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Monday 10 June 2013 – Afternoon

GCSE TWENTY FIRST CENTURY SCIENCE CHEMISTRY A

A172/02 Modules C4 C5 C6 (Higher Tier)

A137230613

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

A172O2

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. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
- Do **not** write in the bar codes.

INFORMATION FOR CANDIDATES

- Your 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 **20** 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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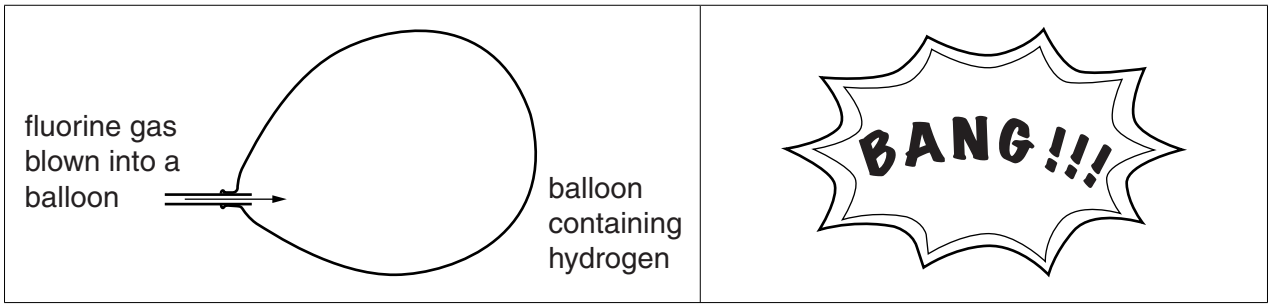
Question 1 begins on page 4

PLEASE DO NOT WRITE ON THIS PAGE

Answer **all** the questions.

1 Hydrogen reacts with the elements in Group 7 of the Periodic Table.

Hydrogen and fluorine explode when they are mixed together.



The word equation for the reaction is

hydrogen + fluorine ⟶ hydrogen fluoride

(a) The formula for hydrogen fluoride is HF.

Write a balanced **symbol** equation for the reaction between hydrogen and fluorine.

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

(b) Chlorine reacts with hydrogen to make hydrogen chloride gas (H*Cl*).

When hydrogen chloride gas dissolves, it forms ions in the water.

(i) Complete the symbol equation for the reaction by filling in the missing **state symbols**.

$$HCl(.....) \longrightarrow H^+(.....) + Cl^-(.....)$$ **[1]**

(ii) How does the equation show that the reaction produces an acid?

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

The reaction makes both positive and negative ions.	☐
One of the ions made is a hydrogen ion.	☐
Chloride ions are very acidic.	☐
A gas dissolves to make a solution.	☐

[1]

(c) Iodine is another element in Group 7.

Predict the **name** and the **formula** of the compound that is made when **iodine** reacts with hydrogen.

name .....

formula .....

[2]

(d) The table shows what happens when fluorine, chlorine and iodine react with hydrogen.

Element	**Reaction when mixed with hydrogen**
fluorine	explodes at room temperature
chlorine	a small spark is enough to make the mixture explode
iodine	reacts slowly when heated strongly

(i) Describe the trend in reactivity of the Group 7 elements with hydrogen.

.....

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

(ii) Bromine reacts steadily with hydrogen when it is heated.
Does this fit the trend of reactivity of the other halogens?
Explain your reasoning.

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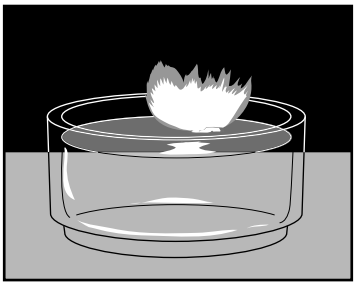
..... **[2]**

[Total: 9]

2 Sodium and potassium are elements in Group 1 of the Periodic Table.

Jake watches a video of the reaction between sodium and water.



(a) Complete the word equation for the reaction between sodium and water.

sodium + water → ..... + ... **[2]**

(b) Jake thinks that the reaction makes an alkali.

How could you show that a solution has an alkaline pH?

.....

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

(c) Jake watches another video. This video shows the reaction of **potassium** with water.

How is this reaction different from the reaction of sodium with water?

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

The two reactions make different gases.	☐
The reaction of sodium takes less time than the reaction of potassium.	☐
The reaction with potassium makes an acid.	☐
The two reactions have different rates.	☐
The two reactions make different alkalis.	☐

[1]

[Total: 5]

3 Alex plans to write an article about flame colours for a school science magazine.

He researches the flame colours of some compounds of metals from Group 1 in the Periodic Table.
He talks about his findings with other science students in an internet chat room.

Alex Hi everyone. Have any of you done any research into flame test colours for Group 1? I have found out that potassium and rubidium both give purple flames. I think that each group has its own flame colour.

Bea I've checked out your research and I agree about the flame colours for potassium and rubidium. I just looked up caesium and that's purple too!

Carl I flame tested some Group 2 elements, none of them were purple. They were all different colours.

Dan Sodium is in Group 1 and gives a yellow flame.

Elly I've looked on the internet and I can't find any elements that give purple flame colours except the ones in Group 1.

Fay Lithium doesn't have a purple flame.

(a) Alex's ideas are that in flame tests:

- all the elements in a group of the Periodic Table have the same flame colour
- each group has its own flame colour.

Explain how each piece of evidence in the chat **supports** or **does not support** Alex's ideas.

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

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

(b) The students' chat is **not** an example of peer review.

Explain why.

.....

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

[Total: 8]

Question 4 begins on page 10

4 Joe knows that 'hard' water contains dissolved calcium ions.

(a) Joe does some research about the concentration of calcium ions in 'hard' water.

Water	**Concentration of calcium ions in mg/dm^3**
very hard	>180
hard	121–180
moderately hard	61–120
soft	0–60

He also finds out the concentration of calcium ions in water from different places.

Water	**Concentration of calcium ions in mg/dm^3**
water from Joe's town	200
water from Plymouth	40
water from London	160

What conclusions can Joe make from the data in the two tables?

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.....

.....

..... **[4]**

(b) Joe does an experiment to find out the **total mass** of dissolved solid in a sample of water from his local town.

He takes 50 cm^3 of the water and evaporates it to leave a solid.

He stores the solid in a desiccator and finds its mass a few days later.

(i) Why is it important that he uses a desiccator?

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

to keep the solid dry	☐
to keep the solid warm	☐
to make sure that the mass reading is accurate	☐
to allow ions in the solid to separate	☐
to neutralise the solid	☐

[2]

(ii) The table shows Joe's results.

Volume of water in cm^3	**Total mass of solid in g**
50	0.02

Calculate the amount of solid in **1 dm^3** of water. Give your answer in g/dm^3.

(1 dm^3 = 1000 cm^3)

..... g/dm^3 **[2]**

(iii) Use your answer to work out the number of **milligrams** (mg) of solid in 1 dm^3 of water.

(1 g = 1000 mg)

..... mg/dm^3 **[1]**

(iv) Joe uses the same technique to analyse a sample of water from London.

He finds that the sample contains 450 mg / dm^3 of dissolved solid.

Joe's research found that London water contains 160 mg / dm^3 of calcium ions.

Why are the two values different?

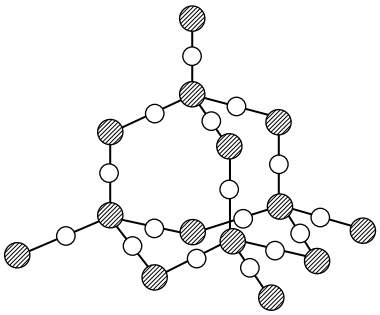
Put a tick (✓) in the box next to the best answer.

Joe overheated the solid so that it decomposed.	☐
The water contained ions other than calcium.	☐
Joe used too small a volume of water in his experiment.	☐
The relative atomic mass of calcium is higher than Joe realised.	☐

[1]

[Total: 10]

5 Carbon dioxide and silicon dioxide are compounds that occur naturally on Earth.
The table shows some information about the two compounds.

	carbon dioxide	**silicon dioxide**
formula	CO_2	SiO_2
structure		
melting point in °C	–78	1710
boiling point in °C	–57	2230
electrical conductivity	does not conduct	does not conduct

(a) Use ideas about structure and bonding to explain the similarities and differences between the properties of carbon dioxide and silicon dioxide.

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

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

(b) Which statement about where carbon dioxide and silicon dioxide are found is correct?

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

They are both found in the atmosphere. ☐

Silicon dioxide is only found in the hydrosphere, carbon dioxide is only found in the lithosphere. ☐

Both carbon dioxide and silicon dioxide are only found in the lithosphere. ☐

Carbon dioxide is found in the atmosphere, silicon dioxide is found in the lithosphere. ☐

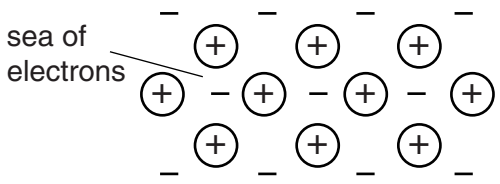
[1]

[Total: 7]

6 Aluminium is a metal with a low density and a high electrical conductivity.

It is used to make overhead power cables.

(a) The diagram shows the bonding in a metal.



What does the symbol ⊕ represent?

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

protons from metal atoms ☐

positively charged metal ions ☐

the nucleus of a metal atom ☐

the positive metal electrode ☐

[1]

(b) Aluminium is extracted by electrolysis of molten aluminium oxide.

Complete and balance the ionic equations to show what happens during the electrolysis of molten aluminium oxide.

..... + $3e^-$ → Al

.....O^{2-} → O_2 + ...

[2]

(c) Aluminium is a metal but aluminium oxide is an ionic compound.

Aluminium metal and molten aluminium oxide conduct electricity in different ways.
Describe and explain the differences.

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

[Total: 6]

7 **(a)** Two different copper compounds react with sulfuric acid to make copper sulfate.

Complete the word equations.

Choose from this list.

copper carbonate **copper chloride** **copper oxide**

copper nitrate **copper sulfate**

sulfuric acid + [ ] → copper sulfate + water

sulfuric acid + [ ] → copper sulfate + carbon dioxide + water

[2]

(b) Complete the table of information about copper compounds.

Name of compound	Formula of positive ion in compound	Formula of negative ion in compound	Formula of compound
copper chloride	Cu^{2+}	Cl^{-}	
copper sulfate	Cu^{2+}		$CuSO_4$
copper hydroxide	Cu^{2+}		$Cu(OH)_2$

[2]

(c) Eve makes some magnesium sulfate by reacting magnesium with sulfuric acid.

She uses 2.4 g of magnesium.

She wants to work out the maximum mass of magnesium sulfate that she can make.

The equation for the reaction and part of Eve's calculation is shown below.

Complete the calculation.

$$\mathbf{Mg + H_2SO_4 \rightarrow MgSO_4 + H_2}$$

Relative mass of Mg = 24 g

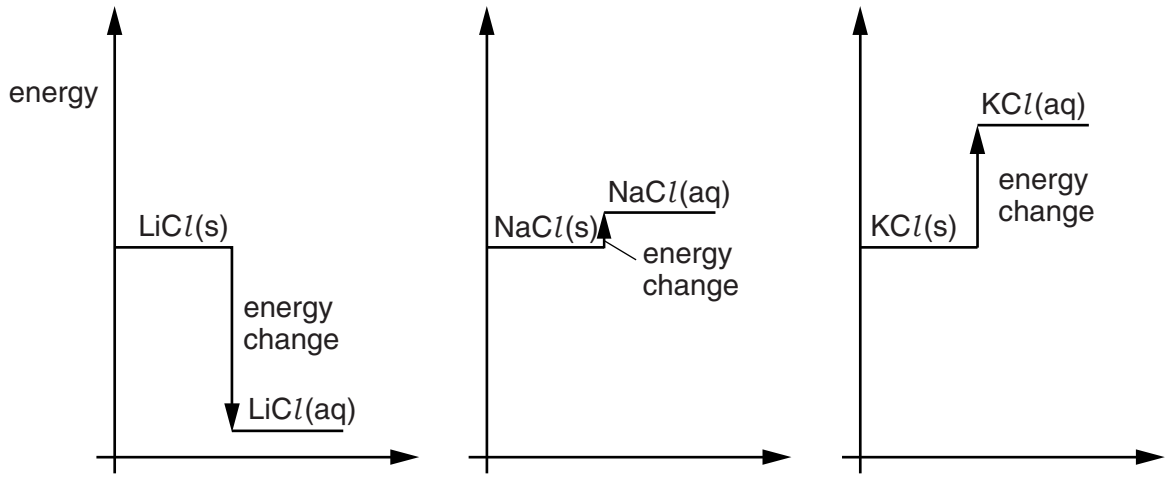
Mass of Mg used in experiment = 2.4 g

Mass of $MgSO_4$ made = ... g **[2]**

[Total: 6]

8 Lithium chloride, sodium chloride and potassium chloride are all soluble in water.

The diagrams show the energy change when each salt dissolves in water.



(a) Tom does an experiment.

He dissolves each compound in water and measures the temperature change that happens when the compound dissolves.

He uses the same amount of each compound and water each time.

Use the energy level diagrams to help you to explain the results Tom should expect from his experiment.

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

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

(b) Draw straight lines to show the correct input and output variable in Tom's experiment.

	temperature
input variable	volume of water
output variable	solubility
	compound

[1]

(c) The energy changes for reactions in industry are carefully controlled. Why is this important?

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

Energy given out by reactions can be used to heat buildings.	☐
Reactions that give out energy use too much fuel to keep them hot.	☐
Energy changes in reactions affect the rate.	☐
Containers for reactions may be damaged by extreme temperatures.	☐
Reactions that take in energy need to be continuously cooled.	☐

[2]

[Total: 9]

END OF QUESTION PAPER

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.