OCR
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	

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

- 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

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Question 1 begins on page 4

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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]

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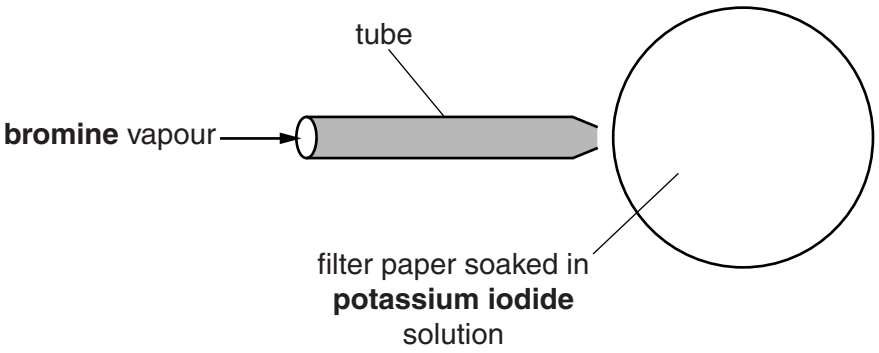
..... **[2]**

(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.

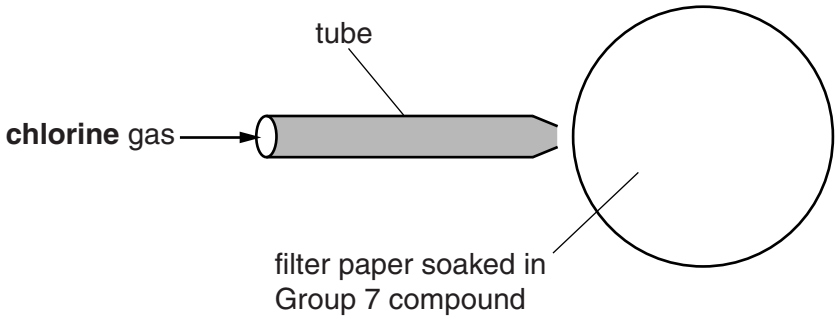
Complete the symbol equation for this reaction.

Br_2 + 2KI → [ ] + [ ]

[2]

(c) Abbi repeats the experiment using chlorine gas.

She passes chlorine gas down a tube onto filter papers soaked in some other Group 7 compounds.



The table shows which compounds she uses.

Gas	Group 7 compound on filter paper
chlorine	potassium fluoride
chlorine	potassium chloride
chlorine	potassium bromide
chlorine	potassium iodide

Before the experiment the solutions of the compounds are all colourless.

State and explain what Abbi will **see** when chlorine gas passes over each Group 7 compound.

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

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

[Total: 10]

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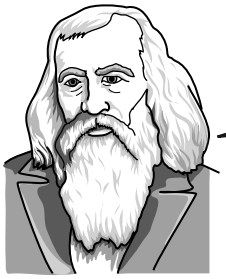
Turn over for the next question

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

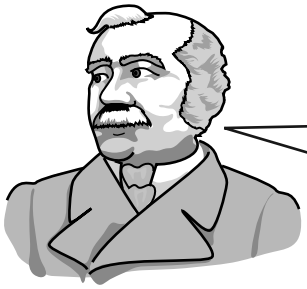


Mendeleev

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

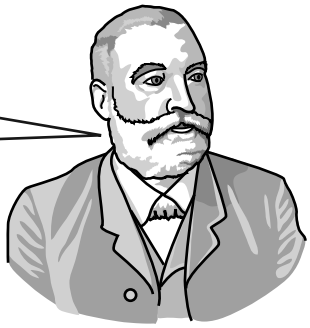
Scientist 2

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



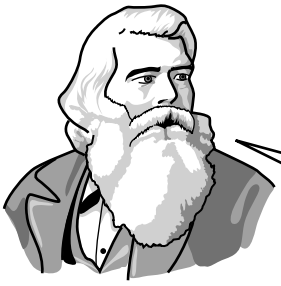
Scientist 3

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]

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_2O	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.

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

(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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..... **[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.

$$2CuO + C \longrightarrow 2Cu + CO_2$$

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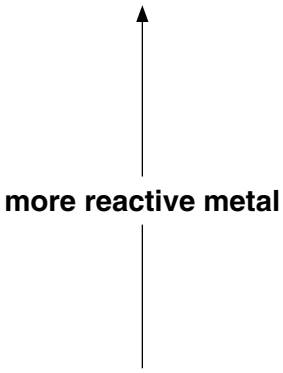
..... **[2]**

(c) The table shows some data about the most cost-effective methods for extracting metals from metal oxides.



Metal oxide	Minimum temperature to make metal by heating with carbon in °C	Most cost-effective method of extraction
calcium oxide	2100	electrolysis
magnesium oxide	1600	electrolysis
aluminium oxide	2100	electrolysis
zinc oxide	900	heating with carbon
iron oxide	700	heating with carbon
lead oxide	400	heating with carbon
copper oxide	100	heating with carbon

Use the data to explain how the method chosen to extract a metal is related to its reactivity and the energy involved.

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

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

[Total: 13]

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.

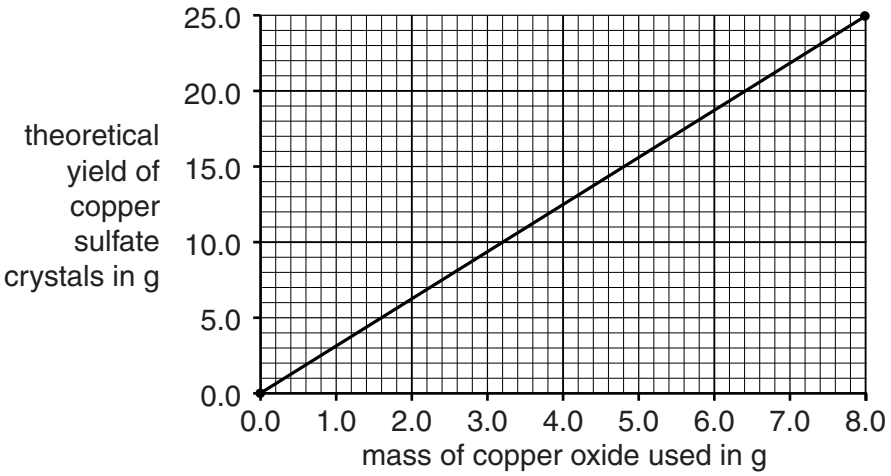
Complete the **word** and **symbol** equation for the reaction.

copper oxide + [ ] → copper sulfate + [ ]

CuO + [ ] → $CuSO_4$ + [ ]

[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 10 g 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 5 kg of copper sulfate crystals.

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

(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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[Total: 9]

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.

SO_4^{2-} H^+ OH^- O^{2-} SO_3^{2-}

[1]

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

Put a (ring) around the correct answer.

Ca^{2+} H^+ OH^- O^{2-} H^-

[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.

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[Total: 5]

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Turn over for the next question

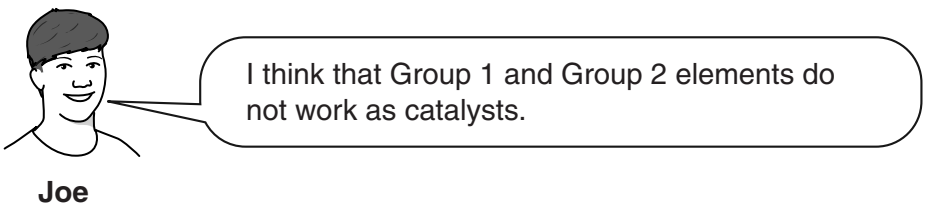
8 Joe wants to find out how effective different compounds are when they are used as catalysts.

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

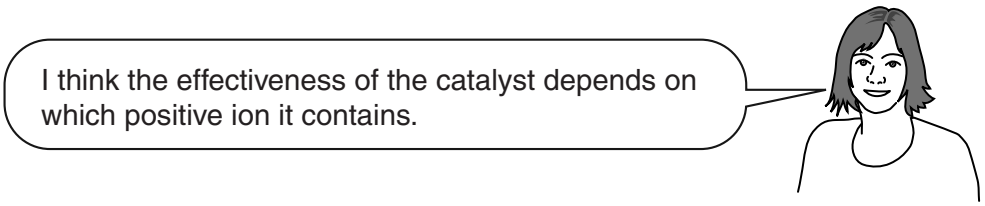
The table shows some information about the catalysts he used and his results.

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

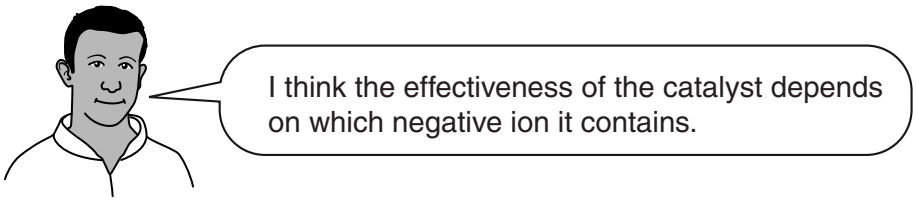
Joe talks about his results with Eve and Jay.



Joe



Eve



Jay

Discuss whether or not the results in the table support the ideas of Joe, Eve and Jay.

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

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[Total: 6]

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.