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| Other Names         |  |  |  |  |  |                  |  |  |  |  |
| Candidate Signature |  |  |  |  |  |                  |  |  |  |  |

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| For Examiner's Use  |      |
| Examiner's Initials |      |
| Question            | Mark |
| 1                   |      |
| 2                   |      |
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| 8                   |      |
| TOTAL               |      |



General Certificate of Secondary Education  
Higher Tier  
June 2015

## Chemistry

### Unit Chemistry C3

CH3HP  
H

Thursday 14 May 2015 9.00 am to 10.00 am

**For this paper you must have:**

- a ruler
  - the Chemistry Data Sheet (enclosed).
- You may use a calculator.

**Time allowed**

- 1 hour

**Instructions**

- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- Do all rough work in this book. Cross through any work you do not want to be marked.

**Information**

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 60.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.
- Question 4(b) should be answered in continuous prose.  
In this question you will be marked on your ability to:
  - use good English
  - organise information clearly
  - use specialist vocabulary where appropriate.

**Advice**

- In all calculations, show clearly how you work out your answer.



J U N 1 5 C H 3 H P O 1

G/KL/111146/Jun15/E5

CH3HP

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Answer **all** questions in the spaces provided.

- 1** **Figure 1** shows the positions of eight elements in the modern periodic table.

**Figure 1**

| Group | 1  | 2 |  |  |  |  |    |  |    |  | 3  | 4  | 5 | 6 | 7  | 0 |  |
|-------|----|---|--|--|--|--|----|--|----|--|----|----|---|---|----|---|--|
|       | Li |   |  |  |  |  |    |  |    |  |    |    | N |   |    |   |  |
|       |    |   |  |  |  |  |    |  |    |  | Al |    |   |   |    |   |  |
|       | K  |   |  |  |  |  | Fe |  | Cu |  |    | As |   |   | Br |   |  |
|       |    |   |  |  |  |  |    |  |    |  |    |    |   |   |    |   |  |
|       |    |   |  |  |  |  |    |  |    |  |    |    |   |   |    |   |  |

Choose the correct chemical symbols from **Figure 1** to complete each sentence.

- 1 (a)** The **two** metals that react vigorously with water are ..... and .....  
[1 mark]
- 1 (b)** The element used as a catalyst in the Haber process is .....  
[1 mark]
- 1 (c)** The **two** elements with five electrons in their outer shell (highest energy level) are  
..... and .....  
[1 mark]
- 1 (d)** Iron has ions with different charges.  
The other metal that has ions with different charges is .....  
[1 mark]

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Turn over for the next question

Turn over ►



2 In 1866 John Newlands produced an early version of the periodic table.

Part of Newlands' periodic table is shown in **Figure 2**.

**Figure 2**

| Column | 1  | 2  | 3  | 4  | 5  | 6  | 7  |
|--------|----|----|----|----|----|----|----|
|        | H  | Li | Be | B  | C  | N  | O  |
|        | F  | Na | Mg | Al | Si | P  | S  |
|        | Cl | K  | Ca | Cr | Ti | Mn | Fe |

Newlands' periodic table arranged all the known elements into columns in order of their atomic weight.

Newlands was trying to show a pattern by putting the elements into columns.

2 (a) Iron (Fe) does **not** fit the pattern in column 7.

Give a reason why.

[1 mark]

.....

.....

2 (b) In 1869 Dmitri Mendeleev produced his version of the periodic table.

Why did Mendeleev leave gaps for undiscovered elements in his periodic table?

[1 mark]

.....

.....



**2 (c)** Newlands and Mendeleev placed the elements in order of atomic weight.

Complete the sentence.

**[1 mark]**

The modern periodic table places the elements in order of .....

**2 (d)** Lithium, sodium and potassium are all in Group 1 of the modern periodic table.

Explain why.

**[2 marks]**

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**3** This question is about the halogens (Group 7).

**3 (a)** How do the boiling points of the halogens change down the group from fluorine to iodine?

[1 mark]

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**3 (b)** Sodium bromide is produced by reacting sodium with bromine.

Sodium bromide is an ionic compound.

**3 (b) (i)** Write down the symbols of the **two** ions in sodium bromide.

[1 mark]

.....

**3 (b) (ii)** Chlorine reacts with sodium bromide solution to produce bromine and one other product.

Complete the word equation for the reaction.

[1 mark]

chlorine + sodium bromide  $\longrightarrow$  bromine + .....

**3 (b) (iii)** Why does chlorine displace bromine from sodium bromide?

[1 mark]

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**3 (b) (iv)** Use the Chemistry Data Sheet to help you to answer this question.

Suggest which halogen could react with sodium chloride solution to produce chlorine.

[1 mark]

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4 This question is about water.

4 (a) Rainwater is soft.

How is hard water produced from rainwater?

[2 marks]

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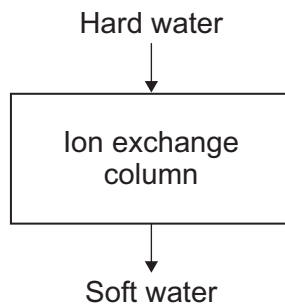
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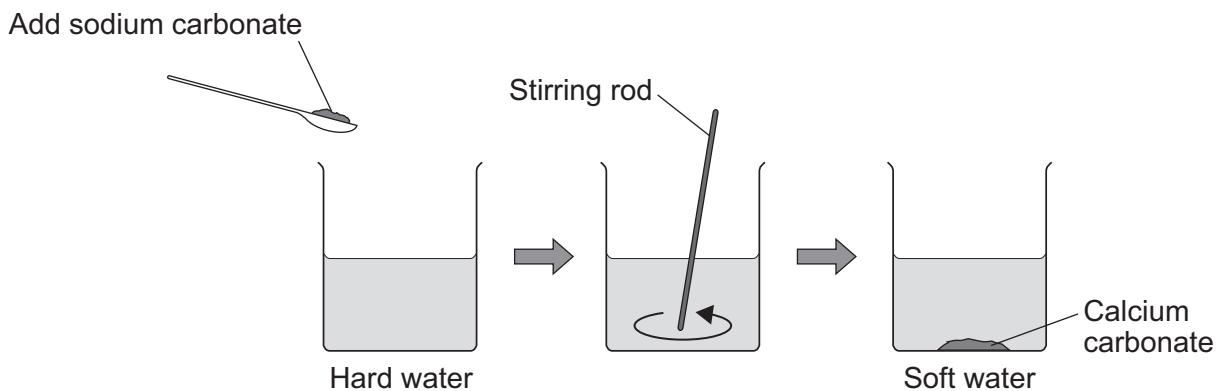
4 (b) In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.

Hard water can be softened by two different methods.

**Method 1: Ion exchange**



**Method 2: Adding sodium carbonate (washing soda)**





Describe how each method softens water **and** compare the advantages of these two methods.

**[6 marks]**

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**Turn over ▶**



**5** This question is about organic compounds.

**5 (a)** Ethanol is an alcohol.  
One use of ethanol is in alcoholic drinks.

Give **two** other uses of ethanol.

[2 marks]

.....  
.....

**5 (b)** Which gas is produced when sodium reacts with ethanol?

[1 mark]

Tick (✓) **one** box.

Carbon dioxide

Carbon monoxide

Hydrogen

Oxygen

**5 (c)** Ethanoic acid ( $\text{CH}_3\text{COOH}$ ) can be produced from ethanol ( $\text{CH}_3\text{CH}_2\text{OH}$ ).

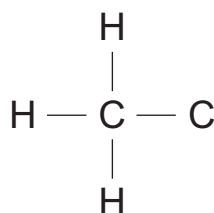
**5 (c) (i)** What type of reaction produces ethanoic acid from ethanol?

[1 mark]

.....

**5 (c) (ii)** Complete the displayed structure of ethanoic acid.

[1 mark]



- 5 (c) (iii)** Solutions of ethanoic acid and hydrochloric acid with the same concentration have different pH values.

Explain why the solution of ethanoic acid has a higher pH than the solution of hydrochloric acid.

**[2 marks]**

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- 5 (d)** Ethanol and ethanoic acid react in the presence of a catalyst to form an ester.

- 5 (d) (i)** Name the ester made from ethanol and ethanoic acid.

**[1 mark]**

.....

- 5 (d) (ii)** What type of chemical is used as a catalyst in this reaction?

**[1 mark]**

.....

- 5 (d) (iii)** Esters are used in perfumes because they smell pleasant and are volatile.

What does volatile mean?

**[1 mark]**

.....

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**Turn over for the next question**

**Turn over ►**



**6** This question is about reversible reactions and chemical equilibrium.

**6 (a)** Reversible reactions can reach equilibrium in a closed system.

**6 (a) (i)** What is meant by a closed system?

**[1 mark]**

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**6 (a) (ii)** Explain why, when a reversible reaction reaches equilibrium, the reaction appears to have stopped.

**[2 marks]**

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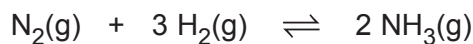
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- 6 (b)** In the Haber process, the reaction of nitrogen with hydrogen to produce ammonia is reversible.



- 6 (b) (i)** Name a natural resource from which hydrogen is produced.

**[1 mark]**

.....

- 6 (b) (ii)** The Haber process uses a catalyst to speed up the reaction.

Explain how a catalyst speeds up a reaction.

**[2 marks]**

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- 6 (b) (iii)** What happens to the amount of ammonia produced at equilibrium if the pressure is increased?

Give a reason for your answer.

**[2 marks]**

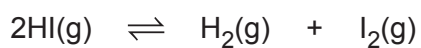
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**Question 6 continues on the next page**

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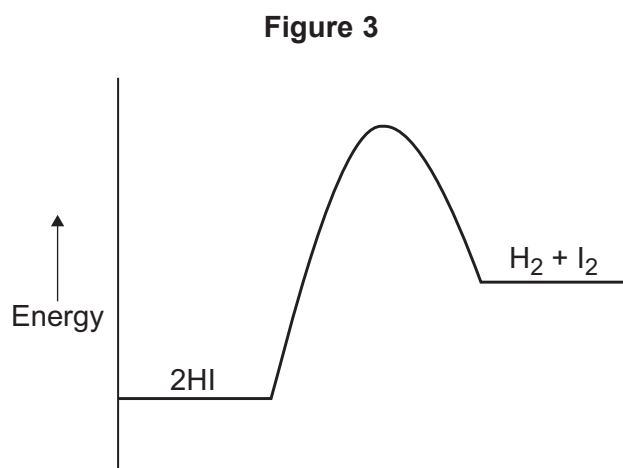


**6 (c)** The decomposition of hydrogen iodide into hydrogen and iodine is reversible.



The forward reaction is endothermic.

The energy level diagram in **Figure 3** is for the forward reaction.



**6 (c) (i)** Draw an arrow to show the activation energy on the diagram in **Figure 3**.

**[1 mark]**



**6 (c) (ii)** How does the diagram in **Figure 3** show that the reaction is endothermic?

**[1 mark]**

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**6 (c) (iii)** Suggest what effect, if any, increasing the temperature will have on the amount of hydrogen iodide at equilibrium.

Give a reason for your answer.

**[2 marks]**

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7 This question is about chemical analysis.

7 (a) A student has solutions of three compounds, **X**, **Y** and **Z**.

The student uses tests to identify the ions in the three compounds.

The student records the results of the tests in **Table 1**.

**Table 1**

| Compound | Test         |                               |  |   |
|----------|--------------|-------------------------------|--|---|
|          | Flame test   | Add sodium hydroxide solution | Add hydrochloric acid and barium chloride solution | Add nitric acid and silver nitrate solution |
| <b>X</b> | no colour    | green precipitate             | white precipitate                                  | no reaction                                 |
| <b>Y</b> | yellow flame | no reaction                   | no reaction  | yellow precipitate                          |
| <b>Z</b> | no colour    | brown precipitate             | no reaction  | cream precipitate                           |

Identify the **two** ions present in each compound, **X**, **Y** and **Z**.

**[3 marks]**

**X** .....

**Y** .....

**Z** .....

7 (b) A chemist needs to find the concentration of a solution of barium hydroxide. Barium hydroxide solution is an alkali.

The chemist could find the concentration of the barium hydroxide solution using two different methods.

**Method 1**

- An excess of sodium sulfate solution is added to 25 cm<sup>3</sup> of the barium hydroxide solution. A precipitate of barium sulfate is formed.
- The precipitate of barium sulfate is filtered, dried and weighed.
- The concentration of the barium hydroxide solution is calculated from the mass of barium sulfate produced.





**Method 2**

- 25 cm<sup>3</sup> of the barium hydroxide solution is titrated with hydrochloric acid of known concentration.
- The concentration of the barium hydroxide solution is calculated from the result of the titration.

Compare the advantages and disadvantages of the two methods.

**[5 marks]**

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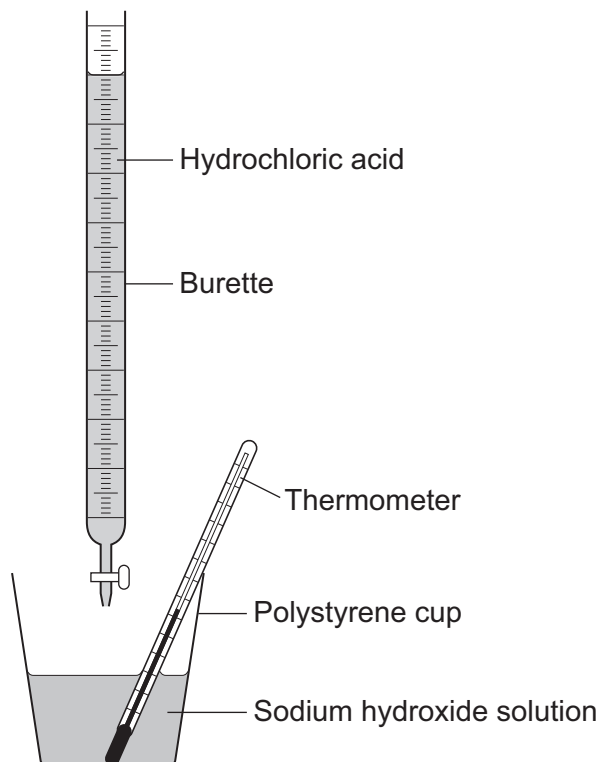
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- 8 A student investigates the energy released when hydrochloric acid completely neutralises sodium hydroxide solution.  
The student uses the apparatus shown in **Figure 4**.

**Figure 4**



The student:

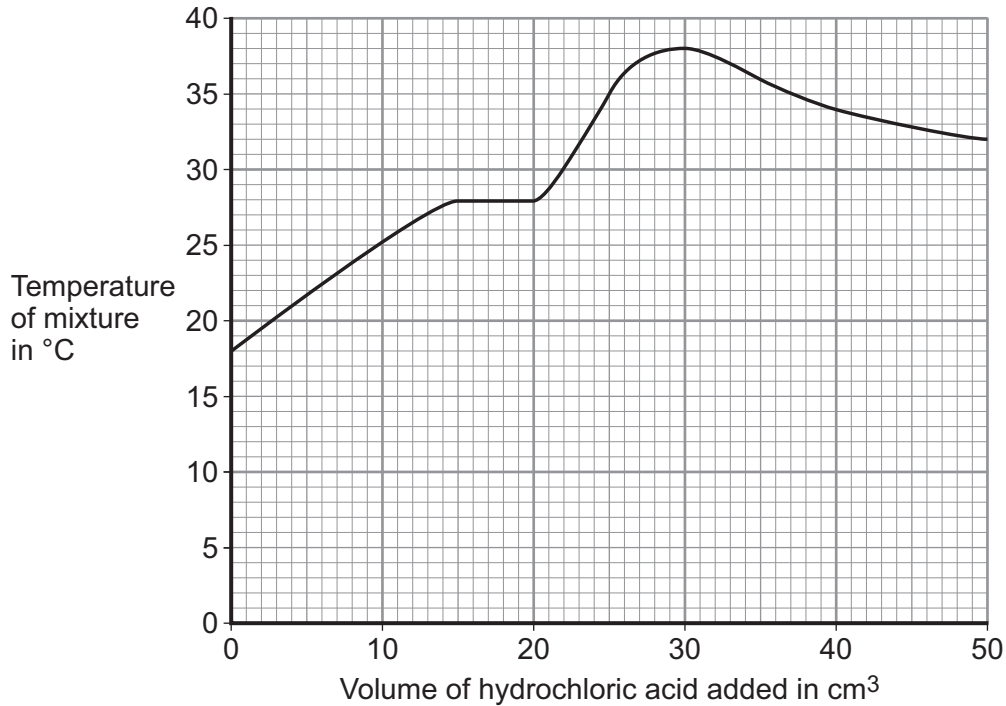
- measures 25 cm<sup>3</sup> sodium hydroxide solution into a polystyrene cup
- fills a burette with hydrochloric acid
- measures the temperature of the sodium hydroxide solution
- adds 5 cm<sup>3</sup> hydrochloric acid to the sodium hydroxide solution in the polystyrene cup
- stirs the mixture and measures the highest temperature of the mixture
- continues to add 5 cm<sup>3</sup> portions of hydrochloric acid, stirring and measuring the highest temperature of the mixture after each addition.

**Question 8 continues on the next page**

**Turn over ►**



- 8 (a)** The student has plotted a graph of the results.  
The graph line has been incorrectly drawn by including an anomalous result.  
The graph is shown in **Figure 5**.

**Figure 5**

- 8 (a) (i)** Suggest a cause for the anomalous result when 20 cm<sup>3</sup> of hydrochloric acid is added.

**[1 mark]**

.....  
.....

- 8 (a) (ii)** Suggest the true value of the temperature of the anomalous point.

**[1 mark]**

Temperature = ..... °C

- 8 (a) (iii)** What was the **total** volume of the mixture when the maximum temperature was reached?

**[1 mark]**

.....

Total volume of the mixture = ..... cm<sup>3</sup>

8 (a) (iv) Calculate the overall temperature increase in this experiment.

[1 mark]

.....

Overall temperature increase = ..... °C

8 (a) (v) Use your answers to 8(a)(iii) and 8(a)(iv) and the equation to calculate the energy released in the reaction. Give the unit.

[2 marks]

Assume the volume in cm<sup>3</sup> is equivalent to the mass of solution in grams.

Equation:  $Q = mc\Delta T$

where:

Q = energy released

m = mass of solution (g)

c = 4.2 (J per g per °C)

$\Delta T$  = change in temperature (°C)

.....

.....

Energy released = ..... Unit = .....

8 (b) The student did the experiment on page 19 again, starting with 50 cm<sup>3</sup> of sodium hydroxide solution instead of 25 cm<sup>3</sup>.

Explain why this would make no difference to the overall temperature increase.

[2 marks]

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END OF QUESTIONS



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