OCR
Oxford Cambridge and RSA

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Tuesday 9 June 2015 – Afternoon

GCSE TWENTY FIRST CENTURY SCIENCE CHEMISTRY A/ADDITIONAL SCIENCE A

A172/01 Modules C4 C5 C6 (Foundation 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 **24** 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

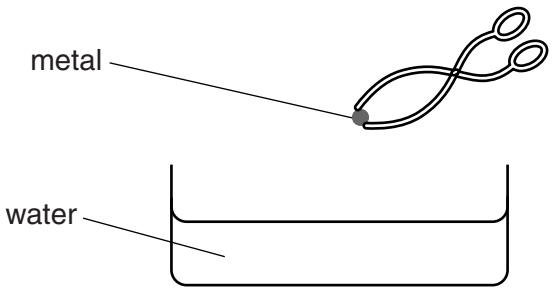
Tests for ions with a negative charge

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

Answer **all** the questions.

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

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



Jack does experiments using lithium, sodium and potassium.

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

The table shows his results.

Metal	**Time taken for the reaction to finish in s**
lithium	35
sodium	12
potassium	5

(a) What does the table show about the reactivity of the Group 1 metals?

Explain your answer.

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.....

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

(b) Jack adds a small piece of potassium to water in a beaker.
He adds some Universal Indicator to the water.
He uses a thermometer to measure the temperature change during the reaction.
He writes down his observations.

Draw straight lines to connect each **observation** with the correct **reason**.

Observation	Reason
Universal Indicator turns blue.	A flammable gas is made.
A flame appears around the potassium.	The reaction is exothermic.
The temperature of the water increases.	Potassium has a very low density.
Potassium stays on the surface of the water.	An alkali is made.

[2]

(c) Potassium is stored in oil.

Jack leaves a piece of potassium out of the oil for a few minutes.
He notices that the shiny surface of the potassium becomes dull very quickly.

What is the potassium reacting with?

Put a (ring) around the correct answer.

hydrogen **oxygen** **nitrogen** **chlorine**

[1]

[Total: 5]

2 Abbi does some experiments to investigate the reactivity of Group 7 elements.

Group 7

F fluorine
Cl chlorine
Br bromine
I iodine

(a) For safety, Abbi does all of the experiments in a fume cupboard. Why is this necessary?

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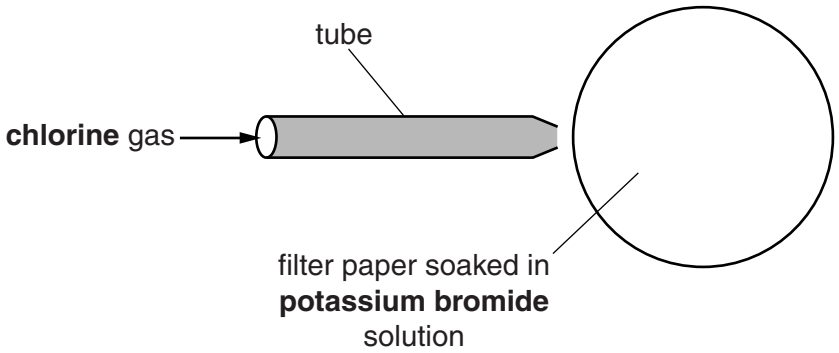
..... **[1]**

(b) Abbi passes chlorine gas over a filter paper soaked in potassium bromide solution. Chlorine gas is blown onto the filter paper down a tube.



The filter paper goes orange because bromine is made.

(i) Complete the word equation for this reaction.

chlorine + potassium bromide → bromine + potassium ……..

[1]

(ii) What is the name for this type of reaction?

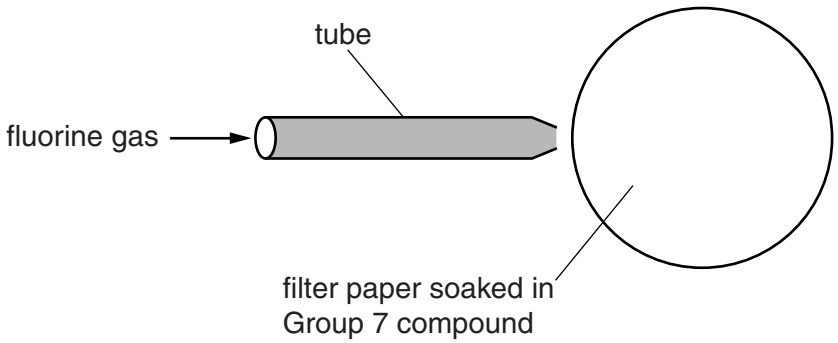
Put a (ring) around the correct answer.

combustion **displacement** **electrolysis** **neutralisation**

[1]

(c) Abbi does some experiments using fluorine.

She passes fluorine gas down a tube onto the filter papers.



The table shows her results.

Gas	Compound on filter paper	Colour change
fluorine	potassium chloride	paper goes pale green
fluorine	potassium bromide	paper goes orange
fluorine	potassium iodide	grey solid appears on paper

Explain why these colour changes happen.

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

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

[Total: 9]

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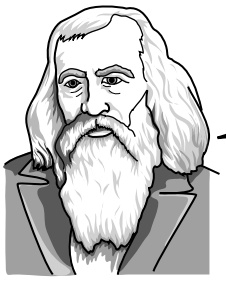
Turn over for the next question

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

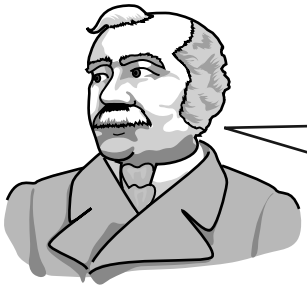


Mendeleev

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

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

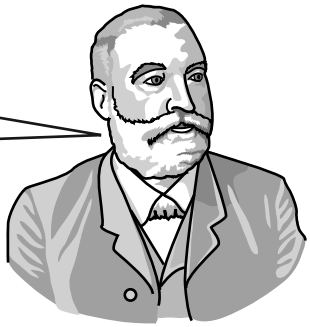
Scientist 2



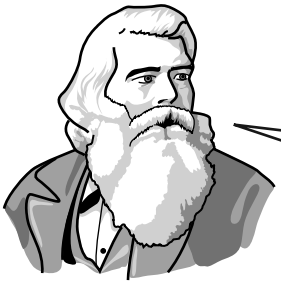
Scientist 3

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

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



Scientist 4



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 Liz collects some samples of rock.

She thinks that the samples contain limestone.

(a) Limestone rock is mainly calcium carbonate.

Liz tests the rock. She adds dilute acid and tests the gas given off using limewater.

What results does Liz expect if the rock contains **carbonate** ions? (See data sheet, page 2)

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

A blue precipitate is made. ☐

The rock turns yellow. ☐

The acid turns red. ☐

The limewater turns milky. ☐

Carbon dioxide is produced. ☐

[1]

(b) Limestone is a solid mineral.

In which part of the Earth are solid minerals found?

Put a (ring) around the correct answer.

atmosphere **hydrosphere** **lithosphere**

[1]

(c) On Earth, limestone only forms in large amounts of water.

Scientists have sent space probes to Mars.

The space probes test rock on Mars to see if it contains limestone.

So far no limestone has been found.

Explain why the scientists are interested in collecting data about limestone on Mars.

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

[Total: 4]

5 Lee looks up some data about some molecular substances.

Substance	Formula	Relative formula mass	State at room temperature
nitrogen	N_2	28	.....
oxygen	.....	32	gas
carbon dioxide	CO_2	44	gas
water	H_2O	18	liquid

(a) Complete the table by filling in the blank spaces. **[2]**

(b) All of the substances in the table are **molecular**.

What does molecular mean?

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

many ions bonded together ☐

a large structure of identical atoms ☐

a small number of atoms bonded together ☐

a structure of protons and electrons ☐

[1]

(c) Lee looks at the data and has this idea.

> I think that if a molecular substance has a relative formula mass of less than 100 it is always a gas.

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

Explain your reasoning.

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

[Total: 6]

6 Metals can be extracted from metal oxides by heating with carbon.

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

copper oxide + carbon ⟶ copper + carbon dioxide

Why is this a reduction reaction?

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

Too much carbon dioxide is made. ☐

The copper oxide loses oxygen. ☐

The mass gets higher. ☐

The process is not very efficient. ☐

[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.

Why does using less energy reduce the **cost to the company** and the **cost to the environment**?

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

Using less energy uses less fuel. ☐

Some fuels are less flammable than others. ☐

All fuels burn to give off energy. ☐

Using more fuel gives off more pollutant gases. ☐

Different types of fuel can be used for the process. ☐

[2]

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

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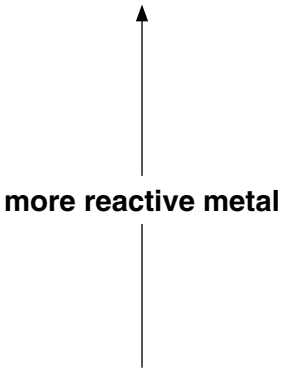
..... **[2]**

(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: 11]

7 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 from copper oxide.

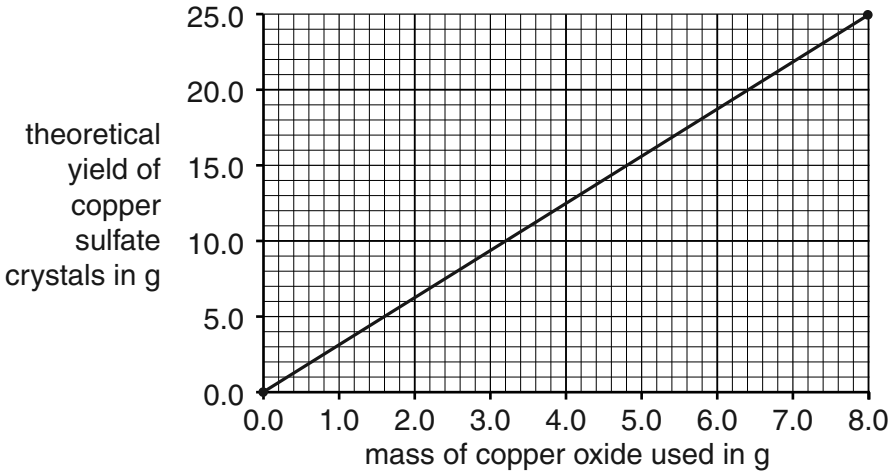
Complete the **word** and **symbol** equation for the reaction.

copper oxide + [ ] → copper sulfate + water

CuO + H_2SO_4 → $CuSO_4$ + [ ]

[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) In practice, Sam finds that he makes a lower mass of copper sulfate crystals than he predicts.

Which statements can explain why this happens?

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

There are impurities in the copper oxide.	☐
Sam adds too much acid.	☐
Sam has not dried his crystals thoroughly.	☐
Some chemicals are lost during the experiment.	☐
The rate of the reaction was too fast.	☐

[2]

[Total: 7]

8 Acid rain contains a dilute solution of sulfuric acid.

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

(a) What can be used to measure acidity?

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

a gas syringe	☐
Universal Indicator	☐
a measuring cylinder	☐
a pH meter	☐

[1]

(b) A water company treats a lake with calcium hydroxide to neutralise acidity.

What is the pH when the water is neutral?

Put a ring around the correct answer.

1 **4** **7** **9** **14**

[1]

(c) The water company measures the temperature of the surface of the lake after neutralisation.

They find that the temperature has increased.

Why do some reactions cause an increase in temperature?

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

Some reactions give out energy.	☐
Some reactions are endothermic.	☐
Reactions need energy to start.	☐
Reactions are faster at higher temperatures.	☐

[1]

(d) The calcium hydroxide is dropped into the lake from a helicopter.

The calcium hydroxide is a fine powder and not large pieces.

What effect does using a fine powder rather than large pieces have on the rate of the reaction?

Explain your answer.

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

[Total: 5]

9 Joe does some experiments to investigate the rate of a reaction.

(a) He measures the time taken for the reaction to finish at different temperatures.

Temperature in °C	Time taken for reaction to finish in s
20	45
30	25
40	15
50	8

Explain what the results show about the rate of reaction.

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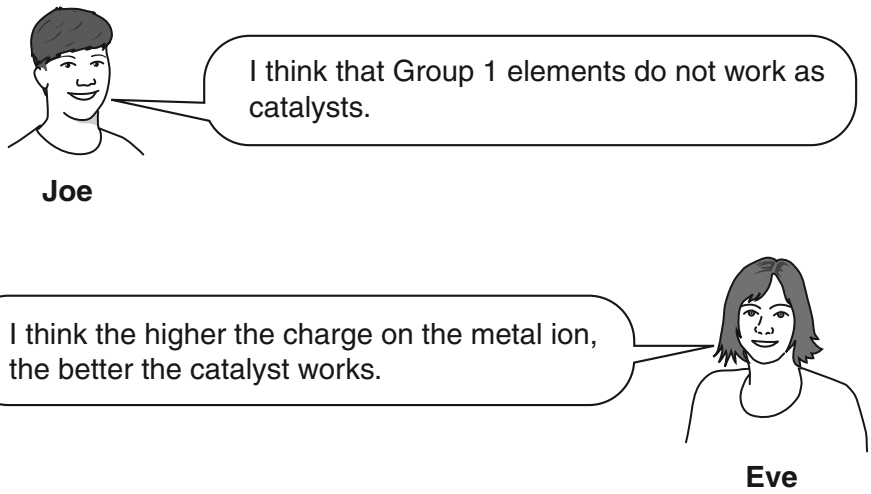
..... **[2]**

(b) Joe investigates the effect of some catalysts on the reaction.
He writes down which metal ion is in each catalyst.

He measures the time taken for the reaction to finish when each catalyst is used.

	Experiment	Metal ion in catalyst	Formula	Time taken for reaction to finish in s
	1	no catalyst		45
Group 1 elements	2	sodium	Na^+	45
	3	potassium	K^+	45
Other elements	4	cobalt	Co^{2+}	15
	5	iron	Fe^{3+}	22

Joe talks about his results with Eve.



Do the results in the table support the ideas of Joe and Eve? Explain your answer.

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

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[Total: 8]

END OF QUESTION PAPER

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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.