Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
5	
TOTAL	

General Certificate of Secondary Education
Higher Tier
January 2012

Chemistry

CHY3H

Unit Chemistry C3

H

Written Paper

Thursday 26 January 2012 9.00 am to 9.45 am

For this paper you must have:
- a ruler
- the Data Sheet (enclosed).

You may use a calculator.

Time allowed
- 45 minutes

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.

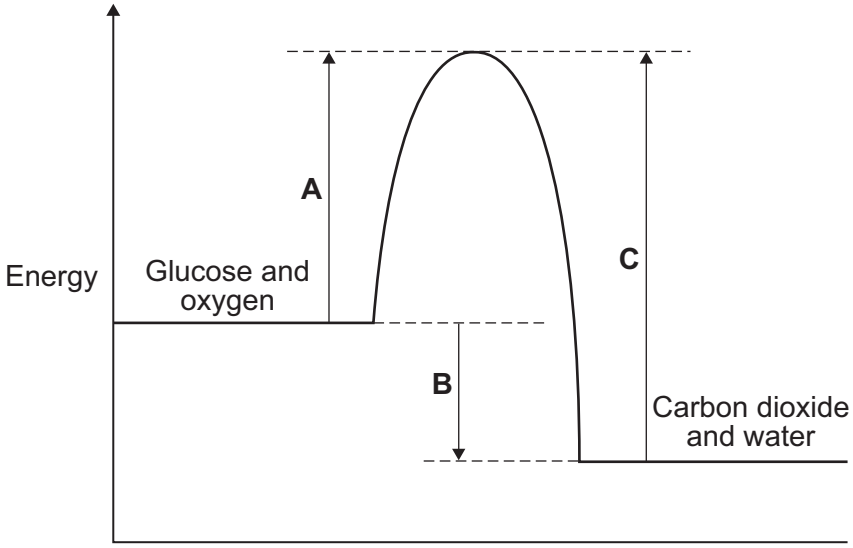
Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 45.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.

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

1 Food provides chemicals and energy to keep your body working. In your body, energy is released by respiration when glucose, $C_6H_{12}O_6$, reacts with oxygen.

$$C_6H_{12}O_6 + 6\,O_2 \rightarrow 6\,CO_2 + 6\,H_2O$$

1 (a) The energy level diagram for the reaction of glucose with oxygen is shown.



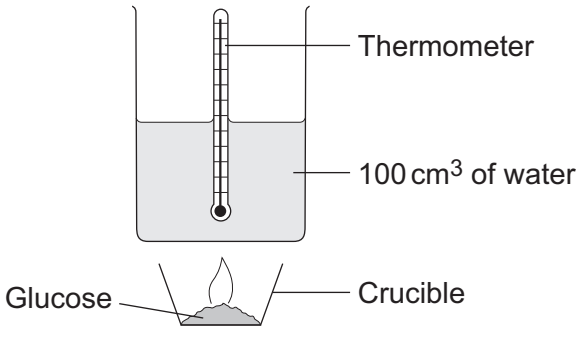
1 (a) (i) Which energy change, **A**, **B** or **C**, represents the activation energy? ☐

(1 mark)

1 (a) (ii) Which energy change, **A**, **B** or **C**, shows that the reaction is exothermic? ☐

(1 mark)

1 (b) A student did an investigation to find the amount of energy released when 1 g of glucose burns in air.



The student:

- recorded the room temperature
- placed 1 g of glucose into the crucible
- set up the equipment as shown in the diagram
- lit the glucose
- recorded the highest temperature of the water.

1 (b) (i) One of the main errors in this experiment is energy loss to the surroundings.

Suggest **one** way that the equipment could be changed to reduce this energy loss.

.....

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(1 mark)

1 (b) (ii) The room temperature was 20 °C and the highest temperature recorded was 42 °C.
Use these temperature readings to calculate how much energy is released when 1 g of glucose burns.
The equation that you need to use is:

Energy released in joules = 100 × 4.2 × temperature change

Show clearly how you work out your answer.

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Burning 1 g of glucose releases ..... joules
(2 marks)

1 (b) (iii) The amount of energy released by 1 g of glucose should be 16 000 J.

Apart from energy loss to the surroundings, suggest **two** other reasons why the student's value was less than expected.

1 .....

.....

2 .....

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(2 marks)

1 (c) Suggest **one** reason why food labels provide information about the energy released by the food.

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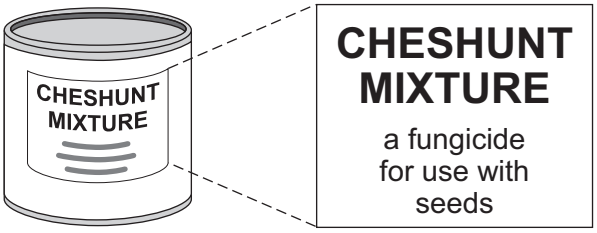
(1 mark)

8

Turn over for the next question

2 Cheshunt mixture is a powder containing copper sulfate, $CuSO_4$, and ammonium carbonate, $(NH_4)_2CO_3$



2 (a) A student tested the Cheshunt mixture.

2 (a) (i) Hydrochloric acid was added.
A gas was produced that turned limewater milky.

Complete the sentence.

The gas was ..... which shows

that ..... ions are in the mixture.

(2 marks)

2 (a) (ii) Sodium hydroxide solution was added.
A gas was produced that indicates that ammonium ions are in the mixture.

Complete the sentence.

The gas was ..... which turns

damp red ..... blue.

(2 marks)

2 (b) Cheshunt mixture is dissolved in water before it is used.
When the student dissolved the Cheshunt mixture in water it formed a blue solution.

2 (b) (i) Suggest how the student knew that copper ions are in this solution.

.....

.....

(1 mark)

2 (b) (ii) The student tested the Cheshunt solution and the result of the test indicated that sulfate ions are in the solution.

Complete the sentence.

The student added a solution of ..... in the presence of

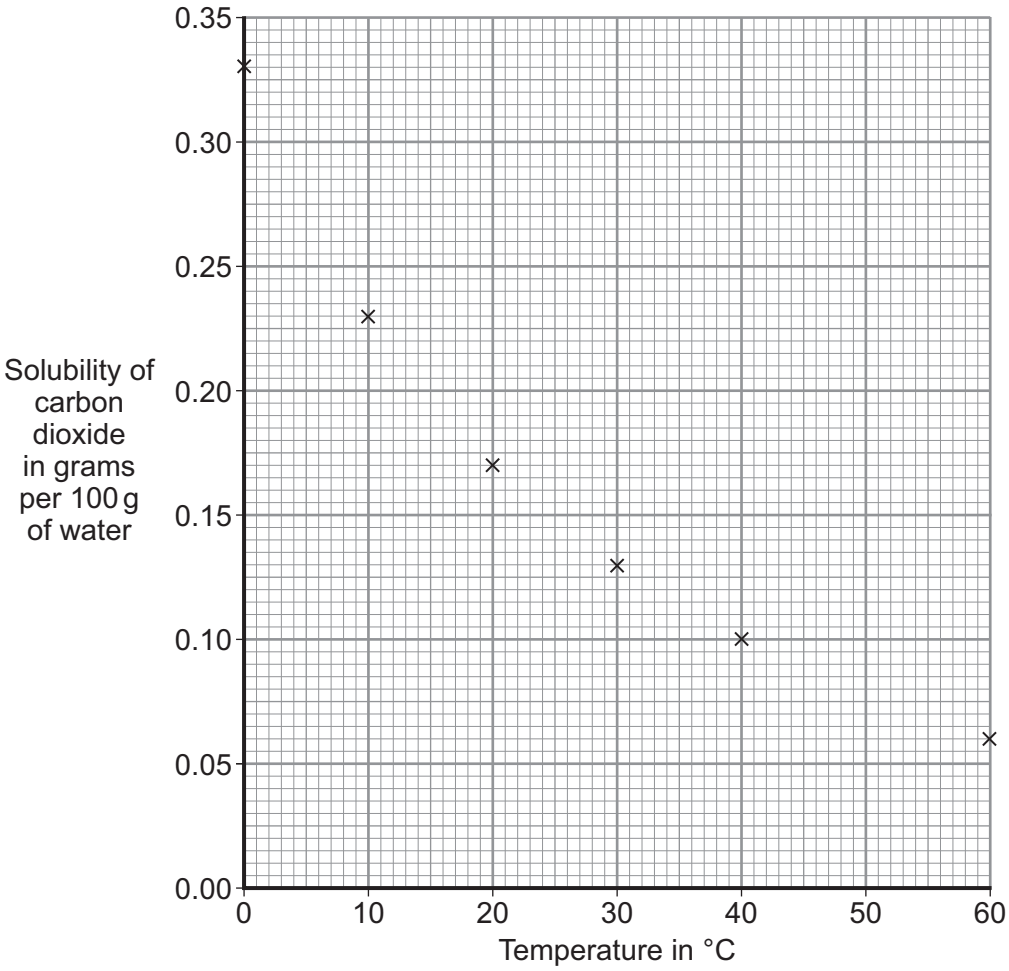
dilute hydrochloric acid and a ..... precipitate was produced.

(2 marks)

7

3 In some parts of the UK, the water is hard.

3 (a) As rain falls through the air, carbon dioxide dissolves in the water. The graph shows the solubility of carbon dioxide in water at different temperatures.



3 (a) (i) Complete the graph by drawing a smooth curve through the points.

(1 mark)

3 (a) (ii) Use the graph to find the mass of carbon dioxide that dissolves in water at 50 °C.

Mass = ... g

(1 mark)

3 (a) (iii) Calculate the mass of carbon dioxide that bubbles out of 100 g of water when the temperature rises from 20 °C to 60 °C.

.....

.....

Mass = ... g

(2 marks)

Question 3 continues on the next page

3 (b) Hard water contains dissolved calcium compounds.
Carbon dioxide dissolved in water reacts with calcium carbonate in limestone.
The product is calcium hydrogencarbonate which dissolves in water.

$$CaCO_3(s) + H_2O(l) + CO_2(g) \rightleftharpoons Ca(HCO_3)_2(aq)$$

When this hard water is heated, an insoluble scale is produced.
Use the chemical equation to explain how this happens.

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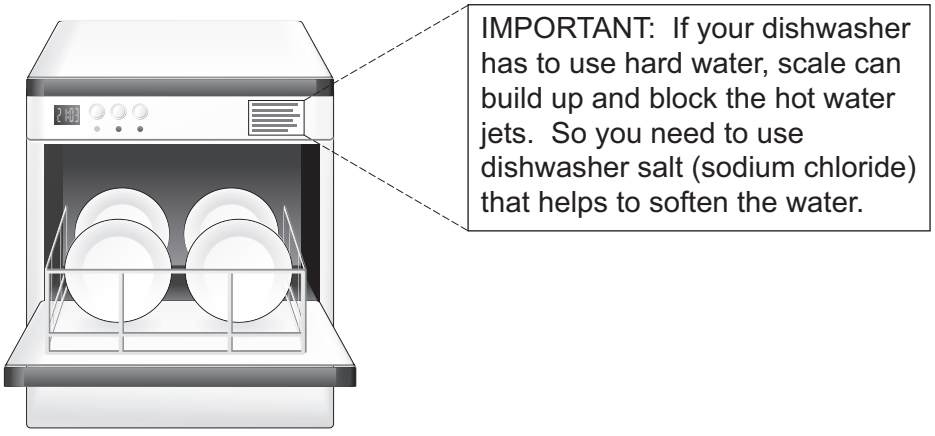
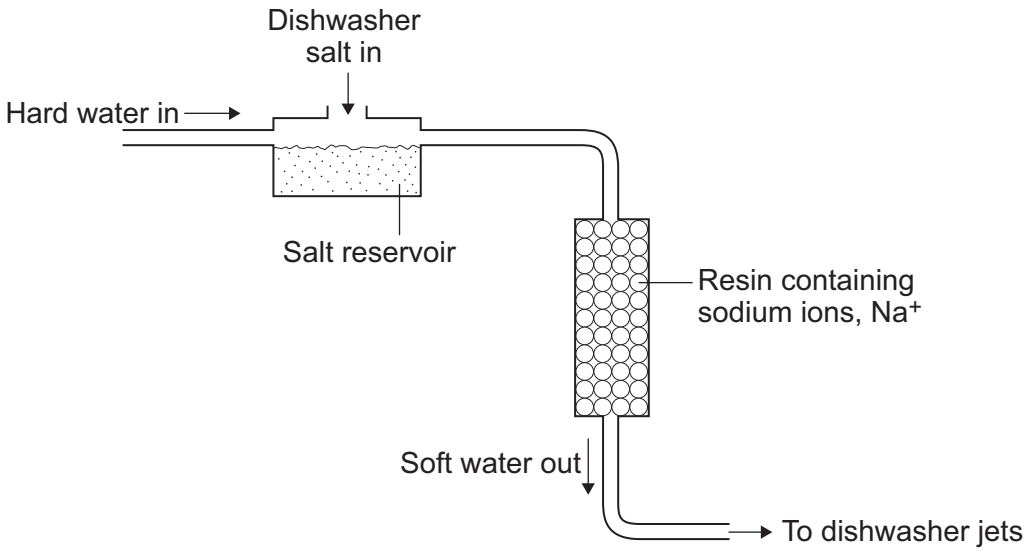
(2 marks)

3 (c) This label was on a dishwasher.



This dishwasher has a built-in water softener.



Use the information and your knowledge and understanding to explain how sodium chloride helps to soften the water in this dishwasher.

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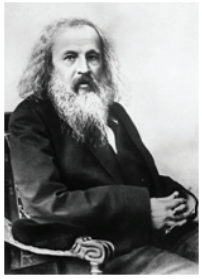
(4 marks)

10

Turn over for the next question

4 By 1869, about 60 elements had been discovered.
Mendeleev arranged these elements in a table, in order of their atomic weight.
He also put elements with similar chemical properties in the same columns.

Mendeleev and part of his table are shown below.



	Group							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Period 1	H							
Period 2	Li	Be	B	C	N	O	F	
Period 3	Na	Mg	Al	Si	P	S	Cl	
Period 4	K Cu	Ca Zn	– –	Ti –	V As	Cr Se	Mn Br	Fe Co Ni

4 (a) (i) Name **one** element in Group 1 of Mendeleev's table that is not in Group 1 of the periodic table on the Data Sheet.
Give a reason why this element should not be in Group 1.

Name of element .....

Reason .....

.....

(2 marks)

4 (a) (ii) Which group of the periodic table on the Data Sheet is missing from Mendeleev's table?

.....

(1 mark)

4 (b) The gaps (–) in Mendeleev's table were for elements that had not been discovered.

4 (b) (i) Compare Mendeleev's table with the periodic table on the Data Sheet.

Name **one** of the elements in Period 4 that had not been discovered by 1869.

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(1 mark)

4 (b) (ii) Mendeleev was able to make predictions about the undiscovered elements. This eventually led most scientists to accept his table.

Suggest what predictions Mendeleev was able to make about these undiscovered elements.

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(2 marks)

4 (c) In terms of their electronic structure:

4 (c) (i) state why lithium and sodium are both in Group 1

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(1 mark)

4 (c) (ii) explain why sodium is more reactive than lithium.

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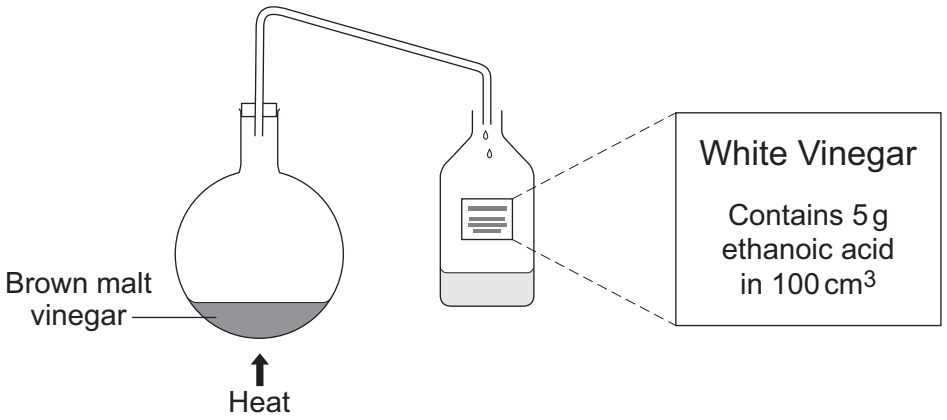
(3 marks)

10

Turn over for the next question

5 White vinegar can be made by distillation of brown malt vinegar.



Ethanoic acid, CH_3COOH, is a *weak acid*.

$$CH_3COOH(aq) \rightleftharpoons CH_3COO^-(aq) + H^+(aq)$$

5 (a) Use the chemical equation to:

5 (a) (i) explain *weak* in terms of ionisation of ethanoic acid

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(1 mark)

5 (a) (ii) explain why, according to Arrhenius, ethanoic acid is an *acid*.

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(1 mark)

5 (b) A student did a titration to find out if the white vinegar contains 5 g of ethanoic acid in 100 cm^3.
To do this, the student placed 25.0 cm^3 of white vinegar in a conical flask with 5 drops of phenolphthalein indicator.
The volume of sodium hydroxide solution needed to react completely with the ethanoic acid in the white vinegar was found by titration.

Describe how the student should do the titration.
Include the names of any equipment needed for the titration.

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(4 marks)

Question 5 continues on the next page

5 (c) The student repeated the titration three more times. The results are shown in the table.

Titration	**1**	**2**	**3**	**4**
Volume of sodium hydroxide in cm^3	23.5	20.1	19.9	20.0

The chemical equation for this reaction is:

$$CH_3COOH + NaOH \rightarrow CH_3COONa + H_2O$$

5 (c) (i) Calculate the volume of sodium hydroxide solution that reacted completely with the ethanoic acid in 25.0 cm^3 of white vinegar.

.....

Volume = ... cm^3

(1 mark)

5 (c) (ii) Is the student able to conclude that the white vinegar contains 5 g of ethanoic acid in 100 cm^3?

Explain your answer.

Use the following to explain your answer:

- your answer to part (c)(i)
- the concentration of the sodium hydroxide solution is 1.0 moles per cubic decimetre
- one mole of ethanoic acid has a mass of 60 g.

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(3 marks)

10

END OF QUESTIONS

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