



Rewarding Learning

ADVANCED SUBSIDIARY (AS)  
General Certificate of Education  
2012

Centre Number

71

Candidate Number

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## Chemistry

Assessment Unit AS 2

*assessing*

Module 2: Organic, Physical  
and Inorganic Chemistry

[AC122]

TUESDAY 19 JUNE, AFTERNOON

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### TIME

1 hour 30 minutes, plus your additional time allowance.

### INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.

Answer **all fifteen** questions.

Answer **all ten** questions in **Section A**. Record your answers by marking the appropriate letter on the answer sheet provided. Use only the spaces numbered 1 to 10. Keep in sequence when answering.

Answer **all five** questions in **Section B**. Write your answers in the spaces provided in this question paper.

## INFORMATION FOR CANDIDATES

The total mark for this paper is 100.

Quality of written communication will be assessed in question **14(b)(iv)**.

In Section A all questions carry equal marks, i.e. **two** marks for each question.

In Section B the figures in brackets printed at the end of each question indicate the marks awarded to each question or part question.

A Periodic Table of Elements (including some data) is provided.

## Section A

For each of the following questions only **one** of the lettered responses (A–D) is correct.

**Select the correct response in each case and mark its code letter by connecting the dots as illustrated on the answer sheet.**

1 The forces of attraction between ethanol molecules are

- A permanent dipole-dipole attractions only.
- B permanent dipole-dipole attractions and hydrogen bonds.
- C hydrogen bonds.
- D hydrogen bonds and van der Waals' forces.

2 Which one of the following is a propagation step in the chlorination of methane?

- A  $\text{Cl}_2 \rightarrow 2\text{Cl}^\bullet$
- B  $\text{CH}_4 + \text{Cl}^\bullet \rightarrow \text{CH}_3\text{Cl} + \text{H}^\bullet$
- C  $\text{CH}_4 \rightarrow \text{CH}_3^\bullet + \text{H}^\bullet$
- D  $\text{CH}_4 + \text{Cl}^\bullet \rightarrow \text{CH}_3^\bullet + \text{HCl}$

- 3 0.47 g of a hydrocarbon was completely burnt in air. The heat produced raised the temperature of 200 g of water by 28.2 °C. The standard enthalpy of combustion of the hydrocarbon is  $-2220 \text{ kJ mol}^{-1}$ .

The specific heat capacity of water is  $4.2 \text{ J g}^{-1} \text{ °C}^{-1}$

Which one of the following is the molar mass of the hydrocarbon?

- A 40  
B 44  
C 185  
D 199
- 4 Which one of the following **decreases** as Group II is descended from magnesium to barium?
- A Atomic radius  
B First ionisation energy  
C Reactivity with water  
D Solubility of the hydroxides

- 5** A solution of a white solid gives a white precipitate with concentrated ammonia solution. This precipitate is soluble in excess concentrated ammonia solution. The solution of the white solid also gives a white precipitate with barium chloride solution. Which one of the following does the solution contain?
- A** Aluminium chloride
  - B** Aluminium sulfate
  - C** Zinc chloride
  - D** Zinc sulfate
- 6** Absorption of infra-red radiation by molecules is caused by
- A** electronic transitions.
  - B** electronic vibrations.
  - C** molecular transitions.
  - D** molecular vibrations.

- 7 An organic compound consists of 40.7% carbon, 5.1% hydrogen and 54.2% oxygen and has a relative molecular mass of 118. Which one of the following is the molecular formula of the compound?

- A  $C_3H_2O_5$   
B  $C_4H_6O_4$   
C  $C_5H_{10}O_3$   
D  $C_6H_{14}O_2$

- 8 Calcium nitrate undergoes thermal decomposition as follows:

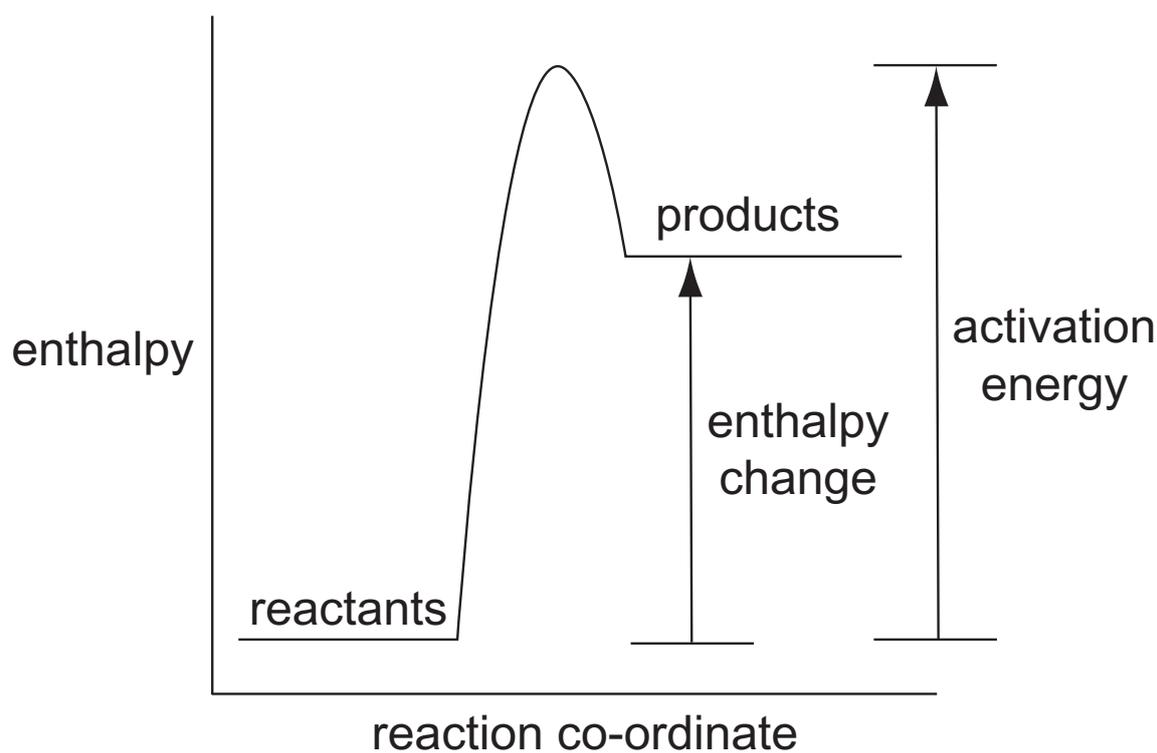


Which one of the following is the total volume of gas formed when 8.20 g of calcium nitrate are completely decomposed at room temperature and pressure?

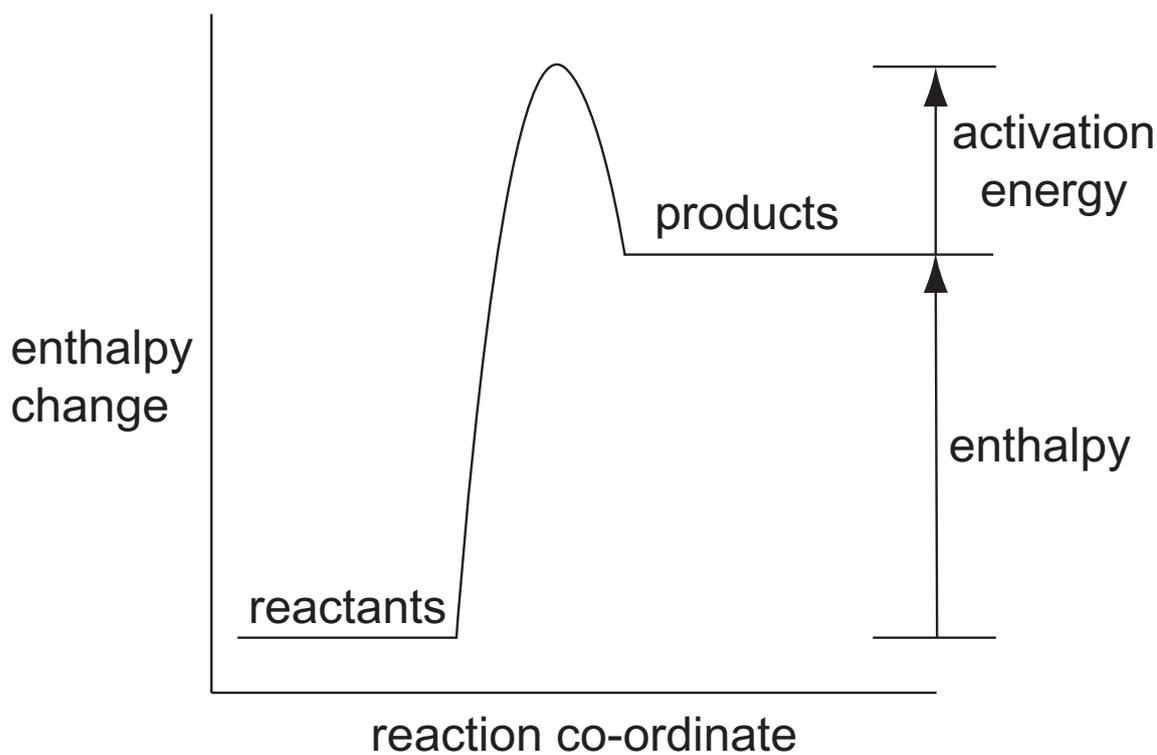
- A  $0.6 \text{ dm}^3$   
B  $2.4 \text{ dm}^3$   
C  $3.0 \text{ dm}^3$   
D  $6.0 \text{ dm}^3$

- 9 The reaction between bromobutane and aqueous sodium hydroxide is an example of
- A electrophilic addition.
  - B electrophilic substitution.
  - C nucleophilic addition.
  - D nucleophilic substitution.

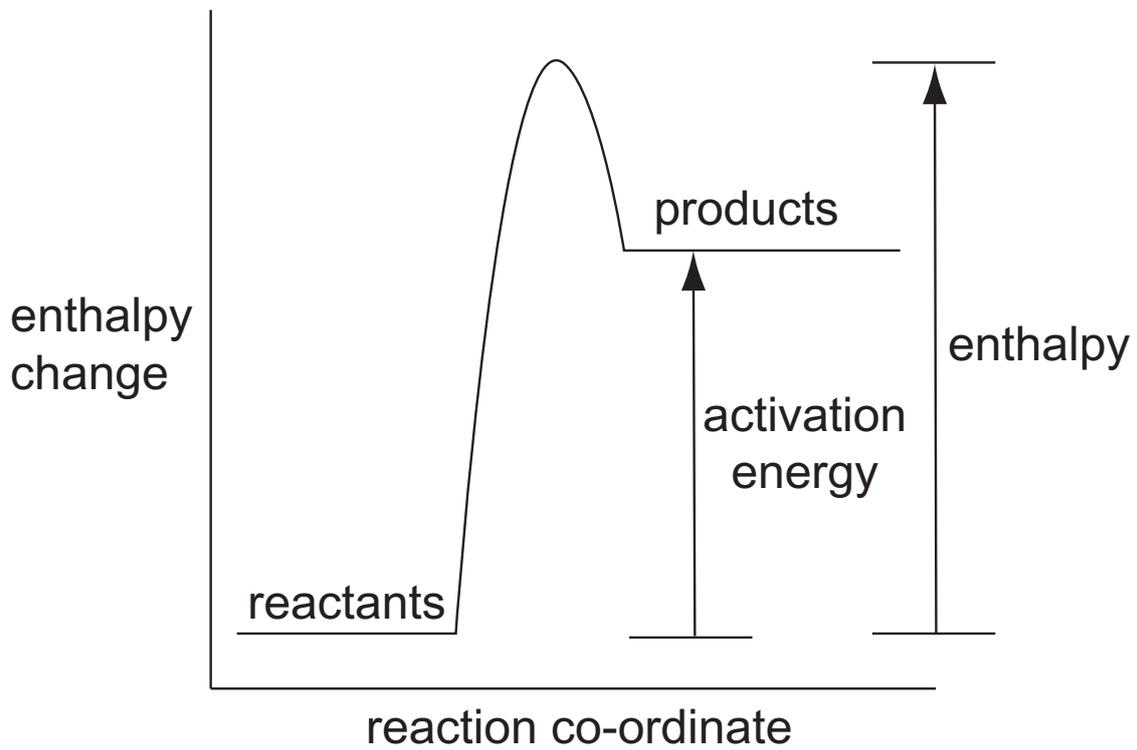
10 Which one of the following represents a correctly labelled enthalpy level diagram?



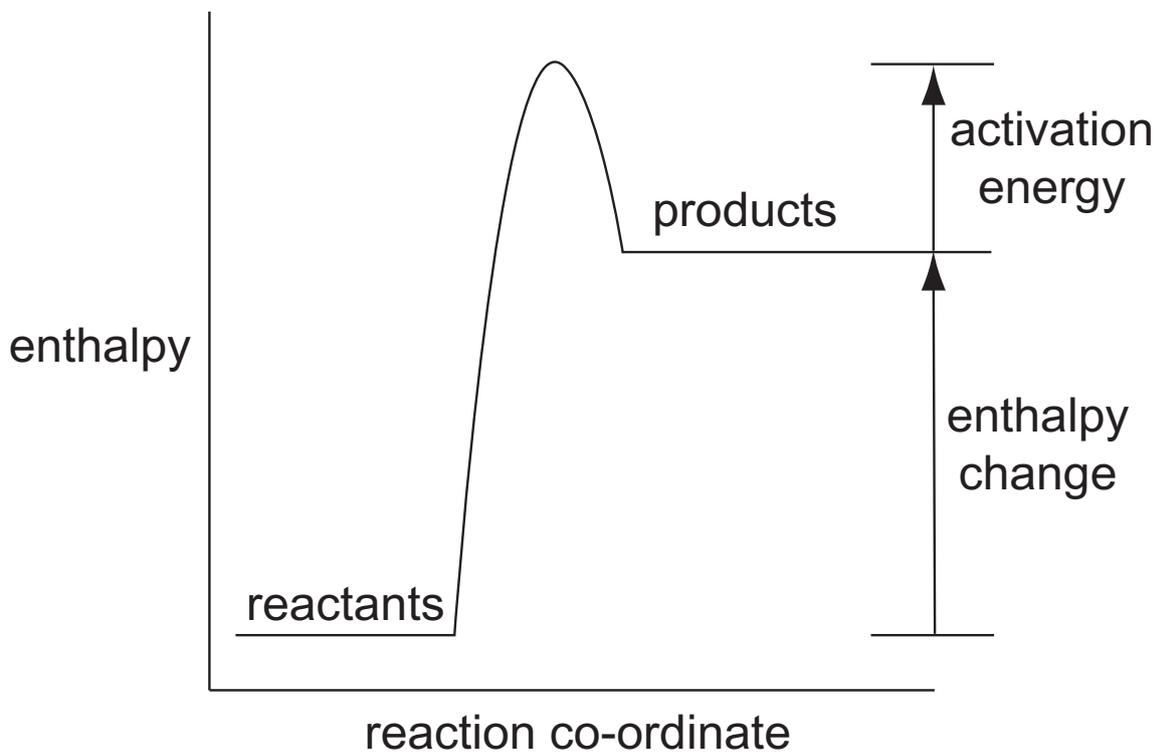
**A**



**B**



**C**



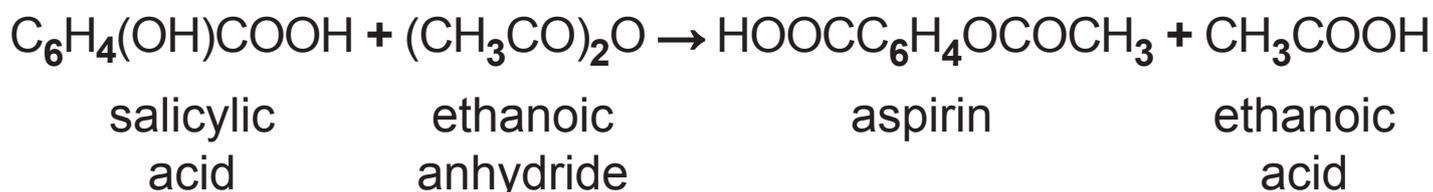
**D**

## Section B

Answer **all five** questions in this section.

- 11** Salicylic acid, extracted from willow bark, was used as a painkiller. Today salicylic acid is used to manufacture aspirin.

Aspirin can be prepared in the laboratory by reacting salicylic acid with ethanoic anhydride according to the following equation:



- (a) A student reacted 3.00 g of salicylic acid with 6.0 cm<sup>3</sup> of ethanoic anhydride.

(i) How many moles of salicylic acid were used? [1]

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(ii) What mass of ethanoic anhydride was used?  
(Density of ethanoic anhydride = 1.08 g cm<sup>-3</sup>) [1]

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(iii) How many moles of ethanoic anhydride were present? [1]

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(iv) What is the maximum number of moles of aspirin which could be formed? [1]

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(v) Calculate the maximum mass of aspirin which could be formed. [1]

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(vi) The student isolated 3.08 g of aspirin. Calculate the percentage yield of aspirin obtained by the student. [1]

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(b) (i) Explain what is meant by the term **atom economy** of a reaction. [1]

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(ii) Calculate the atom economy of the reaction to prepare aspirin. [2]

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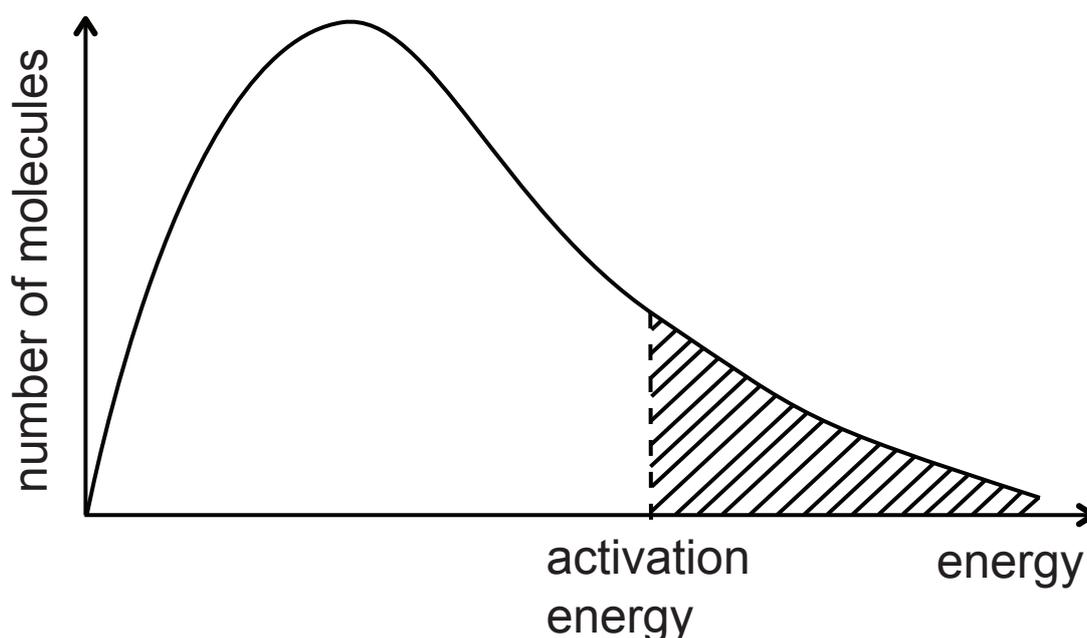
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**12** The first step in the Ostwald Process for the manufacture of nitric acid is the oxidation of ammonia.



**(a)** The reaction is carried out at approximately  $900^\circ\text{C}$ .

The diagram below shows the distribution of molecular energies in the reaction mixture at  $900^\circ\text{C}$ .



**(i)** What is the name given to this distribution of molecular energies in gases? [1]

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**(ii)** Draw on the diagram the distribution of the molecular energies at  $1500^\circ\text{C}$ . [2]

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**(iii)** Use the diagram on page 12 opposite to explain why the rate of the reaction is faster at 1500 °C. [2]

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**(iv)** Explain how the yield of nitrogen(II) oxide is affected by increasing the temperature to 1500 °C. [2]

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(b) The reaction is carried out at 4–10 atmospheres pressure.

(i) Explain how increasing the pressure to 100 atmospheres would affect the rate of the reaction. [2]

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(ii) Explain how increasing the pressure to 100 atmospheres would affect the yield of the nitrogen(II) oxide. [2]

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(c) The catalyst used in the reaction contains rhodium and platinum.

(i) Explain, referring to the diagram on page 12, how the catalyst increases the rate of the reaction. [2]

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(ii) Explain the effect, if any, the catalyst has on the yield of the nitrogen(II) oxide. [2]

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**13** But-1-ene and but-2-ene are gaseous isomers of  $C_4H_8$ .

**(a)** But-1-ene contains a carbon-carbon double bond,  $C=C$ , as well as carbon-carbon single bonds,  $C-C$ .

**(i)** Compare and explain the difference in bond strength and bond length of  $C=C$  and  $C-C$ . [3]

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**(ii)** Explain why but-1-ene is more reactive than butane. [2]

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(iii) Describe a test, including any observations, to show the presence of C=C in but-1-ene. [3]

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**(b)** But-2-ene exists as E–Z isomers.

**(i)** Draw and label the E and Z isomers of but-2-ene. [2]

**(ii)** Explain why but-2-ene can exist as E and Z isomers. [2]

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(c) But-1-ene can be polymerised to form poly(but-1-ene).

(i) What type of polymerisation does but-1-ene undergo? [1]

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(ii) Draw a section of poly(but-1-ene) showing **two** repeating units. [2]

**14** Barium carbonate has a variety of uses which include ceramic glazes and rat poisons.

**(a)** Barium carbonate can be prepared by heating barium sulfide, BaS, with sodium carbonate. Write an equation for this reaction. [1]

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**(b)** Barium carbonate is decomposed at 1360°C.

**(i)** Write the equation for the decomposition of barium carbonate. [1]

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**(ii)** In industry coke (carbon) is added. Suggest the role of coke in this process. [1]

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**(iii)** Compare the thermal stability of barium carbonate to calcium carbonate, explaining any difference. [3]

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(c) Describe a chemical test to distinguish between sodium carbonate and sodium hydrogencarbonate solids. [3]

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15  $C_4H_9OH$  can be produced by fermentation of a sugar solution using the bacterium **clostridium acetobutylicum**.

(a) (i) Suggest **two** conditions necessary for this fermentation process. [2]

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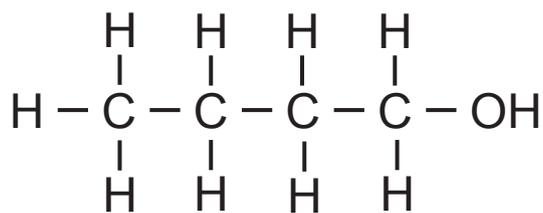
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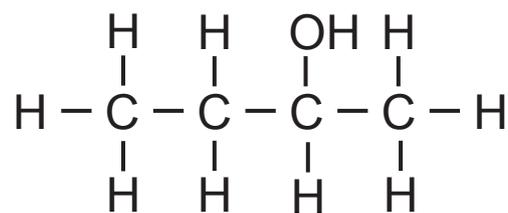
(ii) The fermentation process produces a mixture of alcohols and propanone. Suggest how the mixture may be separated. [1]

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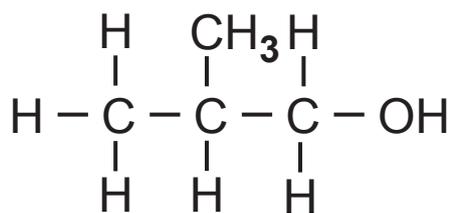
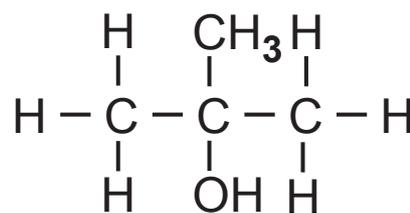
(b)  $C_4H_9OH$  has four isomers; butan-1-ol, butan-2-ol and two others, **A** and **B**.



Butan-1-ol



Butan-2-ol

**A****B**

(i) Give the systematic names of isomers **A** and **B**. [2]

**A** \_\_\_\_\_

**B** \_\_\_\_\_

(ii) Describe, giving experimental details and any observations, how you would use the iodoform test to distinguish between butan-1-ol and butan-2-ol. [4]

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(iii) Name a reagent you could use to distinguish between isomers **A** and **B**. Include any observations that occur when it is reacted with **A** and **B**. [3]

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(c) Butan-1-ol has potential as a biofuel, which is an alternative fuel.

(i) Suggest why butan-1-ol can be considered as an alternative fuel. [1]

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(ii) The equation for the combustion of butan-1-ol is given below.



Use the standard enthalpies of formation given in the table below to calculate the standard enthalpy of combustion for butan-1-ol. [3]

	Standard enthalpy of formation $\text{kJ mol}^{-1}$
Butan-1-ol	-327
Carbon dioxide	-394
Water	-286

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(iii) What are the conditions used for measuring standard enthalpies of formation? [2]

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(iv) Why is no value given for the standard enthalpy of formation of oxygen? [1]

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(d) Ethanol can also be used as a biofuel. The enthalpy of combustion of ethanol can be calculated using bond enthalpies.

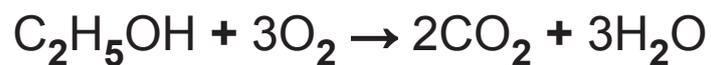
(i) Explain what is meant by the term **bond enthalpy**. [2]

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- (ii) Use the bond enthalpies given in the table below to calculate the enthalpy of combustion of ethanol. [3]



Bond	Bond enthalpy $\text{kJ mol}^{-1}$
C—C	+347
C—H	+413
C—O	+358
O—H	+464
O=O	+498
C=O	+805

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(iii) Using experimental data the standard enthalpy of combustion of ethanol is found to be  $-1407 \text{ kJ mol}^{-1}$ . Explain the difference between this value and that obtained using bond enthalpies. [1]

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**THIS IS THE END OF THE QUESTION PAPER**

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For Examiner's use only	
Question Number	Marks
Section A	
1–10	
Section B	
11	
12	
13	
14	
15	
<b>Total Marks</b>	

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