

Centre Number						Candidate Number				
Surname										
Other Names										
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For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
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

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CH3HP

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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]

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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]

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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]

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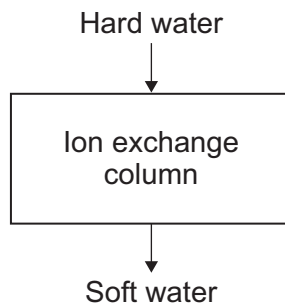
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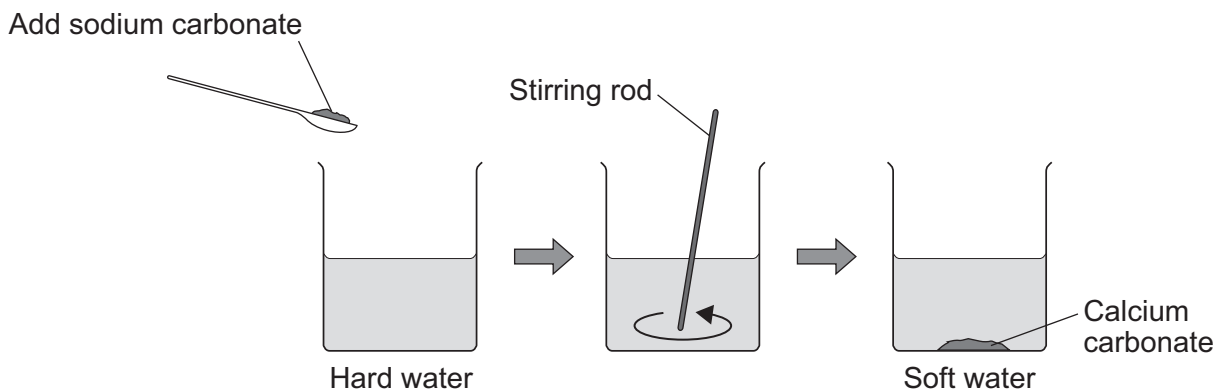
4 (b) In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.

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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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]

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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 (CH_3COOH) can be produced from ethanol ($\text{CH}_3\text{CH}_2\text{OH}$).

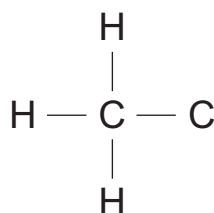
5 (c) (i) What type of reaction produces ethanoic acid from ethanol?

[1 mark]

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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]

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

[1 mark]

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- 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

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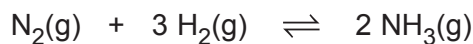
6 (a) (ii) Explain why, when a reversible reaction reaches equilibrium, the reaction appears to have stopped.

[2 marks]

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- 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]

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- 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]

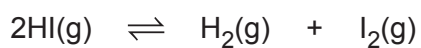
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Question 6 continues on the next page

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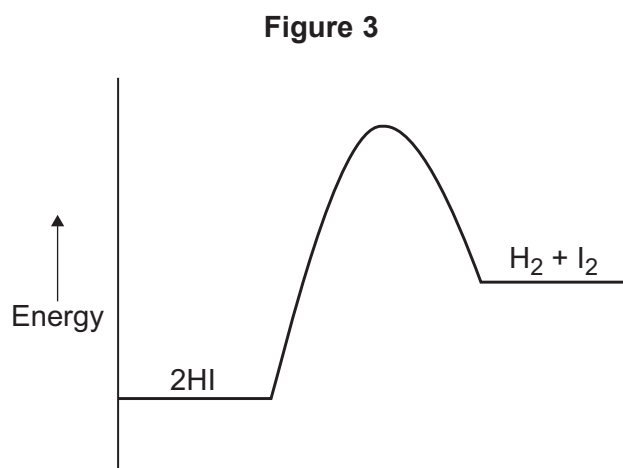


6 (c) The decomposition of hydrogen iodide into hydrogen and iodine is reversible.



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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Turn over for the next question

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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
X	no colour	green precipitate	white precipitate	no reaction
Y	yellow flame	no reaction	no reaction	yellow precipitate
Z	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 cm³ 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 cm³ 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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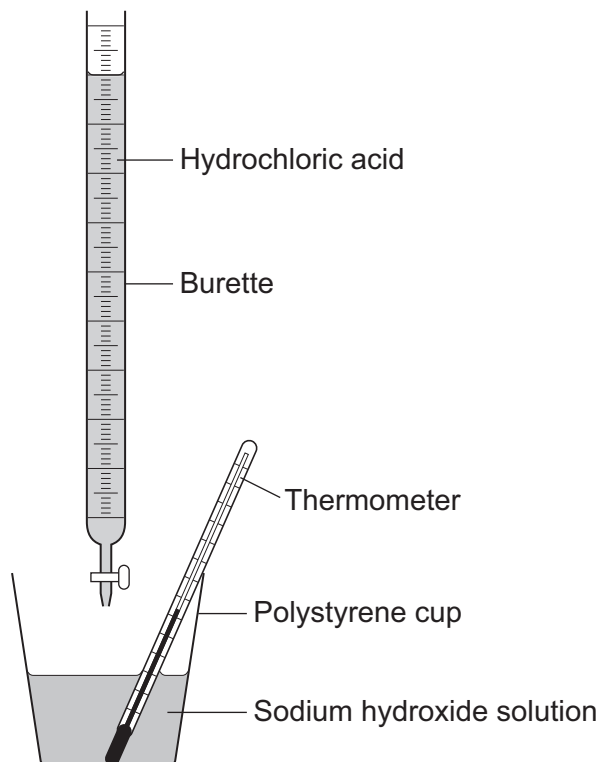
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- 8 A student investigates the energy released when hydrochloric acid completely neutralises sodium hydroxide solution.
The student uses the apparatus shown in **Figure 4**.

Figure 4



The student:

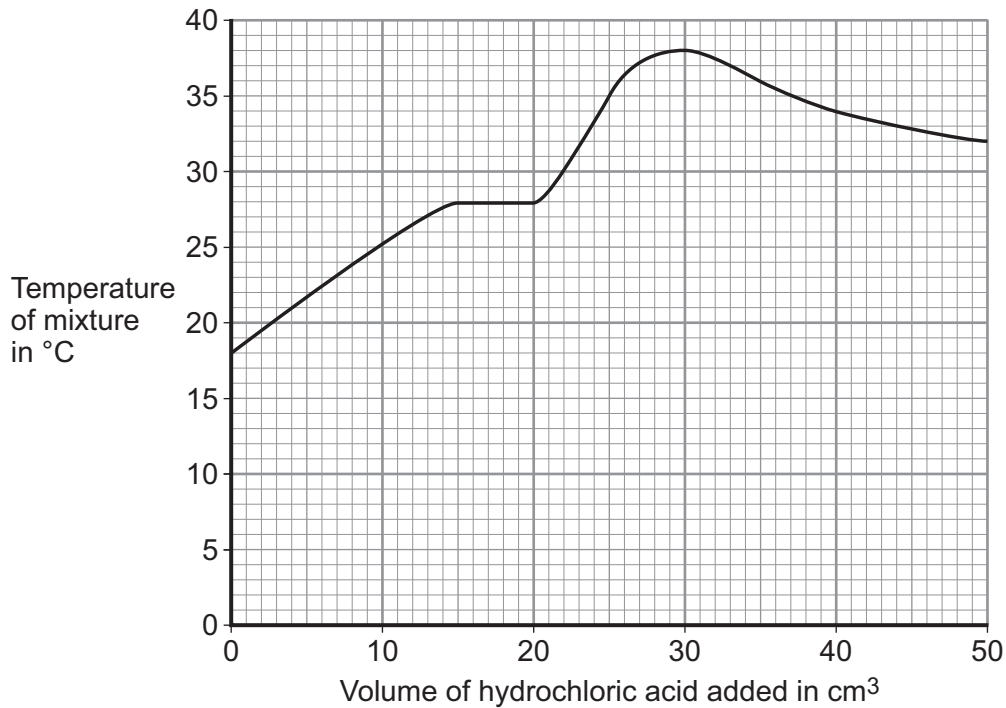
- measures 25 cm³ sodium hydroxide solution into a polystyrene cup
- fills a burette with hydrochloric acid
- measures the temperature of the sodium hydroxide solution
- adds 5 cm³ hydrochloric acid to the sodium hydroxide solution in the polystyrene cup
- stirs the mixture and measures the highest temperature of the mixture
- continues to add 5 cm³ 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 cm³ of hydrochloric acid is added.

[1 mark]

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- 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]

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Total volume of the mixture = cm³

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

[1 mark]

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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 cm³ 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)

ΔT = change in temperature (°C)

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Energy released = Unit =

8 (b) The student did the experiment on page 19 again, starting with 50 cm³ of sodium hydroxide solution instead of 25 cm³.

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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