

Tuesday 22 January 2013 – Morning

**GCSE TWENTY FIRST CENTURY SCIENCE
CHEMISTRY 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

MODIFIED LANGUAGE



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 **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 writes down data about some elements in Group 7.

Element	Formula of molecule	Normal physical state (room temperature 20 °C)	Melting point in °C	Boiling point in °C
fluorine	F ₂	gas	–220	–188
chlorine	Cl ₂	gas	–101	–35
bromine	Br ₂	liquid	–7	–59
iodine	I ₂	solid	114	184

Jack has made a mistake. One of the boiling points is wrong.

- (a) Which boiling point in the table is wrong?

Explain how you made your choice.

.....

 [2]

- (b) Estimate the correct value for the boiling point.

..... °C [1]

- (c) Astatine is another element in Group 7 of the Periodic Table.

What is the formula for a **molecule** of astatine?

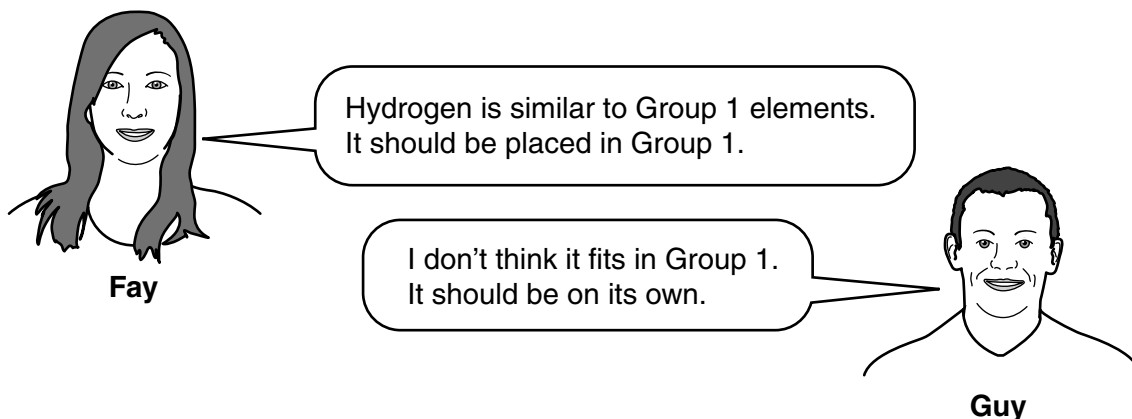
..... [1]

[Total: 4]

- 2 The table shows some information about the element hydrogen.

Properties of hydrogen	
State at room temperature	gas
Type of element	non-metal
Atomic number	1
Number of electrons in outer shell of an atom	1
Maximum number of electrons the outer shell can hold	2
Ion	H ⁺
Formula of chloride	HCl
Reactivity	Very flammable. Reacts with both metals and non-metals. Does not react with water.

(a) Fay and Guy are discussing where hydrogen fits in the Periodic Table.



Use information in the table and your knowledge of Group 1 elements to evaluate the ideas of Fay and Guy.



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

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..... [6]

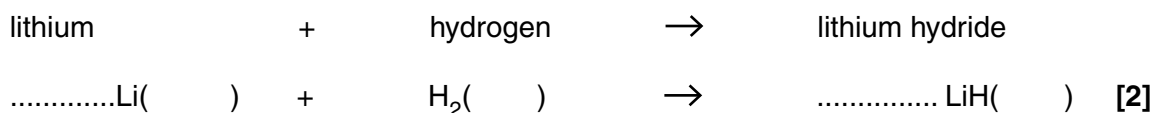
(b) Hydrogen gas reacts with lithium at high temperatures to make lithium hydride.

- (i) At the high temperatures of the reaction, **lithium is a liquid** and **lithium hydride is a solid**.

The equation shows the reaction of lithium with hydrogen.

Fill in the missing **state symbols** and **balance** the equation for the reaction.

The state symbols should match the state of the chemicals at the **high temperatures of the reaction**.



- (ii) The formula for lithium hydride is LiH.

Lithium ions have a charge of +1.

What is the formula of a hydride ion?

Put a (ring) around the correct answer.

H ²⁻	H ⁻	H ₂ ⁻	H ²⁺	H ⁺	H ₂ ⁺	[1]
-----------------	----------------	-----------------------------	-----------------	----------------	-----------------------------	-----

- (iii) Another compound has the formula CaH₂.

What is the name of this compound?

..... [1]

[Total: 10]

3 Arsenic can be used to treat some cancers.

Ben wants to analyse a mineral to see if it contains arsenic.

He looks at a table of flame colours for some elements.

Element	Flame colour
arsenic	blue
barium	green
calcium	red
copper	blue
potassium	purple
sodium	yellow

(a) Ben talks about what a flame test could show.



Ben

I can use these flame colours to show that there is no calcium or sodium in the mineral.

The flame colour will not prove that the mineral contains arsenic.

Explain why what Ben says is true.

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.....

.....

..... [3]

(b) Ben finds an image of the line spectrum of arsenic.

Line spectrum of arsenic



Ben

I will take a line spectrum from the mineral. I expect it to show that the mineral contains arsenic and other elements.

How can Ben use a line spectrum to show that the mineral contains arsenic **and** other elements?

..... [2]

(c) Ben finds out that arsenic is in Group 5 of the Periodic Table.

Some arsenic atoms have different atomic structures to other arsenic atoms.

The table shows information about two different arsenic atoms.

	Relative atomic mass	Number of protons	Number of neutrons	Number of electron shells
arsenic-75	75	33	42	4
arsenic-73	73	33	40	4

How does the table show that the two atoms are the same element?

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

Both atoms have similar relative atomic masses.

☐

Arsenic-75 has two more neutrons than arsenic-73.

☐

Both atoms have the same number of protons.

☐

The number of electron shells is the same.

☐

[1]

[Total: 6]

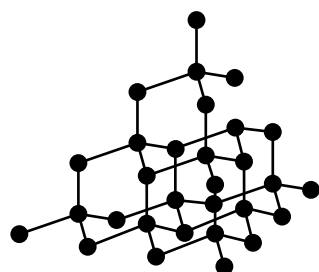
- 4 Sam does some research about the properties of diamond and graphite.

The table shows what he finds out.

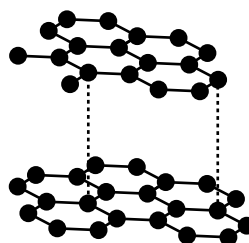
	Diamond	Graphite
Melting point in °C	3560	3650
Boiling point in °C	4830	4830
Solubility in water	insoluble	insoluble
Electrical conductivity	does not conduct	good conductor
Hardness	very hard	soft, flakes easily

Sam notices that some of the properties are similar and some are different.

He finds diagrams that show the structures of diamond and graphite.



diamond



graphite

The table shows some similarities and differences in the **properties** of diamond and graphite.

Use ideas about their **structures** to explain these similarities and differences.



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

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..... [6]

[Total: 6]

- 5 Zoe works for a mining company. The company extracts copper from two different minerals.

They use the minerals cuprite, Cu_2O , and chalcocite Cu_2S .

Zoe works out the percentage mass of copper in cuprite. It is 88.8%.
She uses this formula:

$$\text{percentage mass of copper} = \frac{\text{total mass of copper in gram formula mass (g)}}{\text{gram formula mass of compound (g)}} \times 100\%$$

- (a) (i) Calculate the percentage mass of copper in chalcocite, Cu_2S .

Give your answer to **three** significant figures.

..... % [3]

- (ii) Use your answer to (i) to work out how much copper can be extracted from 1 kg of pure chalcocite.

..... kg [1]

- (b) The minerals are transported from the mine to be processed to make copper.

Zoe thinks about the environmental harm caused by transporting each mineral.



I think that we should use minerals with higher percentages of copper.
Transporting these minerals causes less environmental harm.

Do you agree with Zoe?

Explain your answer.

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

[Total: 6]

6 Read the information about the atmosphere of some planets.

Planet Atmospheres

Other planets do not have the same atmosphere as Earth. Venus has an atmosphere that is mainly **carbon dioxide** with about 4% **nitrogen**. The atmosphere on Jupiter is mainly **hydrogen**, with about 10% **helium**. The atmospheres on both planets contain very small amounts of other gases.

(a) Using the gases named in the information, complete the table below.

Description	Name of gas
A gas whose molecules have a relative formula mass of 2.	
A gas that is a compound.	
A gas that consists of single atoms.	

[3]

(b) The atmospheres contain molecular substances.

What are the properties of molecular substances?

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

They do not conduct electricity.

☐

They all have boiling points above room temperature.

☐

They form crystals at room temperature.

☐

They have low melting points.

☐

They are hard and strong.

☐

[2]

(c) The atoms in a hydrogen molecule are held together by a covalent bond.

Which statements are **true** for the hydrogen molecule?

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

The nuclei of the two atoms are attracted together.

☐

Electrons are attracted together to form a bond.

☐

The nuclei of the two atoms repel each other.

☐

The nucleus of each atom attracts the shared electrons.

☐

The electrons repel the nuclei away from each other.

☐

[2]

[Total: 7]

7 Alex adds dilute hydrochloric acid to solid calcium carbonate.

He sees that the reaction makes bubbles of gas.



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

calcium
carbonate

+

hydrochloric
acid

→

+

+

+

2HCl

→

CaCl_2

+

+

[3]

- (c) The results of the experiments in part (b) confirm that the reaction is faster with more concentrated acid.

Why does this happen?

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

More concentrated acids have larger acid particles.

☐

At higher concentrations there are more particles in the same volume.

☐

Collision rate increases when particles are closer together.

☐

Higher concentrations of acid split the calcium carbonate to give a bigger surface area.

☐

Reactions are faster when particles have less energy.

☐

[2]

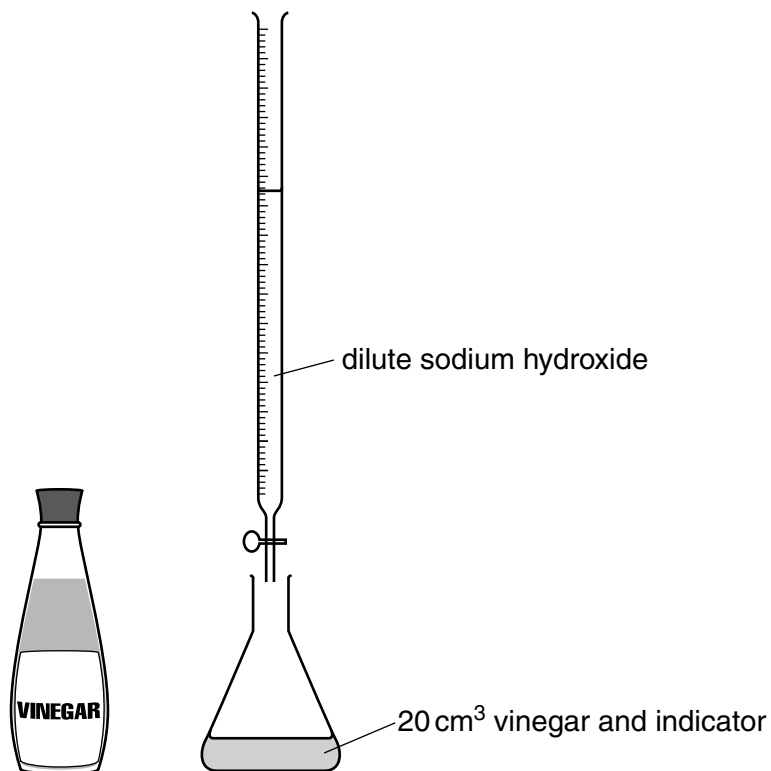
[Total: 11]

17
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Question 8 begins on page 18
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- 8 Some students do titrations to find out the concentration of acid in vinegar.

The diagram shows the equipment they use.



Each student does a first titration then repeats the titration several times.

- (a) Each student calculates an average result from their repeats.

The first titration result is **not** used to calculate the average.

Which statement best explains why?

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

The first result is usually lower than the others.

The first titration is done without an indicator.

The students do not follow the method carefully the first time.

The first result is used to give a rough idea of the volume needed.

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[1]

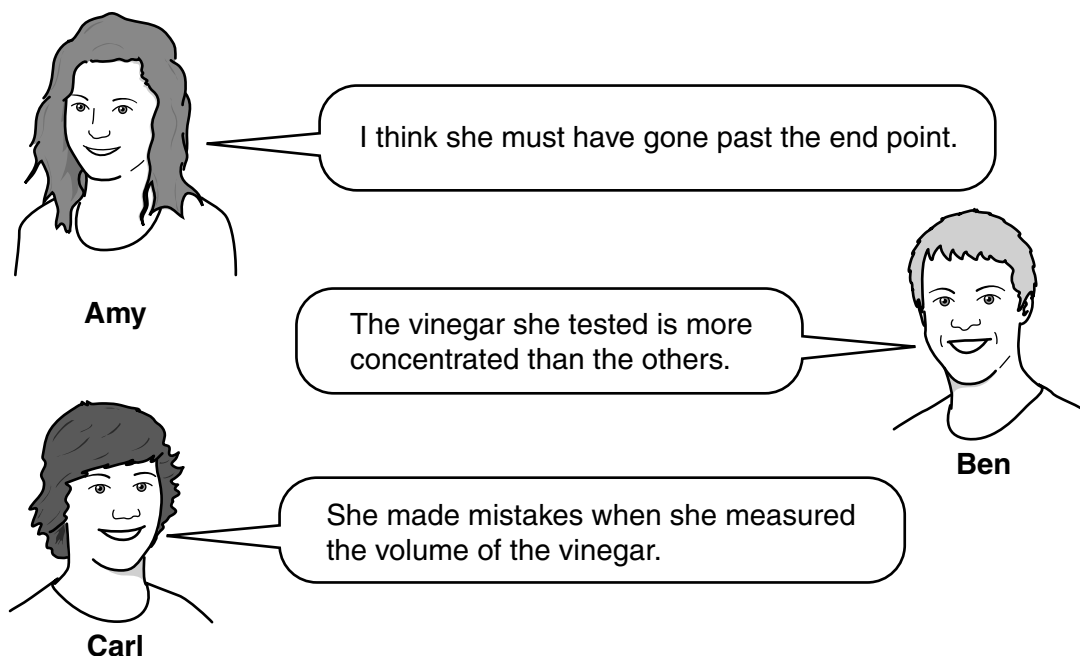
- (b) All students test vinegar from the same bottle and use the same concentration of sodium hydroxide.

The students record their average results in a table.

Name of student	Average volume of sodium hydroxide used in cm ³
Amy	23.4
Ben	24.1
Carl	23.8
Dee	18.2

The students notice that Dee's result is very different from the others.

They suggest explanations for this.



Which student has the best explanation for Dee's result?

Explain why you **agree** or **disagree** with the ideas suggested by each student.

Best explanation

Reasoning.....

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[3]

(c) The acid in the vinegar reacts with the sodium hydroxide.

In the reaction, **hydrogen ions** react with **hydroxide ions**.

Complete the equation for this reaction by filling in the boxes.

Choose formulae from the list.

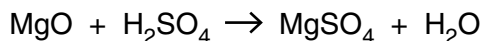


[2]

[Total: 6]

- 9 Magnesium sulfate is used in some medicines.

Magnesium sulfate can be made by reacting magnesium oxide with sulfuric acid.



The table shows the relative formula masses of some of the compounds involved in the reaction.

Compound	Relative formula mass
MgO	40
H ₂ SO ₄	
MgSO ₄	120
H ₂ O	18

- (a) Calculate the mass of sulfuric acid that reacts exactly with 5 g of magnesium oxide.

..... g [2]

- (b) Elly wants to know the maximum mass of magnesium sulfate that can be made from different amounts of magnesium oxide.

Elly works out a formula:

mass of magnesium sulfate in grams = 3 × mass of magnesium oxide in grams

Use the equation and information from the table to explain why Elly's formula works.

.....

 [2]

[Total: 4]

END OF QUESTION PAPER

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The Periodic Table of the Elements

24

1	2	Key										3	4	5	6	7	0	
		relative atomic mass atomic symbol name atomic (proton) number																
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

1	H	hydrogen	1
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* 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.