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Oxford Cambridge and RSA

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Tuesday 9 June 2015 – 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

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

- 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 **20** 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

- 1 Jack investigates the reactions of some Group 1 and Group 2 metals with water.

He adds a small piece of each metal to water and measures how long it takes for the reaction to finish.

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

The table shows his results.

Metal	Group	Time taken for reaction to finish in s
lithium	1	35
sodium	1	12
potassium	1	5
magnesium	2	not finished after 2 minutes
calcium	2	40
strontium	2	9

- (a) What conclusions can you make from the data about the reactivity of Group 1 and Group 2 metals with water?

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..... [3]

- (b) Which of the following statements about the reactions of the Group 1 metals with water are **true** and which are **false**?

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

	True	False
The reactions make hydrogen gas.		
Each reaction makes a different metal oxide.		
The reaction mixture gains mass during every reaction.		
The pH of each solution is neutral at the end of the reaction.		

[2]

[Total: 5]

5

2 Abbi does some experiments with Group 7 elements.

Group 7

F fluorine
Cl chlorine
Br bromine
I iodine

(a) Abbi does an experiment using chlorine.

She uses a fume cupboard.

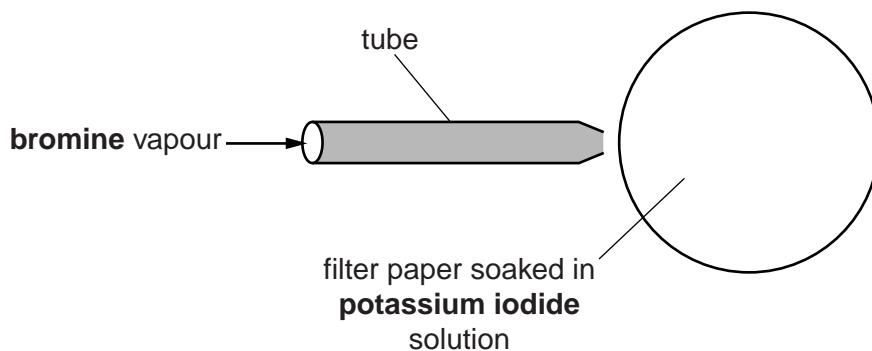
Explain why chlorine is hazardous.

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.....

..... [2]

(b) Abbi passes bromine vapour over a filter paper soaked in potassium iodide solution. Bromine vapour is blown onto the filter paper down a tube.



A grey solid appears on the filter paper because **iodine** is made.

Complete the symbol equation for this reaction.



[2]

7

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Turn over for the next question

3 Mendeleev developed the modern Periodic Table. Other scientists were involved.



Mendeleev

I have developed a new way of arranging the elements in a table.



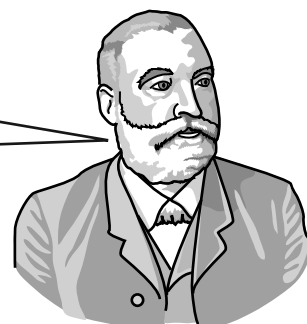
Scientist 2

There are gaps in the table and problems with the order of some elements. This does not work for all elements.



Scientist 3

I have discovered a new element. Its properties mean that it could go in one of the gaps in Mendeleev's table.



Scientist 4

I have discovered a different new element. The properties mean that it could go in a different gap.



Scientist 5

I am going to do the same experiments as Scientist 3 and Scientist 4, and look at the results.

(a) Which **two** scientists are doing a peer review?

Explain how what they say is peer review.

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

(b) Mendeleev's ideas were supported by the discoveries of **Scientist 3** and **Scientist 4**.

Explain why.

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..... [2]

[Total: 5]

10

4 Lee looks up some data about gases in the air.

Gas in the air	Formula	Relative formula mass	Boiling point in °C	Percentage in air
nitrogen	N ₂	28	-196	78
oxygen	O ₂	32	-183	21
carbon dioxide	CO ₂	44	-57	0.04
water vapour	H ₂ O	18	100	variable

(a) All of the gases in the table are covalently bonded.

Which statements describe a covalent bond?

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

Ions attract together due to their opposite charges.

The electrons between the atoms are attracted to each nucleus.

Electrons are shared between atoms.

The electrons of two atoms are attracted to each other.

Electrons are transferred from one atom to another.

[2]

(b) Lee looks at the data and writes down this idea.

I think that there is a correlation between the relative formula mass of a gas and its boiling point.

Does the data in the table support Lee's idea?

Explain your reasoning.

.....

.....

..... [3]

11

- (c) Alex also notices that there is a correlation between the relative masses of gases in the air and their percentages in air.

Gas in the air	Relative mass	Percentage in air %
nitrogen	28	78
oxygen	32	21
argon	40	1
carbon dioxide	44	0.04

Use the data in the table to explain the difference between correlation and cause.

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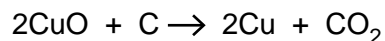
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..... [2]

[Total: 7]

5 Some metals can be extracted from metal oxides by heating with carbon.

(a) The equation shows what happens when copper oxide is heated with carbon.



(i) Which substance is oxidised and which substance is reduced in this reaction?

oxidised

reduced [1]

(ii) Name the waste gas that is made in this reaction.

..... [1]

(b) Large-scale metal extraction processes involve both costs and benefits.

(i) Companies choose metal extraction processes that use as little energy as possible.

Suggest why using less energy reduces both the **cost to the company** and the **cost to the environment**.

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..... [3]

(ii) Give **two** examples of the ways that people **benefit** from large-scale metal extraction processes.

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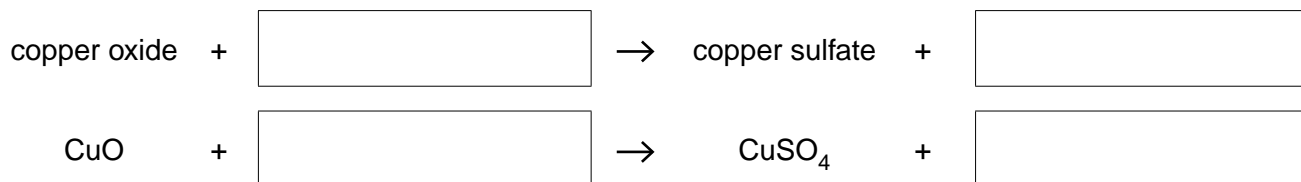
..... [2]

6 Sam works for a company that makes chemicals to kill fungi on plants.

One of the chemicals the company makes is copper sulfate.

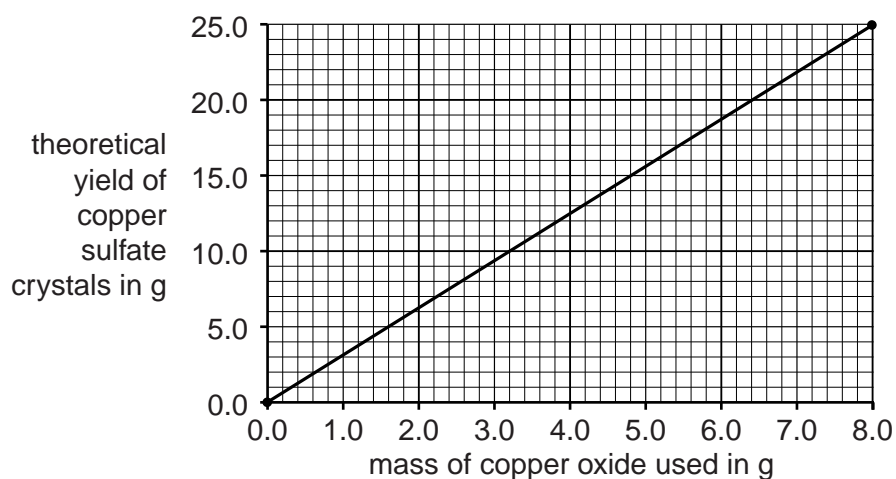
(a) Sam makes some copper sulfate by reacting copper oxide with an acid.

Complete the **word** and **symbol** equation for the reaction.



[2]

(b) Sam draws a graph to show the theoretical yield of copper sulfate crystals that can be made from copper oxide.



(i) What mass of copper oxide would Sam need to make 10g of copper sulfate crystals?

..... [1]

(ii) The company makes the fungicide in large quantities.

Use your answer to (i) to work out how much copper oxide would be needed to make 5kg of copper sulfate crystals.

..... [2]

15

- (iii) Complete the table to show the relative formula masses of copper oxide and copper sulfate.

Compound	Formula	Relative formula mass
Copper oxide	CuO	
Copper sulfate	CuSO ₄	

[2]

- (iv) Copper sulfate crystals do not only contain copper sulfate. The crystals also contain water molecules in their structure. The values on the graph take this into account.

Compare your answers to (iii) with the graph to show that the crystals do not **only** contain copper sulfate.

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

[Total: 9]

16

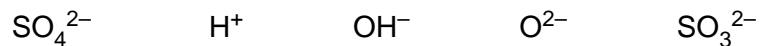
- 7 Acid rain contains a dilute solution of sulfuric acid.

Acid rain causes some lakes to become too acidic, killing fish and other wildlife.

Water companies can treat the lakes with calcium hydroxide to neutralise acidity.

- (a) Which ion causes the acidity in the lake?

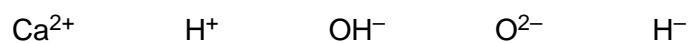
Put a (ring) around the correct answer.



[1]

- (b) Which ion in calcium hydroxide reacts to neutralise the acidity in the lake?

Put a (ring) around the correct answer.



[1]

- (c) The calcium hydroxide is dropped into the lakes from helicopters.

It is in the form of a fine powder to make sure that the reaction is as fast as possible.

Use ideas about collisions to explain why fine powders react faster than larger pieces.

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

[Total: 5]

17

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Turn over for the next question

- 8 Joe wants to find out how effective different compounds are when they are used as catalysts.

He does some experiments to find the time taken for a reaction to finish when different catalyst compounds are used.

The table shows some information about the catalysts he used and his results.

Experiment	Catalyst	Positive ion in catalyst	Negative ion in catalyst	Time taken for reaction to finish in s
1	none	none	none	45
2	sodium chloride	Na ⁺	Cl ⁻	45
3	iron chloride	Fe ²⁺	Cl ⁻	22
4	potassium chloride	K ⁺	Cl ⁻	45
5	magnesium chloride	Mg ²⁺	Cl ⁻	46
6	sodium nitrate	Na ⁺	NO ₃ ⁻	45
7	iron nitrate	Fe ²⁺	NO ₃ ⁻	22
8	potassium nitrate	K ⁺	NO ₃ ⁻	45
9	magnesium nitrate	Mg ²⁺	NO ₃ ⁻	46

Joe talks about his results with Eve and Jay.



Joe

I think that Group 1 and Group 2 elements do not work as catalysts.

I think the effectiveness of the catalyst depends on which positive ion it contains.



Eve



Jay

I think the effectiveness of the catalyst depends on which negative ion it contains.

The Periodic Table of the Elements

	1	2	3	4	5	6	7	0	
	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		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		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		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		139 La* lanthanum 57	178 Hf hafnium 72	181 Ta tantalum 73	184 W tungsten 74	197 Au gold 79	201 Hg mercury 80
				45 Sc scandium 21	48 Ti titanium 22	51 V vanadium 23	52 Cr chromium 24	59 Ni nickel 28	65 Zn zinc 30
				89 Y yttrium 39	91 Zr zirconium 40	93 Nb niobium 41	96 Mo molybdenum 42	106 Pd palladium 46	112 Cd cadmium 48
					55 Mn manganese 25	59 Co cobalt 27	59 Rh rhodium 45	108 Ag silver 47	112 Cd cadmium 48
					[98] Tc technetium 43	103 Rh rhodium 45	106 Pd palladium 46	197 Au gold 79	201 Hg mercury 80
					178 Hf hafnium 72	181 Ta tantalum 73	184 W tungsten 74	195 Pt platinum 78	201 Hg mercury 80
					[261] Rf rutherfordium 104	[262] Db dubnium 105	[266] Sg seaborgium 106	[271] Ds darmstadtium 110	[272] Rg roentgenium 111
					[264] Bh bohrium 107	[268] Mt meitnerium 109	[277] Hs hassium 108	[271] Ds darmstadtium 110	[272] Rg roentgenium 111
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