

**OXFORD CAMBRIDGE AND RSA EXAMINATIONS  
GCSE**

**A172/02**

**TWENTY FIRST CENTURY SCIENCE  
CHEMISTRY A**

**Modules C4 C5 C6 (Higher Tier)**

**TUESDAY 22 JANUARY 2013: Morning**

**DURATION: 1 hour  
plus your additional time allowance**

**MODIFIED ENLARGED 18pt**

<b>Candidate forename</b>		<b>Candidate surname</b>	
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<b>Centre number</b>						<b>Candidate number</b>				
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**Candidates answer on the Question Paper.  
A calculator may be used for this paper.**

**OCR SUPPLIED MATERIALS:**

**Periodic Table (inserted)**

**OTHER MATERIALS REQUIRED:**

**Pencil**


**Ruler (cm/mm)**

**READ INSTRUCTIONS OVERLEAF**

## **INSTRUCTIONS TO CANDIDATES**

- Write your name, centre number and candidate number in the boxes on the first page. 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).

## **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.
- An enlarged copy of the Periodic Table is inserted.
- A list of qualitative tests for ions is printed on pages 4 and 5.

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# TWENTY FIRST CENTURY SCIENCE DATA SHEET

## QUALITATIVE ANALYSIS

### TESTS FOR IONS WITH A POSITIVE CHARGE

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

## TESTS FOR IONS WITH A NEGATIVE CHARGE

Ion	Test	Observation
carbonate $\text{CO}_3^{2-}$	add dilute acid	the solution effervesces; carbon dioxide gas is produced (the gas turns lime water from colourless to milky)
chloride $\text{Cl}^-$	add dilute nitric acid, then add silver nitrate	a white precipitate forms
bromide $\text{Br}^-$	add dilute nitric acid, then add silver nitrate	a cream precipitate forms
iodide $\text{I}^-$	add dilute nitric acid, then add silver nitrate	a yellow precipitate forms
sulfate $\text{SO}_4^{2-}$	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.**

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

**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.**

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**[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	$\text{H}^+$
Formula of chloride	$\text{HCl}$
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.

**FAY**

Hydrogen is similar to Group 1 elements.  
It should be placed in Group 1.

**GUY**

I don't think it fits in Group 1.  
It should be on its own.

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]

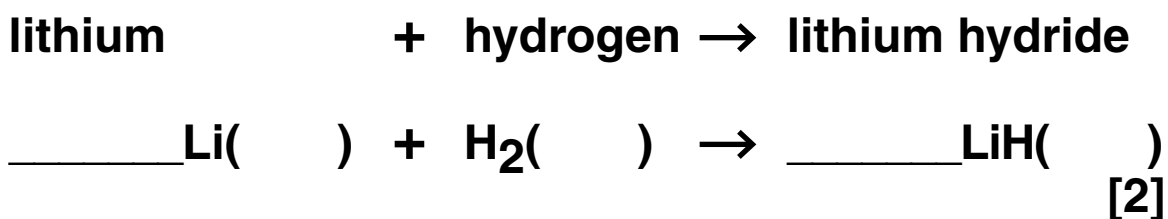
**(b) Hydrogen gas reacts with lithium at high temperatures to make lithium hydride.**

**(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.**

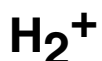
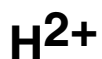
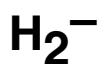
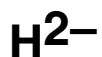


(ii) The formula for lithium hydride is LiH.

Lithium ions have a charge of +1.

What is the formula of a hydride ion?

Put a ring around the correct answer.



[1]

(iii) Another compound has the formula  $\text{CaH}_2$ .

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.**

<b>Element</b>	<b>Flame colour</b>
<b>arsenic</b>	<b>blue</b>
<b>barium</b>	<b>green</b>
<b>calcium</b>	<b>red</b>
<b>copper</b>	<b>blue</b>
<b>potassium</b>	<b>purple</b>
<b>sodium</b>	<b>yellow</b>

**(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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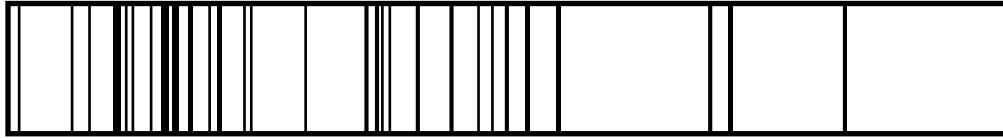
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**[3]**

**(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?**

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**[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.**

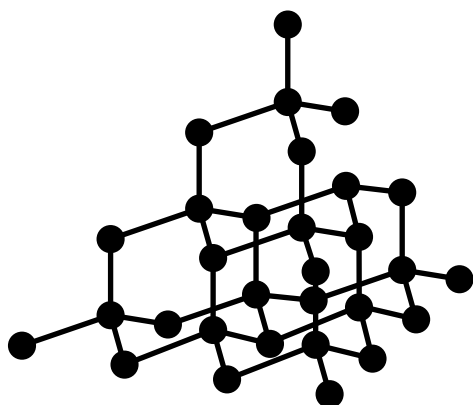
**The table shows what he finds out.**

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

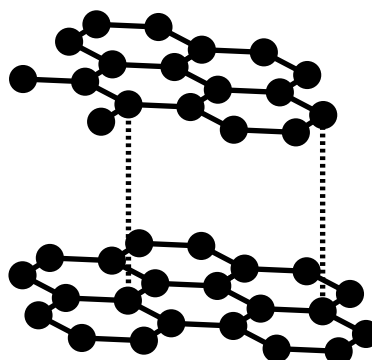
**Sam notices that some of the properties are similar and some are different.**

**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,  $\text{Cu}_2\text{O}$ , and chalcocite  $\text{Cu}_2\text{S}$ .

Zoe works out the percentage mass of copper in cuprite. It is 88.8%.

She uses this formula:

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,  $\text{Cu}_2\text{S}$ .

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.**

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**[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.**

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

**[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.** ☐

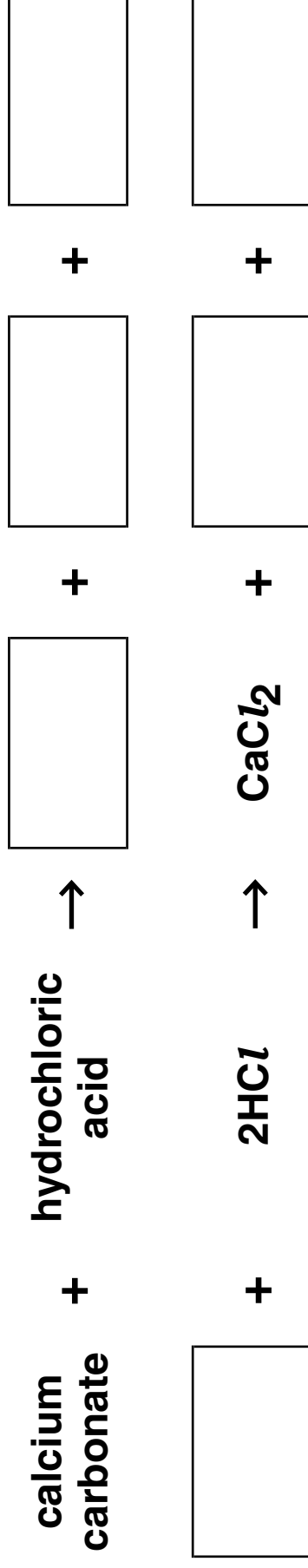
**[2]**

**[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 and symbol equations for the reaction by filling in the boxes.

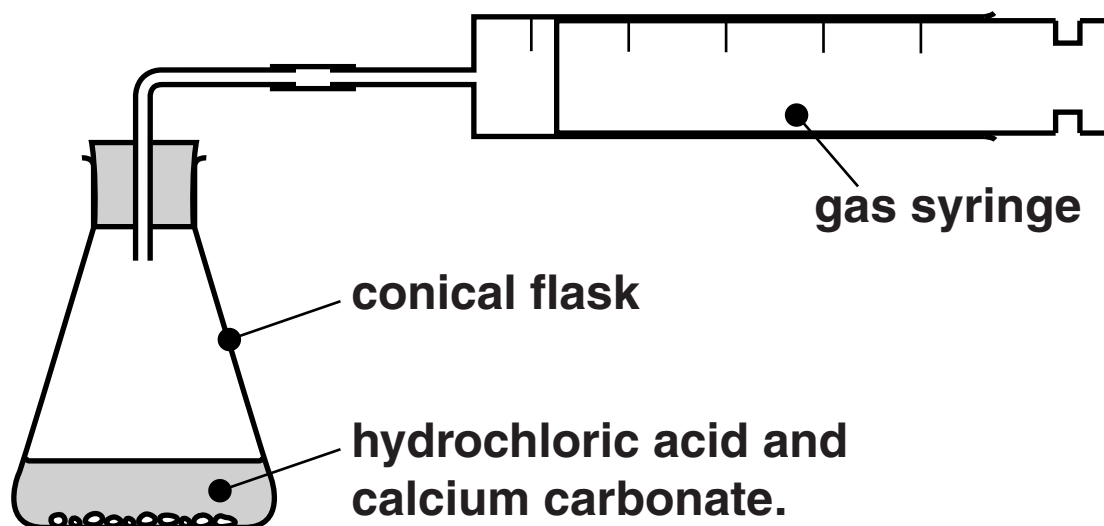


[3]

**(b) Alex predicts that the more concentrated the acid, the faster the reaction.**

**He plans some experiments to find out if his prediction is right.**

**He has this equipment.**



**He has three different concentrations of hydrochloric acid.**

Acid	Concentration
1	20 g/dm <sup>3</sup>
2	10 g/dm <sup>3</sup>
3	5 g/dm <sup>3</sup>

**Describe how Alex could use the equipment and his results to show that the more concentrated the acid, the faster the reaction.**



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

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**[6]**

- (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.**

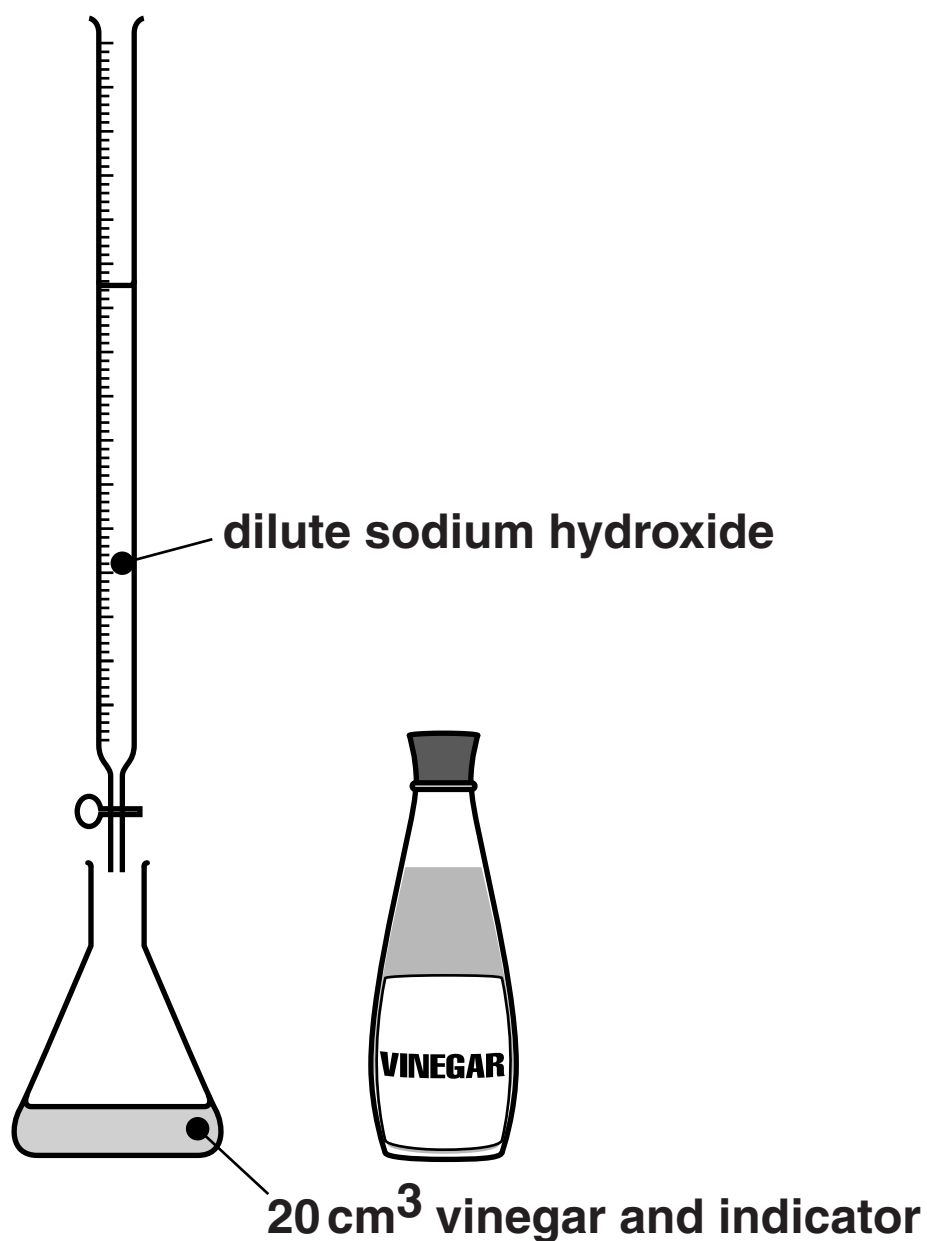
☐

**[2]**

**[TOTAL: 11]**

- 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.**

☐

**[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 <sup>3</sup>
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.

**AMY**

I think she must have gone past the end point.

**BEN**

The vinegar she tested is more concentrated than the others.

**CARL**

She made mistakes when she measured the volume of the vinegar.

**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** \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

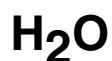
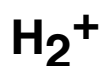
\_\_\_\_\_ **[3]**

- (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.

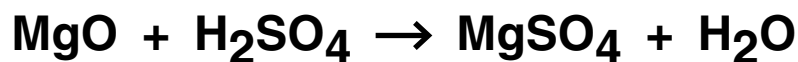


[2]

[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.**

<b>Compound</b>	<b>Relative formula mass</b>
<b>MgO</b>	<b>40</b>
<b>H<sub>2</sub>SO<sub>4</sub></b>	
<b>MgSO<sub>4</sub></b>	<b>120</b>
<b>H<sub>2</sub>O</b>	<b>18</b>

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

\_\_\_\_\_ g

**[2]**

- (b) Elly works out a formula for calculating the maximum mass of magnesium sulfate that can be made from different amounts of magnesium oxide.

Elly's formula is:

$$\begin{aligned} &\text{mass of magnesium sulfate in grams} \\ &= 3 \times \text{mass of magnesium oxide in grams} \end{aligned}$$

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

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[2]

[TOTAL: 4]

**END OF QUESTION PAPER**

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