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Monday 25 June 2012 – Afternoon

GCSE TWENTY FIRST CENTURY SCIENCE CHEMISTRY A

A172/02 Modules C4 C5 C6 (Higher Tier)

A135370612

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

A172021

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

- Your 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.
- The Periodic Table is printed on the back page.
- A list of qualitative tests for ions is printed on page 2.

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 Rubidium is an element in Group 1.

Find rubidium on the Periodic Table.

(a) Which of the following statements about rubidium are **true** and which are **false**?

Put a tick (✓) in the correct box for each statement.

	true	**false**
Rubidium is more reactive than sodium.	☐	☐
Rubidium is a non-metal.	☐	☐
Rubidium has a lower proton number than lithium.	☐	☐
Rubidium reacts with water to make hydrogen gas.	☐	☐

[2]

(b) The formula of lithium hydroxide is LiOH.

What is the formula of rubidium hydroxide?

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

[Total: 3]

2 **(a)** The table shows data about the physical properties of some elements.

Element	Appearance at room temperature	Melting point in °C	Boiling point in °C	Does the element conduct electricity?
Chlorine	green gas	–101	–34	no
Bromine	red-brown liquid	–7	59	no
Iodine	dark grey solid	114	184	no
Lithium	shiny solid	180	1342	yes
Sodium	shiny solid	97.8	883	yes
Potassium	shiny solid	63.5	759	yes

Mendeleev put these elements into two groups in the Periodic Table.

He used their similarities and differences to put lithium, sodium and potassium in one group.

He put chlorine, bromine and iodine into another group.

Discuss which data in the table **support**, and which data **do not support**, Mendeleev's idea of organising these elements into the two groups.

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

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

(b) Sodium and potassium are both in Group 1 of the Periodic Table.

Give one similarity and one difference between the arrangement of electrons in an atom of sodium and an atom of potassium.

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

[Total: 8]

3 The table below shows the number of protons and electrons in five particles, **A**, **B**, **C**, **D** and **E**.

Each particle is either an atom or an ion.

Particle	Number of protons	Number of electrons
A	3	3
B	9	9
C	3	2
D	8	10
E	17	17

(a) Use the letters **A**, **B**, **C**, **D** and **E**, to answer the following questions.

(i) Which two particles are atoms from Group 7 of the Periodic Table?

answer ..... and .....**[1]**

(ii) Which two particles are an atom and an ion of the same element?

answer ..... and .....**[1]**

(iii) Which particle is a negative ion?

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

(b) Particle **C** is an ion.

What is the overall charge on particle **C**?

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

[Total: 4]

4 Liz cuts a piece of sodium with a knife.

(a) When first cut, the surface of the sodium is very shiny.

Describe and explain how the appearance of the sodium changes over the next few minutes.

.....

.....

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

(b) Liz reacts sodium (Na) with chlorine (Cl_2) to make sodium chloride.

sodium + chlorine $\longrightarrow$ sodium chloride

Write a balanced symbol equation for this reaction.

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

[Total: 5]

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Question 5 begins on page 8

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5 Four gases that are in the air are nitrogen, oxygen, argon and carbon dioxide.

(a) Draw a straight line to connect the **name** of each gas to the correct **arrangement of atoms and its relative mass**.

name	arrangement of atoms and its relative mass
nitrogen	 relative mass = 32
oxygen	 relative mass = 40
argon	 relative mass = 44
carbon dioxide	 relative mass = 28

[2]

(b) Which of the following statements about gases in the air are **true**?

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

All of the gases in the air are elements. ☐

Air contains only non-metal elements. ☐

There are weak attractions between molecules in air. ☐

All the gases have high melting points and boiling points. ☐

The gases are good conductors of electricity. ☐

[2]

(c) Molecules in the air contain atoms that are held together by strong covalent bonds.

Which of the following statements are the **best** descriptions of covalent bonds in these molecules?

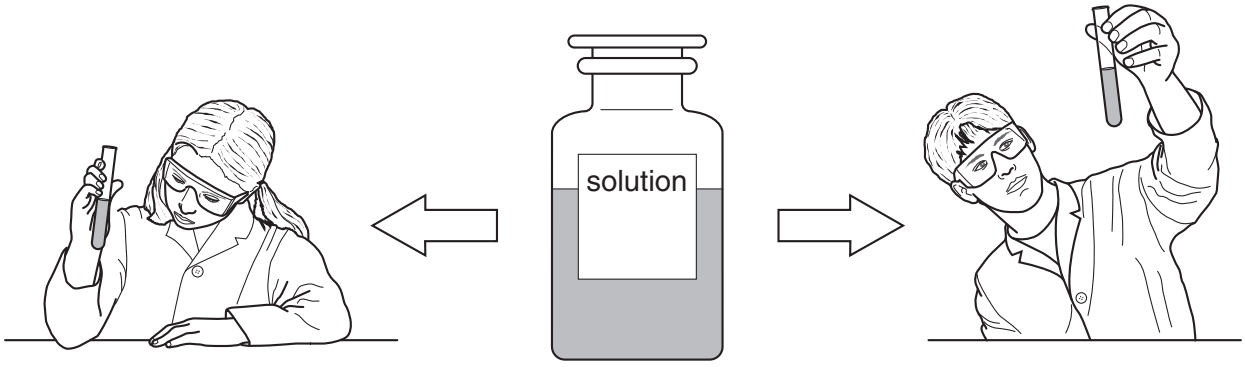
Put ticks (✓) in the boxes next to the **two** best answers.

A covalent bond is made by sharing electrons.	☐
The atoms gain positive or negative charges when the bond is made.	☐
The atoms are held together by the attractions between the nuclei of the atoms and the electrons between them.	☐
Each atom is surrounded by a sea of electrons that can move.	☐
The atoms are bonded covalently into large, three dimensional structures.	☐

[2]

[Total: 6]

6 Amy and Zak test samples of the same solution.



Amy **Zak**

They do tests to identify the positive metal ions and the negative ions in the solution.

They use a fresh sample for each test.

The boxes show the tests they use and their results.

Amy's results

Test	Result
Add a few drops of dilute sodium hydroxide.	white precipitate
Acidify and add dilute silver nitrate.	white precipitate
Acidify and add dilute barium chloride.	white precipitate

Conclusion

The solution contains a mixture of calcium sulfate and calcium chloride.

Zak's results

Test	Result
Add a few drops of dilute sodium hydroxide…	white precipitate
…then add more dilute sodium hydroxide.	precipitate dissolves
Acidify and add dilute silver nitrate.	white precipitate

Conclusion

The solution only contains zinc chloride.

11

Use the data sheet on page 2 to help you answer this question.

Amy and Zak's teacher tells them that **neither** of their conclusions are fully correct.

Look at Amy and Zak's tests and their results.

Explain why neither Amy or Zak has a fully correct conclusion.

Identify the correct metal and non-metal ions in the solution.

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

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

[Total: 6]

7 Jed and Kay live near a lead mine.

The mineral massicot is dug out of this mine.

Massicot contains lead oxide, PbO.

Lead metal can be extracted from massicot by heating it with carbon.

$$2PbO + C \rightarrow 2Pb + CO_2$$

(a) What is the maximum mass of lead that can be extracted from 446 g of lead oxide?

Use the Periodic Table on page 20 to find the relative atomic masses.

Start by working out the relative formula mass of lead oxide.

relative formula mass of lead oxide, PbO = ...

mass of lead that can be extracted from 446 g lead oxide = ... g
[3]

(b) The lead mine produces millions of tonnes of lead ore.

Jed and Kay are talking about the advantages and disadvantages of living near the lead mine.

Jed

The lead mine affects the surrounding area because they have to blast out 10 tonnes of rock to get less than a tonne of lead ore.

Kay

Yes, but the lead mine employs many local people.

(i) Kay has just moved into the area. She has a young family.

Give one **advantage** and one **disadvantage** to Kay of living near a lead mine.

.....

.....

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

(ii) Jed and Kay talk about lead processing at the mine.

Jed

Some waste from processing lead ore is toxic. I think we should close the mine until the process can be made completely safe.

Kay

I don't agree about closing the mine because ...

Suggest reasons that Kay could give for **not** closing the mine.

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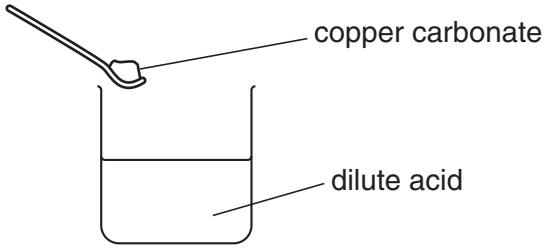
..... **[2]**

[Total: 7]

8 Sue reacts copper carbonate with a dilute acid to make copper chloride.



(a) Complete the word and symbol equations for the reaction by filling in the empty boxes.

copper carbonate + [ ] → copper chloride + carbon dioxide + [ ]

$CuCO_3$ + $2HCl$ → $CuCl_2$ + CO_2 + [ ]

[2]

(b) Which other chemicals react with the same dilute acid to form copper chloride?

Put (rings) around the **two** correct answers.

copper hydroxide **copper nitrate** **copper oxide** **copper sulfate**

[1]

(c) **(i)** Sue measures the pH during the reaction.

Describe and explain how the pH changes during the reaction.

.....

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

(ii) What could Sue use to measure the pH?

Put ticks (✓) in the boxes next to **each** correct answer.

sodium hydroxide ☐

pH meter ☐

litmus ☐

universal indicator ☐

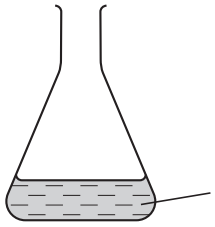
[1]

[Total: 6]

9 Alex wants to use a titration method to make some potassium sulfate.

(a) Alex begins by measuring 25.0 cm^3 of dilute potassium hydroxide into a flask.

He reacts the potassium hydroxide with dilute sulfuric acid.



Alex does titrations to find out the volume of acid that exactly reacts with the 25.0 cm^3 dilute potassium hydroxide.

Describe in detail how Alex does the titrations.

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

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

(b) (i) Alex makes a solution of potassium sulfate in his titration.

Alex makes crystals from his solution. He makes 4.5 g of potassium sulfate crystals.

This is 90% of his theoretical yield.

What is his **theoretical** yield?

Put a (ring) around the correct answer.

0.05% **4.05 g** **5 g** **9 g** **10%** **45%**

[1]

(ii) Alex did not dry his crystals properly.

His crystals contained 1.0 g of water.

Calculate Alex's percentage yield after he has dried his crystals properly.

percentage yield = ... % **[2]**

(c) Alex's friend Ben does a similar experiment.

He starts with the same volume (25.0 cm^3) of the same concentration of potassium hydroxide solution.

He neutralises this with a **more dilute** solution of acid.

(i) What factor is Ben changing in his experiment?

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

(ii) What effect will changing this factor have on the mass of potassium sulfate crystals that Ben makes?

Explain your reasoning.

.....

.....

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

(d) Alex does some more experiments. He reacts dilute sodium hydroxide with hydrochloric acid.

He measures how much hydrochloric acid he needs to neutralise 20 cm^3 of dilute sodium hydroxide.

He tests different concentrations of hydrochloric acid.

He uses the **same concentration of sodium hydroxide** every time.

The table shows some of Alex's results.

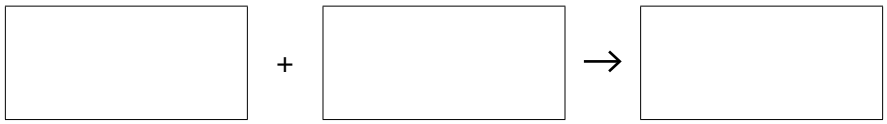
Concentration of hydrochloric acid in g/dm^3	**Volume of hydrochloric acid needed to neutralise 20 cm^3 sodium hydroxide in cm^3**
10.0	80.0
20.0	
40.0	20.0
	13.3
80.0	10.0

(i) Complete the table by filling in the two empty boxes. **[2]**

(ii) Complete the ionic equation for the reaction that happens during neutralisation.

Choose formulae from this list.

H^+ H_2 OH^- H_2O O^{2-} O_2



[1]

[Total: 15]

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.