Rewarding Learning

Centre Number

71	

Candidate Number

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2012

Chemistry

Assessment Unit AS 2

assessing

Module 2: Organic, Physical and Inorganic Chemistry

[AC122]

AC122

TUESDAY 19 JUNE, AFTERNOON

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 $Cl_2 \rightarrow 2Cl^{\bullet}$
B $CH_4 + Cl^{\bullet} \rightarrow CH_3Cl + H^{\bullet}$
C $CH_4 \rightarrow CH_3^{\bullet} + H^{\bullet}$
D $CH_4 + Cl^{\bullet} \rightarrow CH_3^{\bullet} + HCl$

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 kJ mol^{-1}.
The specific heat capacity of water is 4.2 J g^{-1} $°C^{-1}$
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:

$$2Ca(NO_3)_2(s) \rightarrow 2CaO(s) + 4NO_2(g) + O_2(g)$$

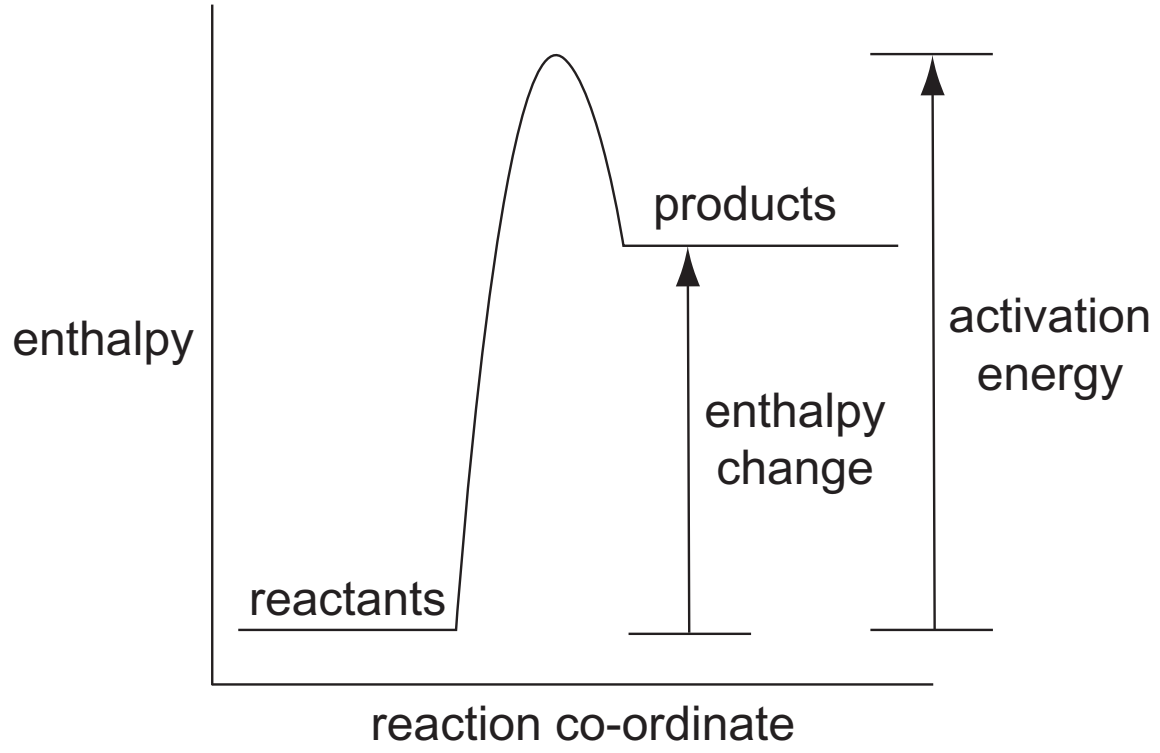
Which one of the following is the total volume of gas formed when 8.20 g of calcium nitrate are completely decomposed at room temperature and pressure?

A 0.6 dm^3
B 2.4 dm^3
C 3.0 dm^3
D 6.0 dm^3

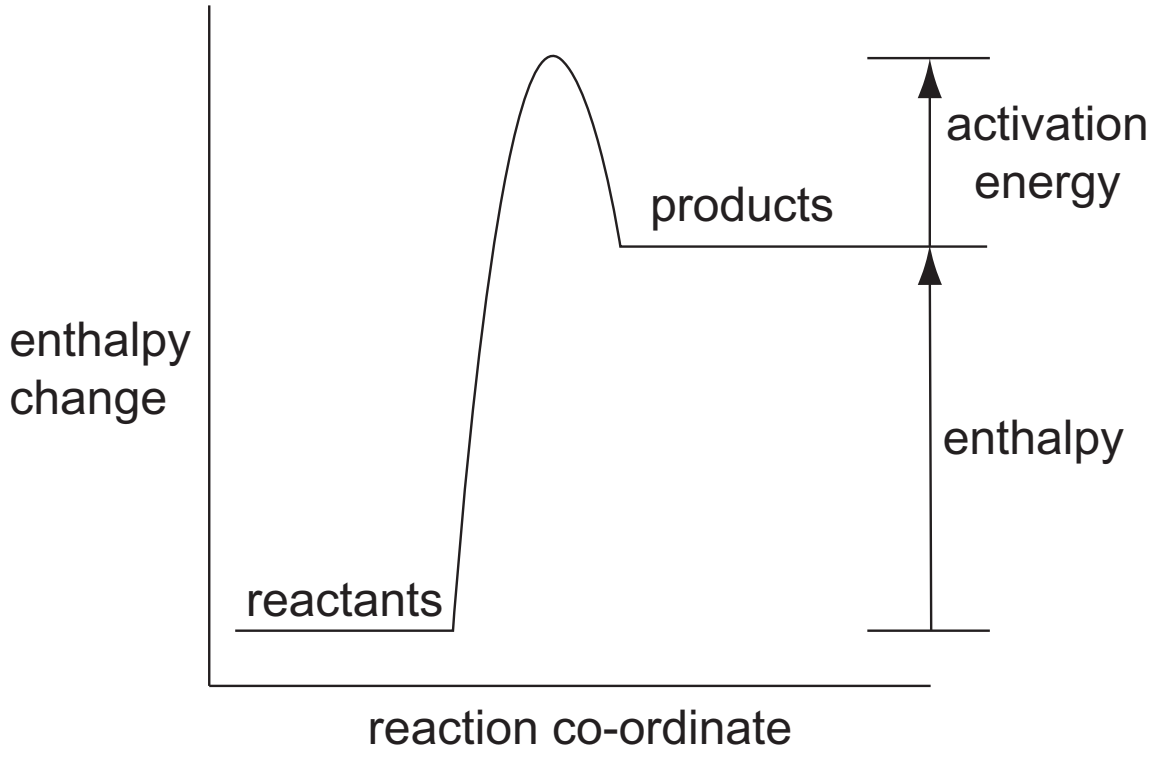
9 The reaction between bromobutane and aqueous sodium hydroxide is an example of

A electrophilic addition.
B electrophilic substitution.
C nucleophilic addition.
D nucleophilic substitution.

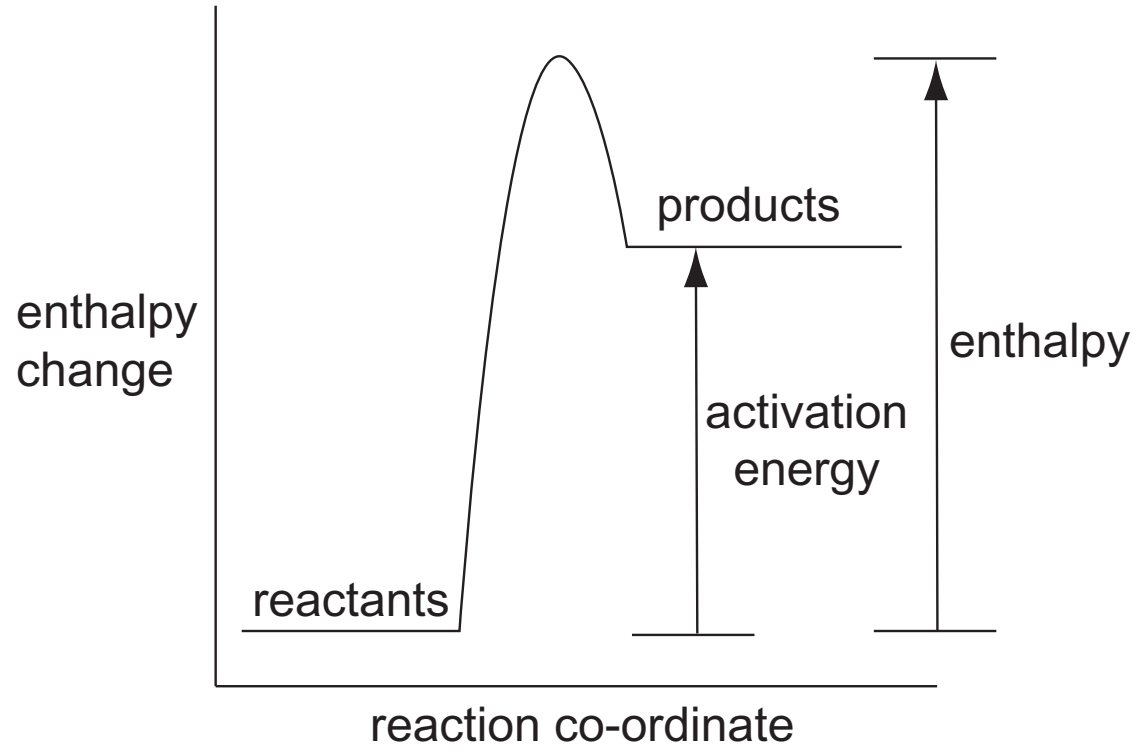
10 Which one of the following represents a correctly labelled enthalpy level diagram?



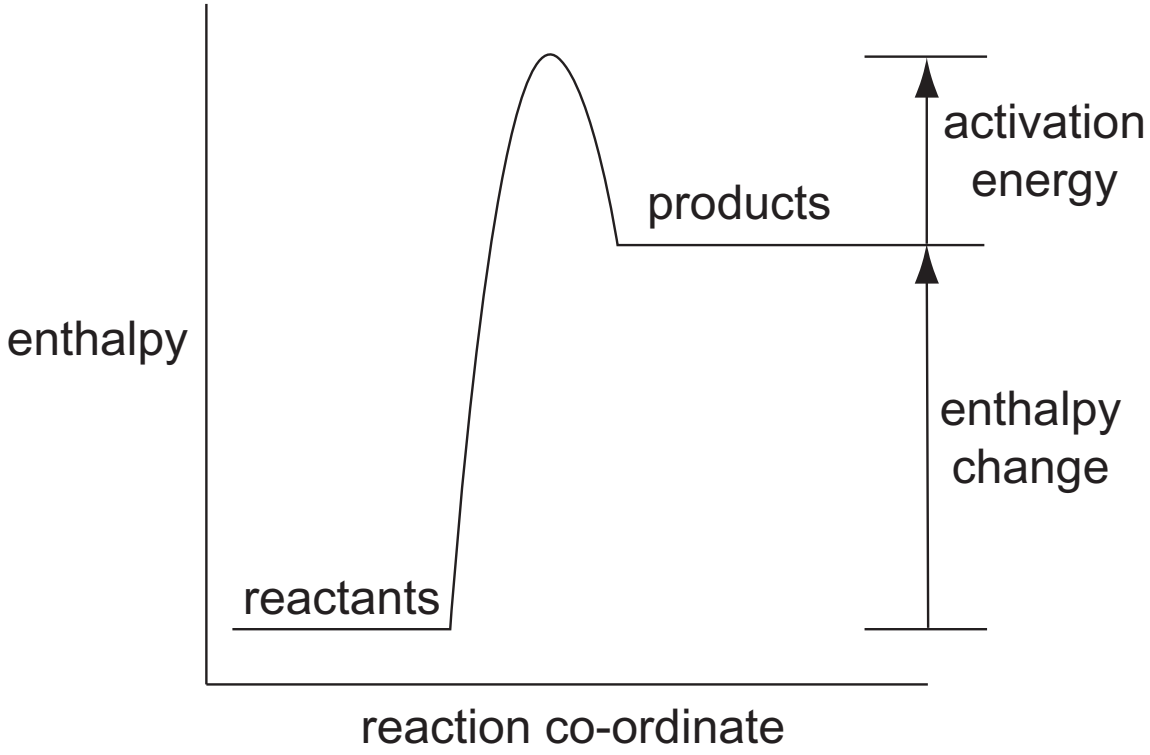
A



B


products
enthalpy change
enthalpy
activation energy
reactants
reaction co-ordinate

C


activation energy
products
enthalpy
enthalpy change
reactants
reaction co-ordinate

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:

$$C_6H_4(OH)COOH + (CH_3CO)_2O \rightarrow HOOCC_6H_4OCOCH_3 + CH_3COOH$$

salicylic acid	ethanoic anhydride	aspirin	ethanoic acid

(a) A student reacted 3.00 g of salicylic acid with 6.0 cm^3 of ethanoic anhydride.

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

_____

(ii) What mass of ethanoic anhydride was used? (Density of ethanoic anhydride = 1.08 g cm^{-3}) [1]

_____

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

_____

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

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

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

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

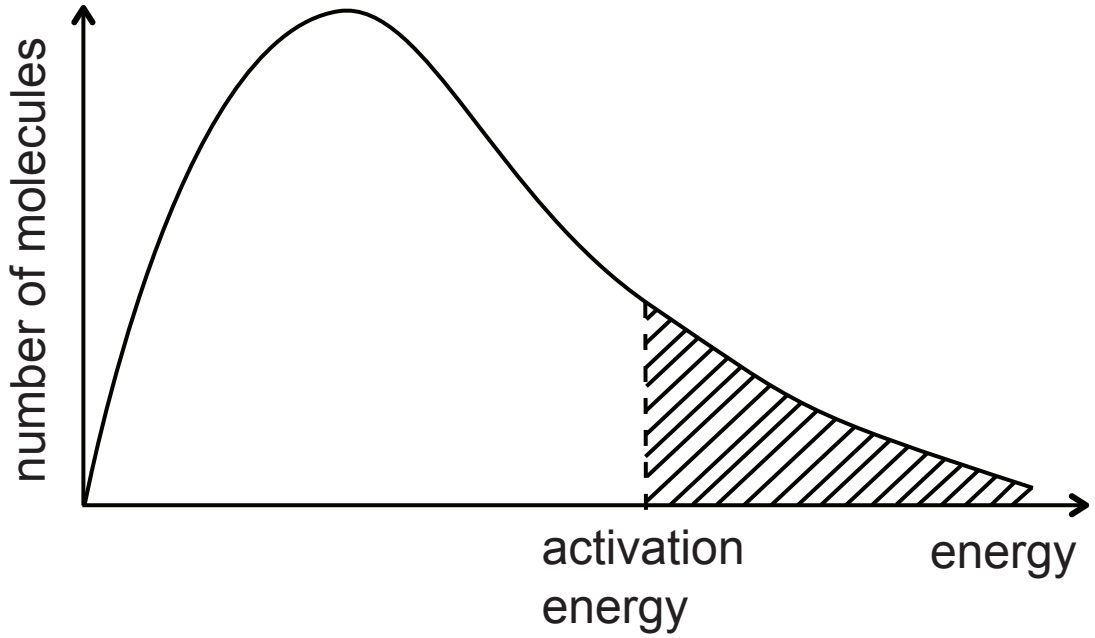
(ii) Calculate the atom economy of the reaction to prepare aspirin. [2]

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

$4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO(g) + 6H_2O(g)$ $\Delta H = -950\,kJ\,mol^{-1}$

(a) The reaction is carried out at approximately 900 **°C**.

The diagram below shows the distribution of molecular energies in the reaction mixture at 900 **°C**.



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

(ii) Draw on the diagram the distribution of the molecular energies at 1500 **°C**. [2]

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

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

(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]

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

(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]

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

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]

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

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

(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]

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

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

_____

(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]

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

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

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

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

(iv) Describe how you would carry out a flame test to distinguish between barium carbonate and calcium carbonate, giving the result for each compound. [5]

Quality of written communication [2]

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

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]

_____

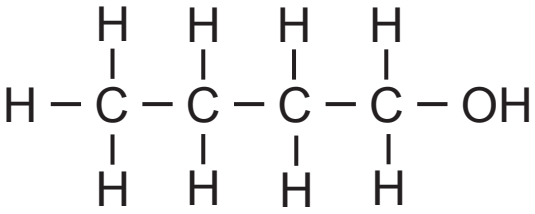
_____

_____

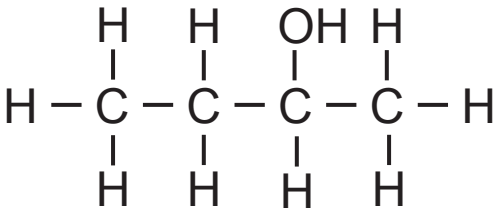
(ii) The fermentation process produces a mixture of alcohols and propanone. Suggest how the mixture may be separated. [1]

_____

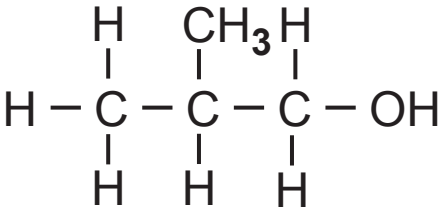
(b) C_4H_9OH has four isomers; butan-1-ol, butan-2-ol and two others, **A** and **B**.



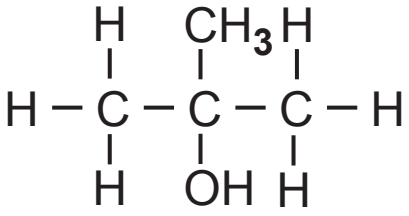
Butan-1-ol



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]

(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]

(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]

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

$$C_4H_9OH(l) + 6O_2(g) \rightarrow 4CO_2(g) + 5H_2O(g)$$

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 kJ mol^{-1}
Butan-1-ol	**–**327
Carbon dioxide	**–**394
Water	**–**286

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

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

(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]

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

$$C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$$

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

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

THIS IS THE END OF THE QUESTION PAPER

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