

THIS IS A NEW SPECIFICATION

**H**

Monday 10 June 2013 – Afternoon

**GCSE TWENTY FIRST CENTURY SCIENCE  
CHEMISTRY 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

Candidate forename		Candidate surname	
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Centre number						Candidate number				
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**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 $\text{Ca}^{2+}$	add dilute sodium hydroxide	a white precipitate forms; the precipitate does not dissolve in excess sodium hydroxide
copper $\text{Cu}^{2+}$	add dilute sodium hydroxide	a light blue precipitate forms; the precipitate does not dissolve in excess sodium hydroxide
iron(II) $\text{Fe}^{2+}$	add dilute sodium hydroxide	a green precipitate forms; the precipitate does not dissolve in excess sodium hydroxide
iron(III) $\text{Fe}^{3+}$	add dilute sodium hydroxide	a red-brown precipitate forms; the precipitate does not dissolve in excess sodium hydroxide
zinc $\text{Zn}^{2+}$	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 $\text{CO}_3^{2-}$	add dilute acid	the solution effervesces; carbon dioxide gas is produced (the gas turns lime water from colourless to milky)
chloride $\text{Cl}^-$	add dilute nitric acid, then add silver nitrate	a white precipitate forms
bromide $\text{Br}^-$	add dilute nitric acid, then add silver nitrate	a cream precipitate forms
iodide $\text{I}^-$	add dilute nitric acid, then add silver nitrate	a yellow precipitate forms
sulfate $\text{SO}_4^{2-}$	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**

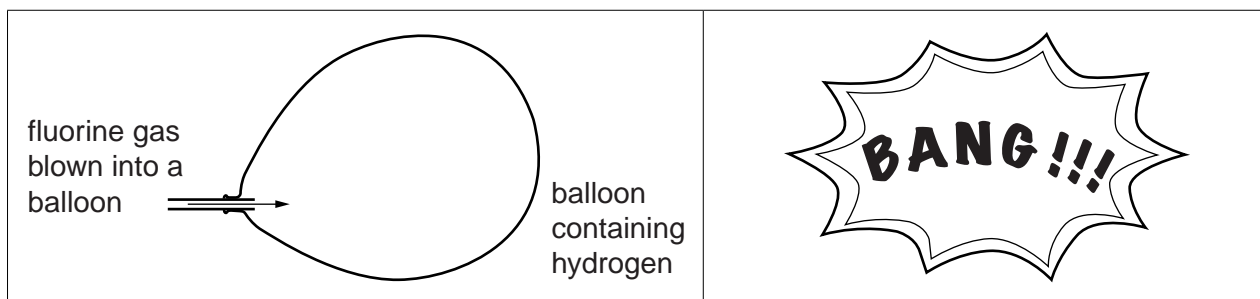
**PLEASE DO NOT WRITE ON THIS PAGE**

4

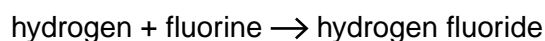
Answer **all** the questions.

- 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



- (a) The formula for hydrogen fluoride is HF.

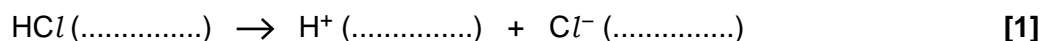
Write a balanced **symbol** equation for the reaction between hydrogen and fluorine.

..... [2]

- (b) Chlorine reacts with hydrogen to make hydrogen chloride gas (HCl).

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**.



5

(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.

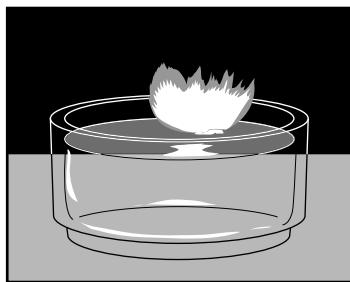
.....  
 ..... [2]

[Total: 9]

6

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  $\rightarrow$  ..... + ..... [2]

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

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

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

7

(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]





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

Explain why.

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

[Total: 8]

**Question 4 begins on page 10**

## 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 $\text{mg}/\text{dm}^3$
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 $\text{mg}/\text{dm}^3$
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?

.....

.....

.....

..... [4]

11

- (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  $50\text{ cm}^3$  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 $\text{cm}^3$	Total mass of solid in g
50	0.02

Calculate the amount of solid in  $1\text{ dm}^3$  of water. Give your answer in  $\text{g}/\text{dm}^3$ .

( $1\text{ dm}^3 = 1000\text{ cm}^3$ )

.....  $\text{g}/\text{dm}^3$  [2]

- (iii) Use your answer to work out the number of **milligrams** (mg) of solid in  $1\text{ dm}^3$  of water.

( $1\text{ g} = 1000\text{ mg}$ )

.....  $\text{mg}/\text{dm}^3$  [1]

12

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

He finds that the sample contains  $450 \text{ mg/dm}^3$  of dissolved solid.

Joe's research found that London water contains  $160 \text{ mg/dm}^3$  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]



14

(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.

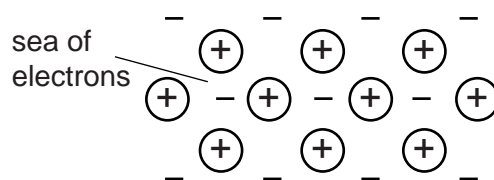
[1]

[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  $\oplus$  represent?

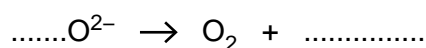
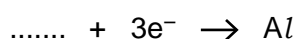
Put a tick ( $\checkmark$ ) in the box next to the best answer.

- 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.



[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.

.....

.....

..... [3]

[Total: 6]

16

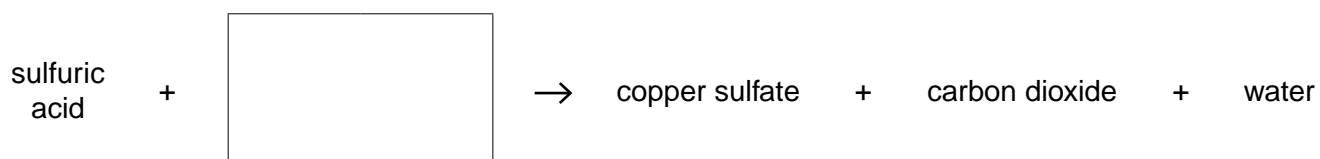
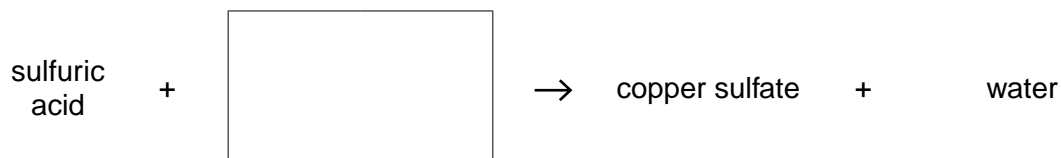
7 (a) Two different copper compounds react with sulfuric acid to make copper sulfate.

Complete the word equations.

Choose from this list.

**copper carbonate    copper chloride    copper oxide**

**copper nitrate    copper sulfate**



[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	$\text{Cu}^{2+}$	$\text{Cl}^-$	
copper sulfate	$\text{Cu}^{2+}$		$\text{CuSO}_4$
copper hydroxide	$\text{Cu}^{2+}$		$\text{Cu}(\text{OH})_2$

[2]



17

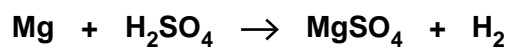
(c) Eve makes some magnesium sulfate by reacting magnesium with sulfuric acid.

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.



Relative mass of Mg = 24 g

Mass of Mg used in experiment = 2.4 g

Mass of  $\text{MgSO}_4$  made = ..... g [2]

[Total: 6]



19

(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**



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# The Periodic Table of the Elements

	1	2	3	4	5	6	7	0										
	7 <b>Li</b> lithium 3	9 <b>Be</b> beryllium 4	11 <b>Na</b> sodium 11	12 <b>Mg</b> magnesium 12	13 <b>Al</b> aluminium 13	14 <b>N</b> nitrogen 7	15 <b>P</b> phosphorus 15	16 <b>O</b> oxygen 8	17 <b>Cl</b> chlorine 17	18 <b>Ar</b> argon 18								
	19 <b>K</b> potassium 19	20 <b>Ca</b> calcium 20	21 <b>Sc</b> scandium 21	22 <b>Ti</b> titanium 22	23 <b>V</b> vanadium 23	24 <b>Cr</b> chromium 24	25 <b>Mn</b> manganese 25	26 <b>Fe</b> iron 26	27 <b>Co</b> cobalt 27	28 <b>Ni</b> nickel 28	29 <b>Cu</b> copper 29	30 <b>Zn</b> zinc 30	31 <b>Ga</b> gallium 31	32 <b>Ge</b> germanium 32	33 <b>As</b> arsenic 33	34 <b>Se</b> selenium 34	35 <b>Br</b> bromine 35	36 <b>Kr</b> krypton 36
	37 <b>Rb</b> rubidium 37	38 <b>Sr</b> strontium 38	39 <b>Y</b> yttrium 39	40 <b>Zr</b> zirconium 40	41 <b>Nb</b> niobium 41	42 <b>Mo</b> molybdenum 42	43 <b>Tc</b> technetium [98]	44 <b>Ru</b> ruthenium 44	45 <b>Rh</b> rhodium 45	46 <b>Pd</b> palladium 46	47 <b>Ag</b> silver 47	48 <b>Cd</b> cadmium 48	49 <b>In</b> indium 49	50 <b>Sn</b> tin 50	51 <b>Sb</b> antimony 51	52 <b>Te</b> tellurium 52	53 <b>I</b> iodine 53	54 <b>Xe</b> xenon 54
	55 <b>Cs</b> caesium 55	56 <b>Ba</b> barium 56	57 <b>La*</b> lanthanum 57	72 <b>Hf</b> hafnium 72	73 <b>Ta</b> tantalum 73	74 <b>W</b> tungsten 74	75 <b>Re</b> rhenium 75	76 <b>Os</b> osmium 76	77 <b>Ir</b> iridium 77	78 <b>Pt</b> platinum 78	79 <b>Au</b> gold 79	80 <b>Hg</b> mercury 80	81 <b>Tl</b> thallium 81	82 <b>Pb</b> lead 82	83 <b>Bi</b> bismuth 83	84 <b>Po</b> polonium 84	85 <b>At</b> astatine 85	86 <b>Rn</b> radon 86
	[223] <b>Fr</b> francium 87	[226] <b>Ra</b> radium 88	[227] <b>Ac*</b> actinium 89	[261] <b>Rf</b> rutherfordium 104	[262] <b>Db</b> dubnium 105	[266] <b>Sg</b> seaborgium 106	[264] <b>Bh</b> bohrium 107	[277] <b>Hs</b> hassium 108	[268] <b>Mt</b> meitnerium 109	[271] <b>Ds</b> darmstadtium 110	[272] <b>Rg</b> roentgenium 111	Elements with atomic numbers 112-116 have been reported but not fully authenticated						

1 <b>H</b> hydrogen 1
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relative atomic mass atomic symbol name atomic (proton) number
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Key

\* 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.