by a reaction with dilute nitric acid.

(i) The reaction makes a salt that has the formula $Al(NO_3)_3$.

What is the name of this salt?

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

(ii) The dilute nitric acid reacts with the solid aluminium oxide to make a solution of the salt and water.

Complete the formulae for the compounds involved in the reaction by filling in the missing state symbols.

solid aluminium oxide	Al_2O_3( )
dilute nitric acid	HNO_3( )
water	H_2O( )

[2]

(iii) This is the equation for the reaction.

Balance the equation.

$$Al_2O_3 + 6HNO_3 \rightarrow \text{.....} \; Al(NO_3)_3 + \text{.....} \; H_2O$$

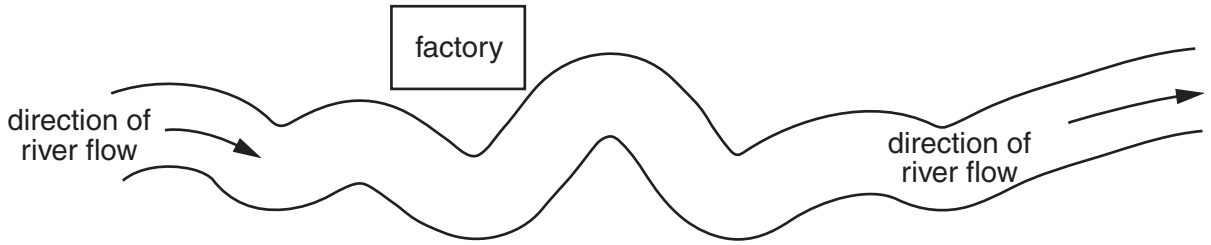
[1]

[Total: 7]

5 Zak works for a company that makes salts.

The company has a factory beside a river.

Part of Zak's job is to check that the factory does not affect the pH of the water in the river.



(a) Zak measures the pH of the water from the river **before** it flows past the factory.

Explain why he does this.

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

(b) Zak plans to take other samples of water from the river to find out if the factory affects the pH of the water.

What should Zak consider when planning to take more samples?

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

(c) What could Zak use to test the pH of a sample of water?

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

pH meter	☐
dilute sodium chloride	☐
litmus paper	☐
universal indicator solution	☐
dilute potassium hydroxide	☐

[1]

(d) Zak finds that all of the water samples are slightly acidic.

Put a tick (✓) in the box next to the best explanation for this.

A substance in the water produces H^+ ions.	☐
A substance in the water produces OH^- ions.	☐
A substance in the water produces H^- ions.	☐
A substance in the water produces OH^+ ions.	☐
There are too many negative ions in the water	☐

[1]

(e) Zak wants to find out if chloride ions or sulfate ions from the factory are entering the river water.

He tests some of the river water using dilute silver nitrate.

He tests some of the river water using dilute barium nitrate.

Explain how the results of these tests will show if the river water contains chloride ions or sulfate ions.

Use the Data Sheet on page 2 to help you.

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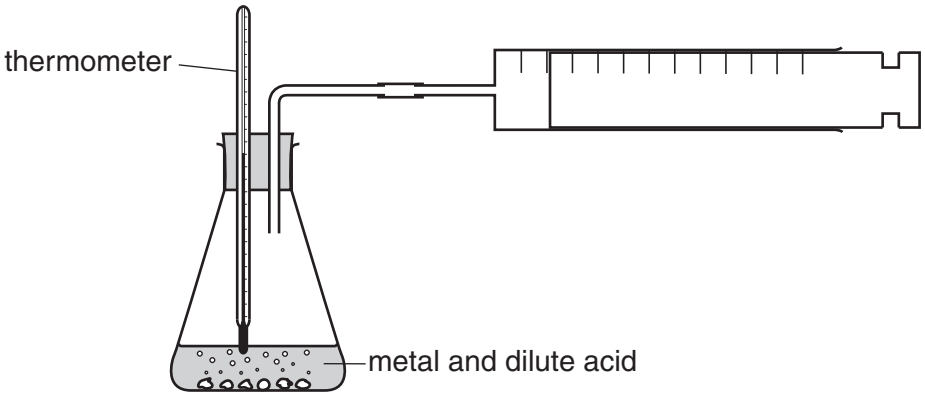
[Total: 7]

6 Eve investigates the rate of reaction when five different metals react with dilute acid.



(a) In each experiment Eve adds a different metal to dilute hydrochloric acid.

She records the time taken to make 10 cm^3 gas.

(i) What is the **name** and **formula** of the gas that is made when a metal reacts with an acid?

name .....

formula .....

[2]

(ii) Zak does the same experiments as Eve.

Zak also measures the temperature change during each reaction.

The tables shows their results.

Eve's Results

Metal	Time taken to make 10 cm^3 gas in seconds
zinc	20
magnesium	14
copper	no gas made
calcium	10
lithium	8

Zak's Results

Metal	Time taken to make 10 cm^3 gas in seconds	Temperature change after 10 cm^3 gas is made in °C
zinc	11	4
magnesium	8	5
copper	no gas made	0
calcium	6	7
lithium	4	8

Eve makes this comment about the results:

'Zak's results look very different to mine, but I think all of the results can be used to give a reliable order of reactivity.'

Explain how Eve can use the results to put the metals in order of reactivity and how all of the results can be used to give the same order.

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

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(b) Eve does more experiments using zinc metal.
She compares the rate of reaction when the same mass of zinc reacts with dilute acid.
In one experiment she uses a large piece of zinc.
In a second experiment she uses zinc powder.

Use ideas about collisions between particles to explain why the rate of reaction for the two experiments is different.

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[Total: 11]

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).

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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.