


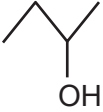
**AS Level Chemistry B**  
**H033/02 Chemistry in depth**

**Question Set 6**

6 Bioethanol is a well-known biofuel. Biobutanol is another biofuel and can be used in some combustion engines. Biobutanol can be produced in the UK from sugar beet.

(a) Butanol has the molecular formula,  $C_4H_{10}O$ . There are four structural isomers with this formula that contain the  $-OH$  functional group.

Complete the table below to show **one** other structural isomer of  $C_4H_{10}O$  that contains an  $-OH$  group.

<b>skeletal formula</b>			
<b>name</b>	butan-1-ol	butan-2-ol	

[2]

(b) Explain why the combustion of butan-1-ol is exothermic, using ideas about bond-breaking and bond-making.

You do not need to list the specific bonds broken and made.

..... [2]

(c) One disadvantage of butan-1-ol as a fuel is that it requires a higher oxygen to fuel ratio for complete combustion when compared to ethanol.

Write equations to show that butan-1-ol requires a higher oxygen to fuel ratio than ethanol for complete combustion.

combustion of butan-1-ol:

combustion of ethanol:

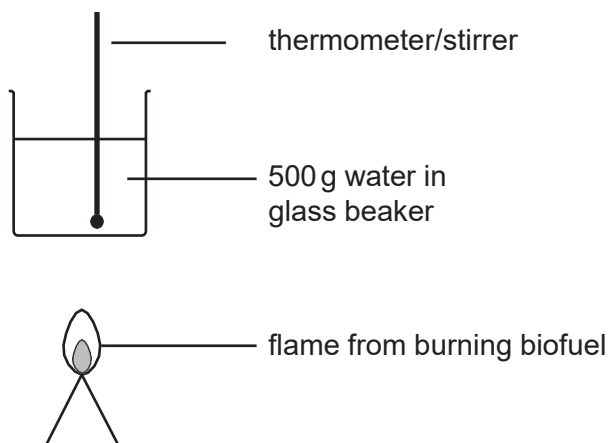
[1]

- (d) In a simple laboratory experiment, the combustion of 1.00 g of a biofuel compound raised the temperature of 500 g of water by 16.0 °C.

Calculate a value for the enthalpy change of combustion of the biofuel compound.  
( $M_r$  of the biofuel compound = 214)

$$\Delta_c H = \dots\dots\dots \text{kJ mol}^{-1} \quad [3]$$

- (e) The laboratory set-up used to obtain the data in part (d) is shown below.

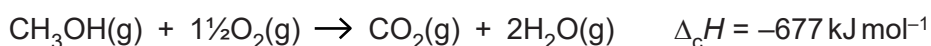


This set-up can be modified to improve the accuracy of the value for the enthalpy change.

Suggest and explain **one** simple modification that could improve the accuracy. [1]

- (f) Another alcohol that is used in some fuels is methanol,  $\text{CH}_3\text{OH}$ .

An equation for the complete combustion of methanol is shown below.



Use this information and the data in the table below to calculate a value for the bond enthalpy of the C–O bond.

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

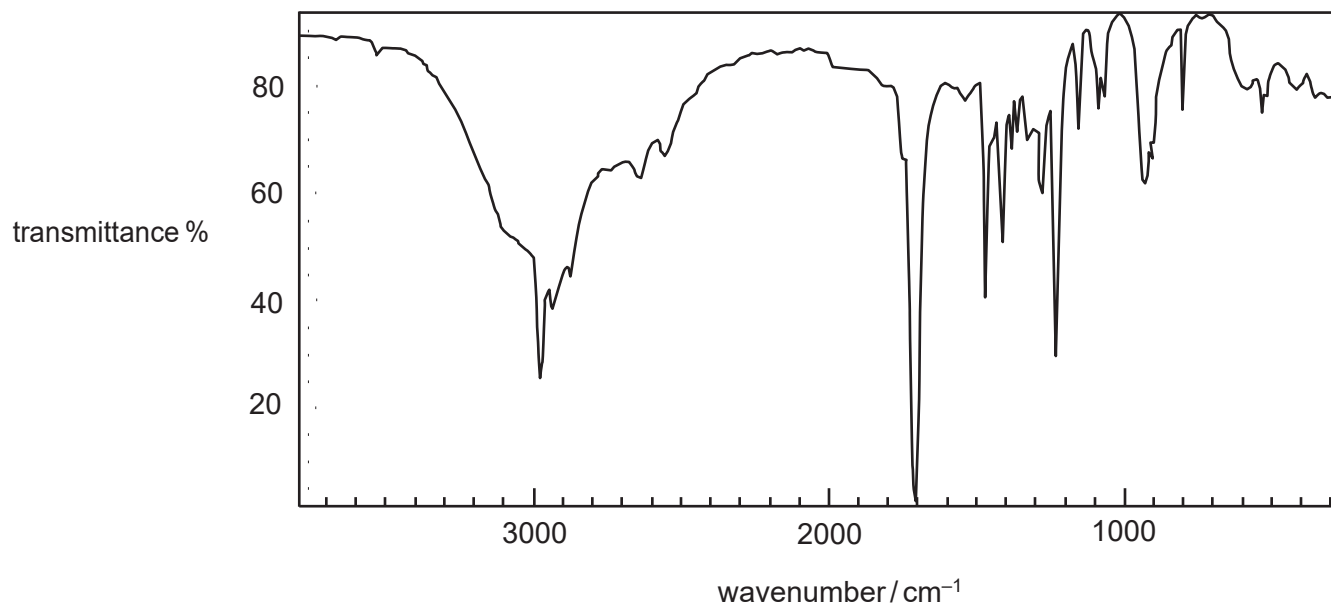
bond enthalpy of C–O bond =  $\dots\dots\dots \text{kJ mol}^{-1} \quad [3]$

(g)\* Apart from being used in fuels, alcohols are also important in the preparation of other organic chemicals.

Alcohol **A**,  $C_4H_{10}O$ , is an isomer of butanol.

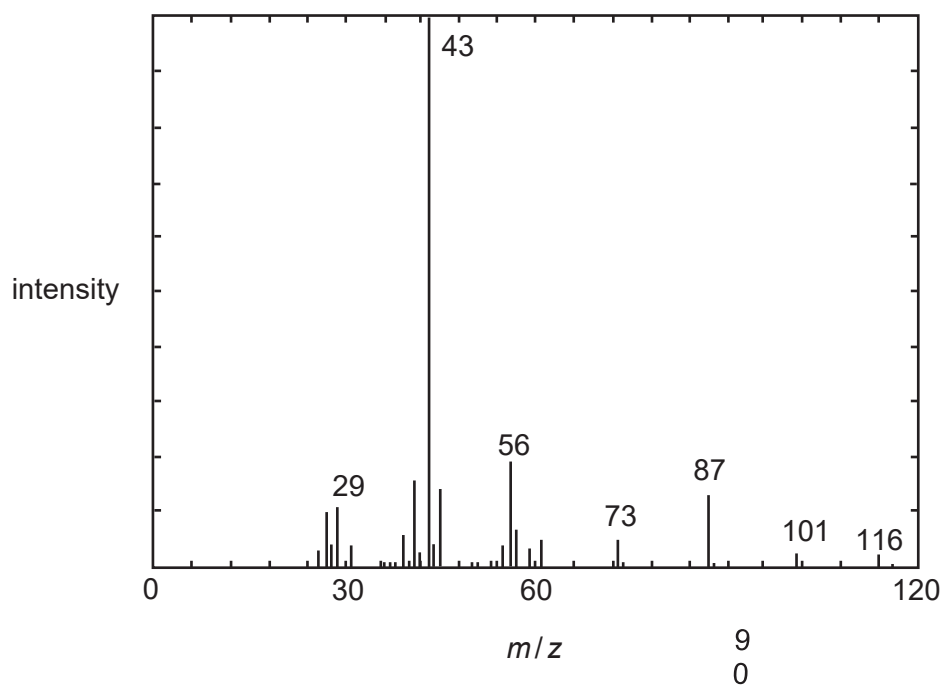
Alcohol **A** can be oxidised to compound **C** using acidified potassium dichromate(VI).

The infrared spectrum of compound **C** is shown below.



Alcohol **A** reacts with a carboxylic acid **D** to give compound **E**.

The mass spectrum of compound **E** is shown below.



Using the information on page 8, determine the formulae of the **two** possible compounds that could be alcohol **A**. Determine the corresponding formulae for compounds **C** and **E**, and the formula of **D**.

Give full reasoning for all compounds.

[6]

**Total Marks for Question Set 6: 18**



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