



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:

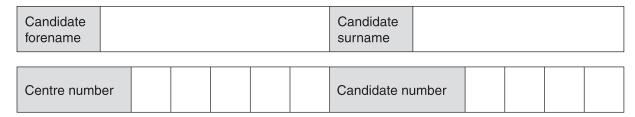
None

Other materials required:

- Pencil
- Ruler (cm/mm)

**Duration:** 1 hour





### **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.



### 2

# TWENTY FIRST CENTURY SCIENCE DATA SHEET

# Qualitative analysis

# Tests for ions with a positive charge

Ion	Test	Observation
calcium Ca <sup>2+</sup>	add dilute sodium hydroxide	a white precipitate forms; the precipitate does not dissolve in excess sodium hydroxide
copper Cu <sup>2+</sup>	add dilute sodium hydroxide	a light blue precipitate forms; the precipitate does not dissolve in excess sodium hydroxide
iron(II) Fe <sup>2+</sup>	add dilute sodium hydroxide	a green precipitate forms; the precipitate does not dissolve in excess sodium hydroxide
iron(III) Fe <sup>3+</sup>	add dilute sodium hydroxide	a red-brown precipitate forms; the precipitate does not dissolve in excess sodium hydroxide
zinc Zn <sup>2+</sup>	add dilute sodium hydroxide	a white precipitate forms; the precipitate dissolves in excess sodium hydroxide

# Tests for ions with a negative charge

lon	Test	Observation	
carbonate CO <sub>3</sub> <sup>2-</sup>	add dilute acid	the solution effervesces; carbon dioxide gas is produced (the gas turns lime water from colourless to milky)	
chloride C <i>l</i> <sup>-</sup>	add dilute nitric acid, then add silver nitrate	a white precipitate forms	
bromide Br <sup>-</sup>	add dilute nitric acid, then add silver nitrate a cream precipit		
iodide I <sup>-</sup>	add dilute nitric acid, then add silver nitrate	a yellow precipitate forms	
sulfate SO <sub>4</sub> <sup>2-</sup>	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?
	[3]
(b)	Which of the following statements about the reactions of the Group 1 metals with water are <b>true</b> and which are <b>false</b> ?

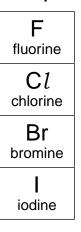
Put a tick (✓) in one box in each row.

	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]

2 Abbi does some experiments with Group 7 elements.

### **Group 7**



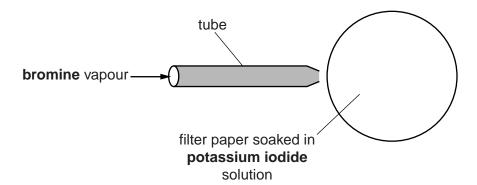
(a) Abbi does an experiment using chlorine.

She uses a fume cupboard.

Explain why chlorine is hazardous.

[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.

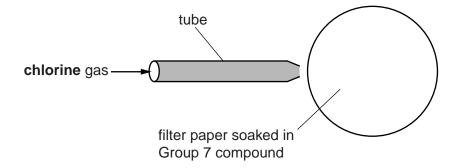
Complete the symbol equation for this reaction.



6

(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.			
	•		
[6			

[Total: 10]

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Turn over for the next question

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



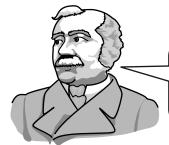
I have developed a new way of arranging the elements in a table.

Mendeleev

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



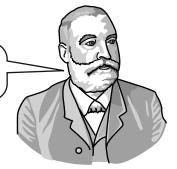
Scientist 2



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

Scientist 3

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



Scientist 4



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

Scientist 5

(a)	Which <b>two</b> scientists are doing a peer review?
	Explain how what they say is peer review.
	[3]
(b)	Mendeleev's ideas were supported by the discoveries of <b>Scientist 3</b> and <b>Scientist 4</b> .
	Explain why.
	[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 <sub>2</sub>	28	-196	78
oxygen	02	32	-183	21
carbon dioxide	CO <sub>2</sub>	44	<b>-</b> 57	0.04
water vapour	H <sub>2</sub> O	18	100	variable

		•					l
(a)	All of the	gases in	the table are c	ovalently bonded.			
	Which sta	tements	describe a cov	alent bond?			
	Put a tick	(✓) in the	e boxes next to	the <b>two</b> correct a	answers.		
	lons	attract to	gether due to t	heir opposite cha	rges.		
	The e	electrons	between the a	toms are attracte	d to each nucleu	ıs.	
	Elect	rons are	shared betwee	en atoms.			
	The e	electrons	of two atoms a	are attracted to ea	ach other.		
	Elect	rons are	transferred fro	m one atom to an	other.		[0]
(b)	Lee looks	at the da	ata and writes	down this idea.			[2]
			that there is a confirmation of a gas and its	correlation between boiling point.	en the relative for	rmula	
	Does the	data in th	ne table suppor	t Lee's idea?			
	Explain yo	our reaso	ning.				
							[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

data in the table to explain the difference between correlation and cause.	Jse t
[2]	
[Total: 7]	

5	Some metals	can be	extracted	from	metal	oxides	by	heating	with	carbon
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(	a)	The equation	shows what	happens w	hen copper	oxide is h	eated with	carbon
٦	,							

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

		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)	Lar	ge-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.	าє
		[	3]
	(ii)	Give <b>two</b> examples of the ways that people <b>benefit</b> from large-scale metal extraction processes.	or
		[	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
4	<b>.</b>	calcium oxide	2100	electrolysis
		magnesium oxide	1600	electrolysis
more react		aluminium oxide	2100	electrolysis
	tive metal	zinc oxide	900	heating with carbon
	tive metai	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 communic	cation will be assessed in your ar	nswer.

[Total: 13]

6	Sam works for a	company that	makes chen	nicals to kill	fungi on r	olants
•	Carri Works for a	company ma	illanco olloli	inodio to mii	Turigi ori j	Jiaiito

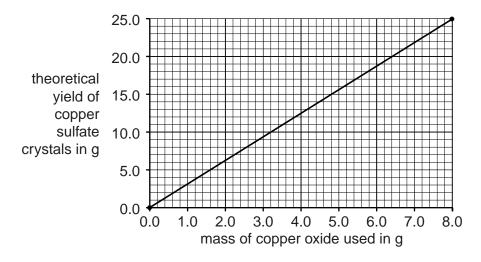
One of the chemicals the company makes is copper sulfate.

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

Complete the word and symbol equation for the reaction.

copper oxide	+	$\rightarrow$	copper sulfate	+	
CuO	+	$\rightarrow$	CuSO <sub>4</sub>	+	
					[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.



(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 <sub>4</sub>	

[2	
	4

(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 <b>only</b> contain copper sulfate.
	[2]

[Total: 9]

Acid rain contains a dilute solution of sulfuric acid.							
Acid rain causes some lakes to become too acidic, killing fish and other wildlife.							
Wa	Water companies can treat the lakes with calcium hydroxide to neutralise acidity.						
(a)	Which ion causes the acidity in the lake?						
	Put a ring arou	ut a ring around the correct answer.					
	SO <sub>4</sub>	2–	H <sup>+</sup>	OH <sup>-</sup>	O <sup>2-</sup>	SO <sub>3</sub> <sup>2-</sup>	F47
							[1]
(b)	Which ion in calc	ium hydrox	ide reacts t	o neutralise	the acidity in	the lake?	
	Put a ring around the correct answer.						
	C	a <sup>2+</sup>	H <sup>+</sup>	OH-	O <sup>2-</sup>	H-	[1]
(c)	The calcium hydroxide is dropped into the lakes from helicopters.						
	It is in the form of	the form of a fine powder to make sure that the reaction is as fast as possible.					
	Use ideas about	collisions to	explain w	hy fine powd	ers react fas	ter than larger pieces.	
							. [3]

[Total: 5]

7

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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 <sup>+</sup>	Ct-	45
3	iron chloride	Fe <sup>2+</sup>	Ct-	22
4	potassium chloride	K <sup>+</sup>	Ct-	45
5	magnesium chloride	Mg <sup>2+</sup>	Cl-	46
6	sodium nitrate	Na <sup>+</sup>	NO <sub>3</sub> -	45
7	iron nitrate	Fe <sup>2+</sup>	NO <sub>3</sub> -	22
8	potassium nitrate	K <sup>+</sup>	NO <sub>3</sub> -	45
9	magnesium nitrate	Mg <sup>2+</sup>	NO <sub>3</sub> -	46

Joe talks about his results with Eve and Jay.



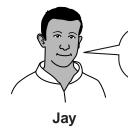
I think that Group 1 and Group 2 elements do not work as catalysts.

Joe

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



Eve



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

[Total: 6]

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.
 [6]

### **END OF QUESTION PAPER**



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# The Periodic Table of the Elements

				20			
0	4 He	20 Ne	40 <b>Ar</b> argon 18	84 Kr krypton 36	131 Xe xenon 54	[222] <b>Rn</b> radon 86	t fully
7		19 F fluorine 9	35.5 Ct chlorine 17	80 Br bromine 35	127 <b>I</b> iodine 53	[210] At astatine 85	orted but no
9		16 0 oxygen 8	32 S sulfur 16	79 Se selenium 34	128 Te tellurium 52	[209] Po polonium 84	ve been repo
2		14 N nitrogen 7	31 P phosphorus 15	75 As arsenic 33	122 Sb antimony 51	209 Bi bismuth 83	s 112-116 hav authenticated
4		12 C carbon 6	28 Si silicon 14	73 Ge germanium 32	119 <b>Sn</b> tin 50	207 <b>Pb</b> lead 82	mic numbers a
3		11 <b>B</b> boron 5	27 At aluminium 13	70 <b>Ga</b> gallium 31	115 In indium 49	204 T <b>t</b> thallium 81	Elements with atomic numbers 112-116 have been reported but not fully authenticated
	·			65 <b>Zn</b> zinc 30	112 Cd cadmium 48	201 Hg mercury 80	Eleme
				63.5 Cu copper 29	108 <b>Ag</b> silver 47	197 <b>Au</b> gold 79	[272] Rg roentgenium 111
				59 Ni nickel 28	106 Pd palladium 46	195 Pt platinum 78	[271] Ds damstadtium 110
				59 <b>Co</b> cobalt 27	103 <b>Rh</b> rhodium 45	192 <b>Ir</b> iridium 77	[268] Mt meitnerium 109
	1 H hydrogen 1			56 Fe iron 26	101 <b>Ru</b> ruthenium 44	190 Os osmium 76	[277] Hs hassium 108
				55 Mn manganese 25	[98] Tc technetium 43	186 Re rhenium 75	[264] <b>Bh</b> bohrium 107
		mass ool number		52 Cr chromium 24	96 Mo molybdenum 42	184 W tungsten 74	[266] Sg seaborgium 106
	Key	relative atomic mass atomic symbol name atomic (proton) number		51 V vanadium 23	93 Nb niobium 41	181 Ta tantalum 73	[262]
		relati <b>at</b> c atomic		48 Ti titanium 22	91 Zr zirconium 40	178 Hf hafnium 72	[261] Rf rutherfordium 104
				45 Sc scandium 21	89 Y yttrium 39	139 La* Ianthanum 57	[227] Ac* actinium 89
2		9 Be beryllium 4	24 Mg magnesium 12	40 Ca calcium 20	88 Sr strontium 38	137 <b>Ba</b> barium 56	[226] <b>Ra</b> radium 88
_		7 Li Iithium 3	23 Na sodium 11	39 K potassium 19	85 <b>Rb</b> rubidium 37	133 Cs caesium 55	[223] Fr francium 87

\* 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.