Oxford Cambridge and RSA

AS Level Chemistry B

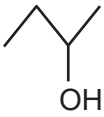
H033/02 Chemistry in depth

Question Set 6

6 Bioethanol is a well-known biofuel. Biobutanol is another biofuel and can be used in somecombustion 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.

skeletal formula			
name	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:

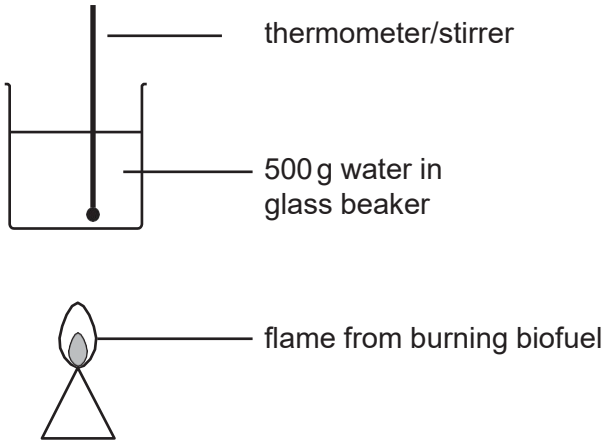
[1]

(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)

$\Delta_c H$ = ...kJ mol^{-1} **[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, CH_3OH.

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

$$CH_3OH(g) + 1\tfrac{1}{2}O_2(g) \rightarrow CO_2(g) + 2H_2O(g) \qquad \Delta_c H = -677\ kJ\ mol^{-1}$$

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

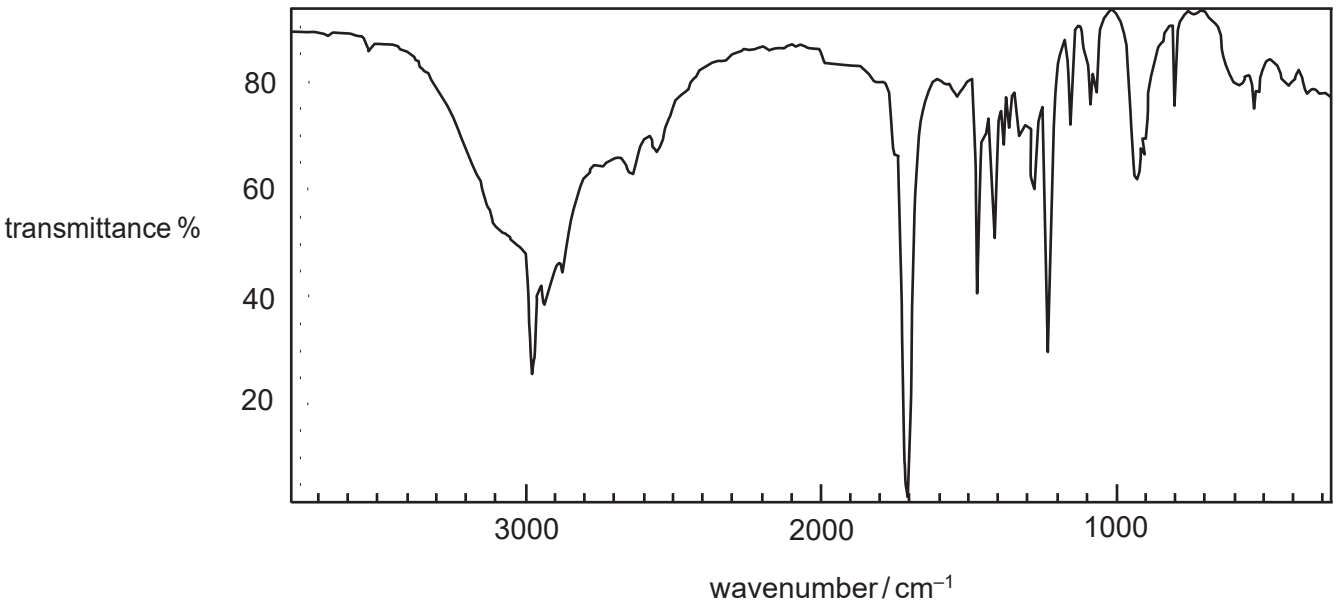
Bond	Bond enthalpy / kJ mol^{-1}
C–H	+413
O=O	+498
O–H	+464
C=O	+805

bond enthalpy of C–O bond = ...kJ mol^{-1} **[3]**

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

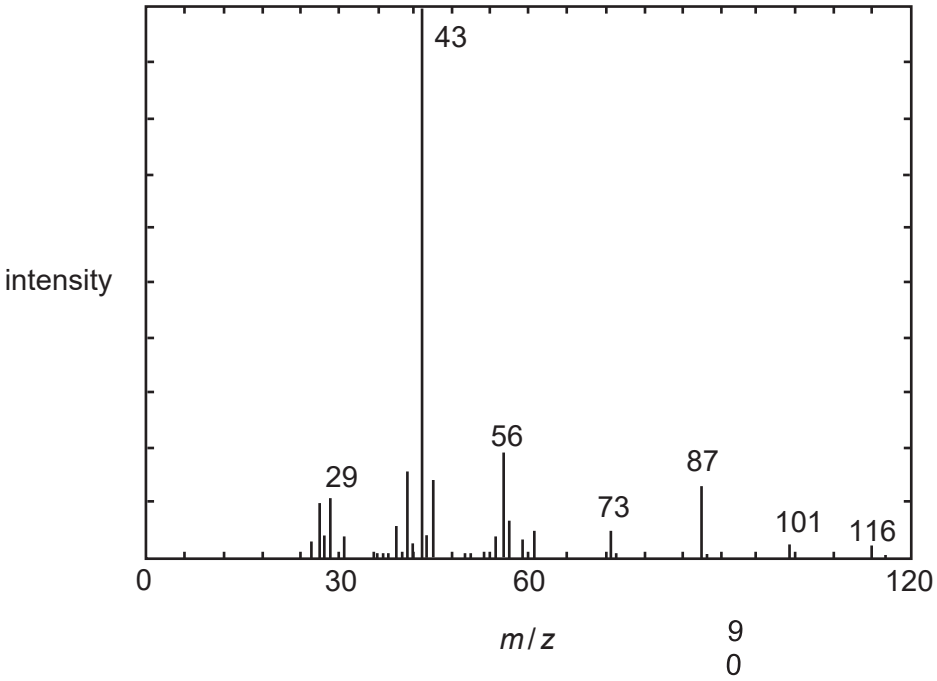
Alcohol **A**, $C_4H_{10}O$, is an isomer of butanol.
Alcohol **A** can be oxidised to compound **C** using acidified potassium dichromate(VI).

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