

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										



General Certificate of Secondary Education
Higher Tier
June 2015

Chemistry

Unit Chemistry C3

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.

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
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4	
5	
6	
7	
8	
TOTAL	

CH3HP
H



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

G/KL/111146/Jun15/E5

CH3HP

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ANSWER IN THE SPACES PROVIDED**



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]

4

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]

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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]

.....

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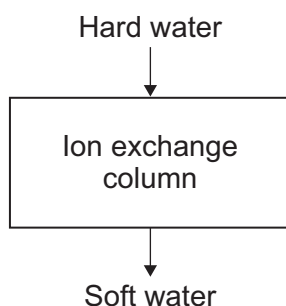
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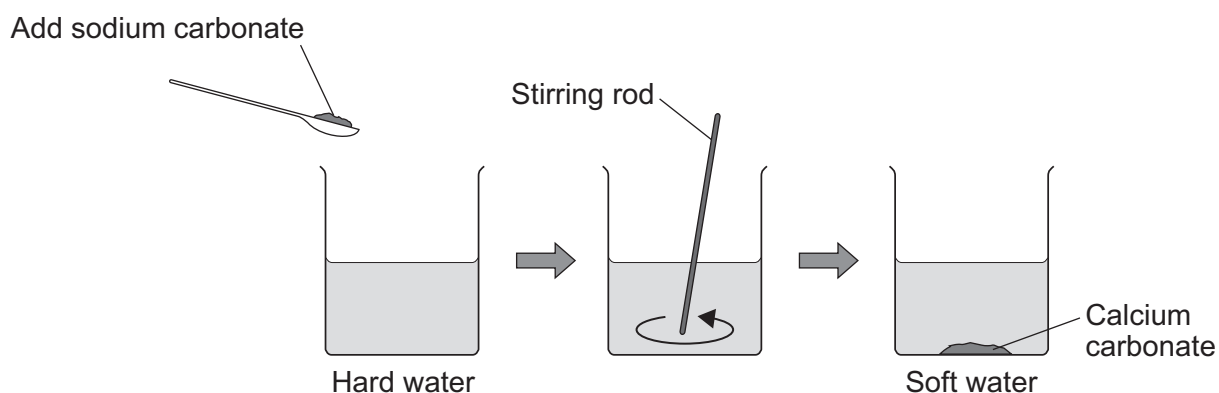
4 (b) In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.

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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Extra space

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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]

.....

.....

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 ($\text{CH}_3\text{CH}_2\text{OH}$).

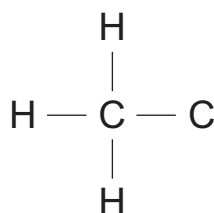
5 (c) (i) What type of reaction produces ethanoic acid from ethanol?

[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]

.....

- 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]

.....

10

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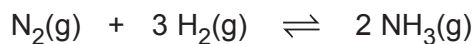
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- 6 (b)** In the Haber process, the reaction of nitrogen with hydrogen to produce ammonia is reversible.



- 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]

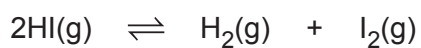
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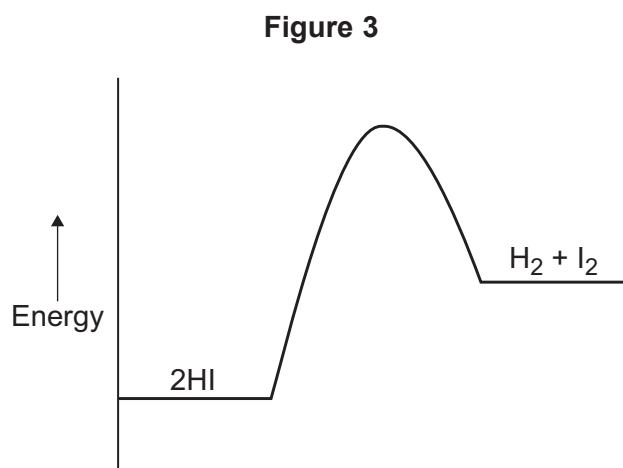


- 6 (c)** The decomposition of hydrogen iodide into hydrogen and iodine is reversible.



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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12

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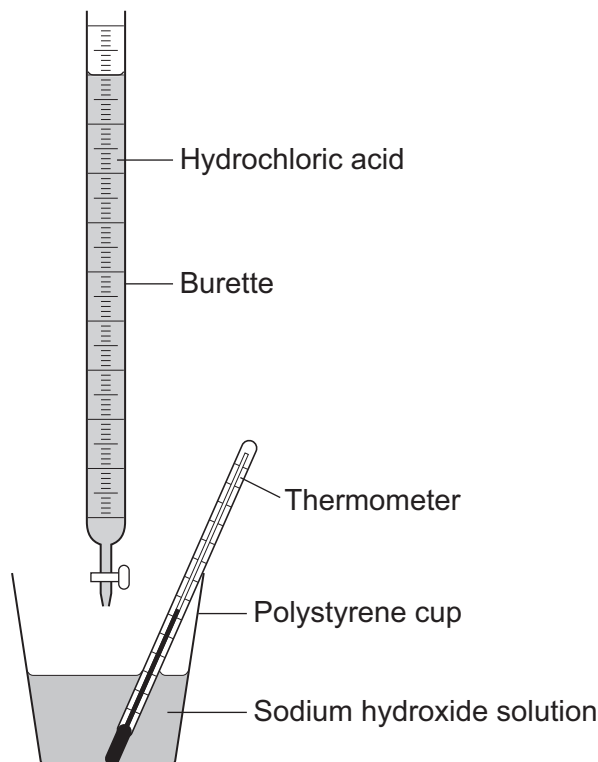
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- 8 A student investigates the energy released when hydrochloric acid completely neutralises sodium hydroxide solution.
The student uses the apparatus shown in **Figure 4**.

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

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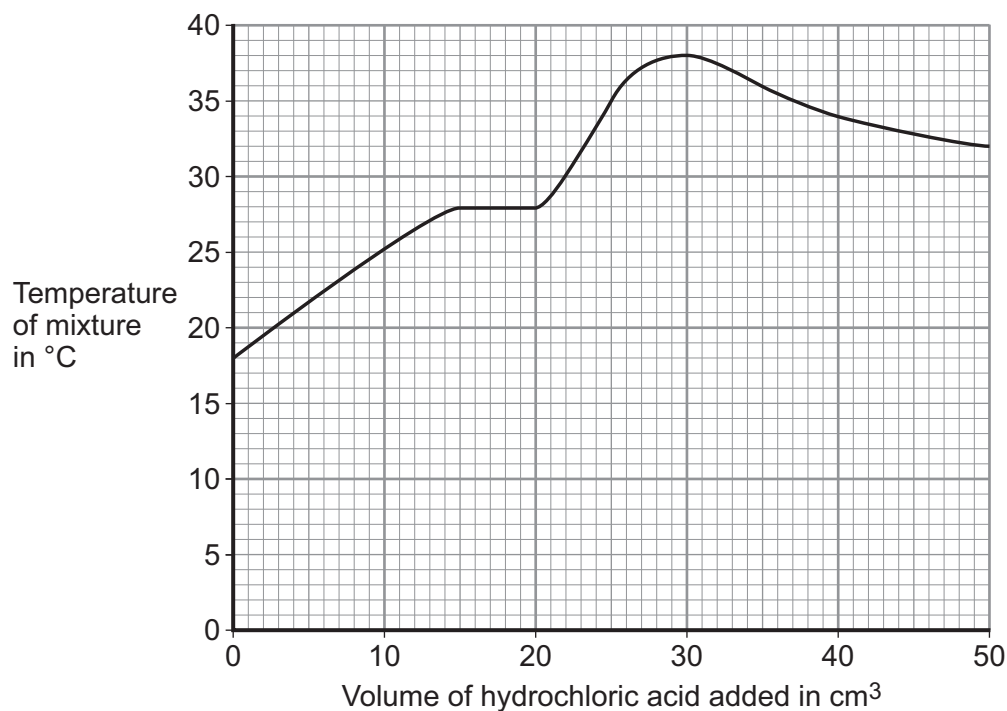


8 (a) The student has plotted a graph of the results.

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]

.....

.....

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 = ... cm³



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 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)

.....
.....

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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