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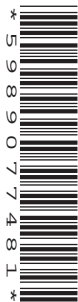
Wednesday 15 June 2016 – Afternoon

**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. If additional space is required, you should use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- 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

3

Answer **all** the questions.

- 1 In 1864, a chemist called John Newlands had an idea of arranging the elements in order, depending on their chemical properties.

He called his idea the 'Law of Octaves'.

- (a) Newlands put elements with similar properties together.

He put lithium, sodium and potassium together.

Give **two** ways that the properties of lithium, sodium and potassium are similar.

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.....

.....

..... [2]

- (b) The table shows Newlands' arrangement of some of the elements.

He put elements with similar properties into the same row of his table.

Row			
1	^1H	^{19}F	$^{35.5}\text{Cl}$
2	^7Li	^{23}Na	^{39}K
3	^9Gl	^{24}Mg	^{40}Ca
4	^{11}Bo	^{27}Al	^{52}Cr
5	^{12}C	^{28}Si	^{48}Ti
6	^{14}N	^{31}P	^{55}Mn
7	^{16}O	^{32}S	^{56}Fe

- (i) The symbols that Newlands used for some of the elements are different to those on the Periodic Table today.

The numbers shown with each symbol give the atomic mass of each element.

What symbols do we use today for the elements ^9Gl and ^{11}Bo in Newlands' table?

^9Gl ^{11}Bo [2]

(ii) Nina and Marty discuss Newlands' table.



Nina

All of the elements in row 2 are in Group 1 of the Periodic Table.
I think the rows in Newlands' table match up with groups in the Periodic Table.



Marty

That is only partly true. For example row 5 of Newlands' table only partly matches a group in the Periodic Table.

Explain why Marty is right. Use elements in row 5 to support your answer.

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..... [2]

(iii) Newlands' table does not include any elements from one of the groups in the Periodic Table.

Identify the missing group and suggest why Newlands could not include these elements in his table.
Use the Periodic Table to help you.

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

5

- (c) Newlands' arrangement was based on putting the elements in order of their relative atomic masses.

Mendeleev improved Newlands' arrangement.
Mendeleev reversed the order of some elements and left gaps.
His arrangement worked for more elements.

- (i) Why did reversing the order of some elements and leaving gaps make the arrangement work for more elements?

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

- (ii) What decides the order of elements in the Periodic Table today?

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

the number of neutrons in the atom

the proton number

the type of bonds the elements form

the relative atomic mass

[1]

[Total: 11]

6

2 Joe collects some samples of a mineral.

He thinks the mineral contains Group 1 elements.

He looks up the flame colours and the emission spectra for some Group 1 elements.

Element	Flame colour	Emission spectrum
lithium	red	
sodium	very strong yellow-orange	
potassium	pale purple	
rubidium	purple	

He does a flame test and records the emission spectrum produced by the mineral.

These are his results.

	Flame colour	Emission spectrum
mineral	yellow-orange	

What conclusions can you make about which elements the mineral **does** and **does not** contain? Give your reasons and explain why neither the flame test nor the emission spectra data can be used to identify **all** of the elements in the mineral. [6]

7



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

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[Total: 6]

8

3 The table gives some information about the elements in Group 7.

(a) Complete the table by filling in the missing information.

Element	Normal state at room temperature	Colour at room temperature
fluorine	gas	pale yellow
chlorine		
bromine		
iodine		grey

[2]

(b) Which statements about the atoms of the elements in Group 7 are true?

Put ticks (✓) in the boxes next to the two correct answers.

The all have the same number of electron shells.

They all have the same number of outer shell electrons.

They all form ions with the same charge.

They all have the same charge on the nucleus.

They all form ions by losing electrons.

[2]

(c) Group 7 elements are *diatomic*.

What does this mean?

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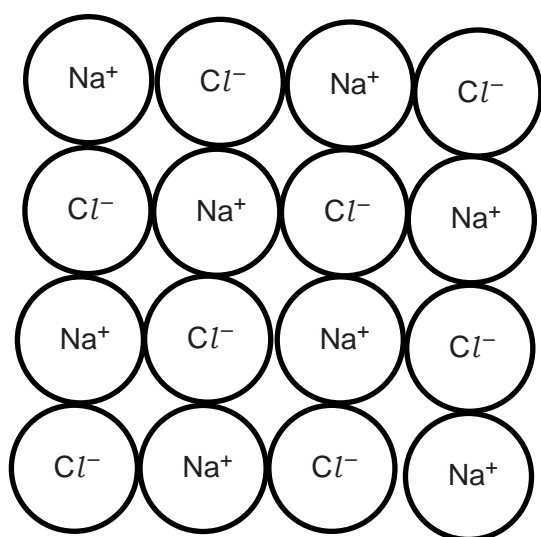
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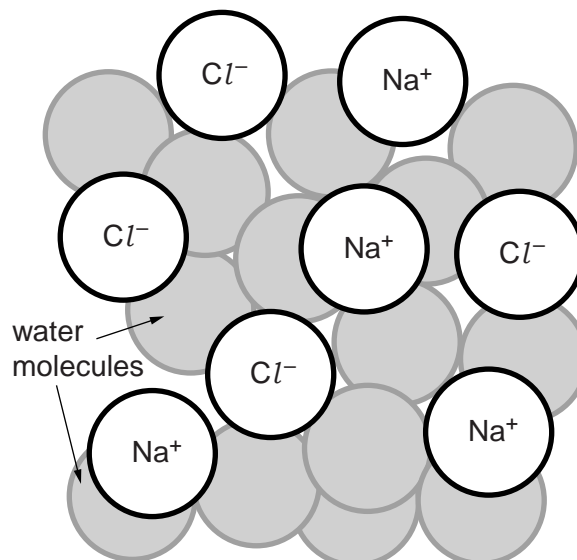
4 Sodium chloride is the main compound in common salt.

(a) Solid salt has very different properties compared to salt dissolved in water.

These diagrams show the structures of solid salt and salt dissolved in water (salt solution).



solid salt



salt solution

State and explain how the properties and structure of solid salt change when it dissolves in water, using ideas from the diagrams to support your answer.



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

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..... [6]

- (b) Salt is put on roads in winter because it lowers the freezing point of water.

Liz does some experiments to investigate whether salt can be used to stop water from freezing in extreme weather conditions.

She adds different masses of salt to 100cm^3 of water and records the temperature when the water freezes.

Here are her results.

Mass of salt added to 100cm^3 water in g	Freezing point in $^{\circ}\text{C}$
0.0	0
5.0	-3
10.0	-6
15.0	-9

Liz talks about her results.



My data shows that there is a relationship between the freezing point and the mass of salt added.

I can use this data to predict how much salt I need to add to water to stop it freezing at -30°C .

- (i) What is the relationship shown in this data between the mass of salt added and the freezing point?

.....

.....

..... [2]

- (ii) Use the relationship to predict how much salt would need to be added to 100cm^3 of water to lower the freezing point to -30°C .

Show your working.

[2]

- (c) Liz does some more experiments using two higher masses of salt.

These are her results.

Mass of salt added to 100 cm ³ water in g	Freezing point in °C
25.0	-15
35.0	-5

- (i) Liz thinks that these results do not fully match predictions made based on the trend in the previous table.

Explain why she is right.

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 [3]

- (ii) Liz wants to investigate the relationship between mass of salt and the freezing point of water when she adds up to 50.0g of salt.

Describe what experiments she should do.

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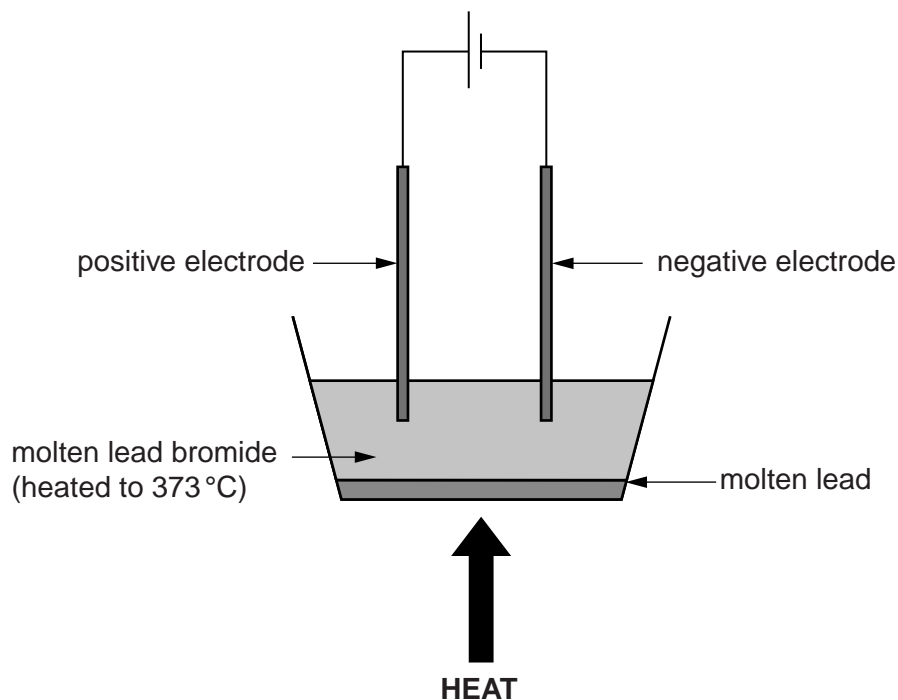
 [3]

[Total: 16]

12

- 5 The melting point of lead bromide is 373 °C.

Molten lead bromide can be electrolysed using this apparatus.



- (a) During the electrolysis lead forms at one electrode.
The lead collects as a liquid at the bottom of the container.

What does this tell you about the melting point of lead?

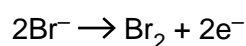
.....
..... [1]

- (b) At which electrode would you expect lead to form?
Explain your reasoning.

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

- (c) The formula for lead bromide is PbBr_2 .

This is the half equation that shows what happens to the bromide ions during the electrolysis.



Write a half equation to show what happens to the lead ions during the electrolysis.

[2]

[Total: 4]

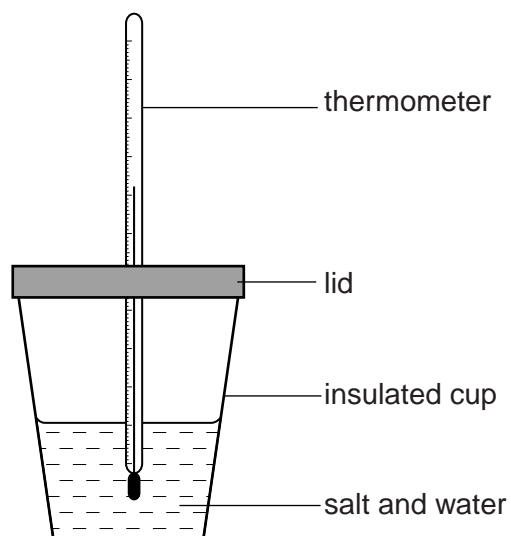
13

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14

- 6 Rose investigates the energy changes when three salts dissolve in water. She adds the same amount of each salt to the same amount of water. She measures the maximum temperature change when each salt dissolves.



The table shows her results.

Salt	Temperature change in °C	Type of energy change
lithium chloride	+7.0	exothermic
sodium chloride	-0.5	endothermic
potassium chloride	-4.0	endothermic

16

- 7 Matt finds out some information about the bonding in some compounds and the ions that they produce when they dissolve in water. He dissolves the compounds in water and tests their pH values.

The table shows his results.

Compound	Bonding in compound	When dissolved in water		
		Positive ion	Negative ion	pH
sodium hydroxide	ionic	sodium	hydroxide	14
calcium bromide	ionic	calcium	bromide	7
ammonia	covalent	ammonium	hydroxide	9
hydrogen chloride	covalent	hydrogen	chloride	1
ethanoic acid	covalent	hydrogen	ethanoate	3
calcium hydroxide	ionic	calcium	hydroxide	12
citric acid	covalent	hydrogen	citrate	3

- (a) Which compounds in the table are acidic?
Put a tick (✓) in the boxes next to each correct answer.

sodium hydroxide	<input type="checkbox"/>
calcium bromide	<input type="checkbox"/>
ammonia	<input type="checkbox"/>
hydrogen chloride	<input type="checkbox"/>
ethanoic acid	<input type="checkbox"/>
calcium hydroxide	<input type="checkbox"/>
citric acid	<input type="checkbox"/>

[1]

- (b) Matt looks at the information and puts forward this idea.

I can identify the alkalis from their pH values.
I think all alkalis are ionic and one of the ions they produce is always the same.

Does the data support Matt's ideas?

Explain your reasoning.

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..... [2]

- (c) Draw straight lines to show the state of pure ethanoic acid and pure citric acid at room temperature.

ethanoic acid

solid

citric acid

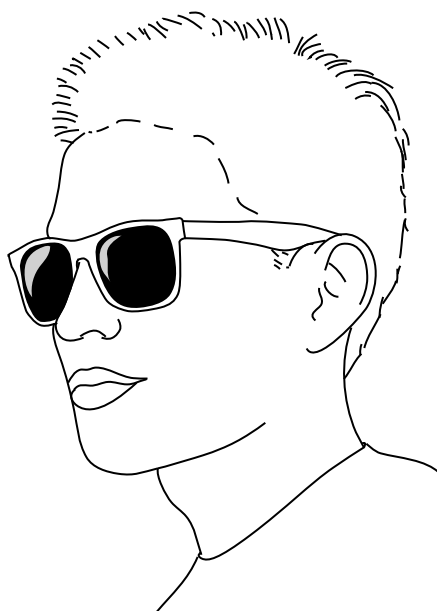
liquid

gas

[2]

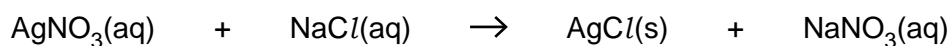
[Total: 5]

- 8 Silver chloride is a salt that is used to make lenses that darken in bright light.



- (a) Silver chloride can be made from silver nitrate in a precipitation reaction.

This is the symbol equation for the reaction.



- (i) Explain how this equation shows that silver chloride forms as a precipitate.

.....
 [1]

- (ii) Write a word equation for the reaction.

[1]

- (b) When light shines on silver chloride, AgCl , a solid forms which makes the lenses go dark.

The solid is silver metal.

Suggest the name of the **other** element that forms in the reaction.

..... [1]

19

- (c) Silver chloride is made using precipitation.
Sodium chloride can be made using titration. Sodium chloride is a soluble salt.

What techniques are needed to produce pure, dry samples of solid silver chloride and solid sodium chloride?

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

Technique	Needed for silver chloride	Needed for sodium chloride	Needed for both
filtration of reaction mixture			
heating strongly to evaporate water			
leaving in a warm oven			

[3]

[Total: 6]

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).

A large area of lined paper for writing answers. It features a vertical margin line on the left side and horizontal dotted lines for writing. The lines are evenly spaced and extend across the width of the page.

A series of horizontal dotted lines for writing, with a vertical solid line on the left side. The lines are evenly spaced and extend across most of the page width.

The page contains a vertical solid line on the left side, creating a margin. The rest of the page is filled with horizontal dotted lines spaced evenly down the page, intended for handwriting practice.

A large area of the page is reserved for writing, featuring a vertical solid line on the left side and horizontal dotted lines extending across the page.



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The Periodic Table of the Elements

	1	2	3	4	5	6	7	0										
	7 Li lithium 3	9 Be beryllium 4	11 Na sodium 11	12 C carbon 6	13 Al aluminium 13	14 N nitrogen 7	15 O oxygen 8	16 F fluorine 9	18 Ar argon 18									
	19 K potassium 19	20 Ca calcium 20	21 Sc scandium 21	22 Ti titanium 22	23 V vanadium 23	24 Cr chromium 24	25 Mn manganese 25	26 Fe iron 26	27 Co cobalt 27	28 Ni nickel 28	29 Cu copper 29	30 Zn zinc 30	31 Ga gallium 31	32 Ge germanium 32	33 As arsenic 33	34 Se selenium 34	35 Br bromine 35	36 Kr krypton 36
	37 Rb rubidium 37	38 Sr strontium 38	39 Y yttrium 39	40 Zr zirconium 40	41 Nb niobium 41	42 Mo molybdenum 42	43 Tc technetium 43	44 Ru ruthenium 44	45 Rh rhodium 45	46 Pd palladium 46	47 Ag silver 47	48 Cd cadmium 48	49 In indium 49	50 Sn tin 50	51 Sb antimony 51	52 Te tellurium 52	53 I iodine 53	54 Xe xenon 54
	55 Cs caesium 55	56 Ba barium 56	57 La* lanthanum 57	72 Hf hafnium 72	73 Ta tantalum 73	74 W tungsten 74	75 Re rhenium 75	76 Os osmium 76	77 Ir iridium 77	78 Pt platinum 78	79 Au gold 79	80 Hg mercury 80	81 Tl thallium 81	82 Pb lead 82	83 Bi bismuth 83	84 Po polonium 84	85 At astatine 85	86 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						

1	H hydrogen 1
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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.