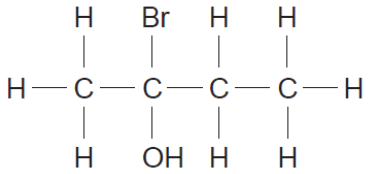
GCE AS LEVEL CHEMISTRY

S21- B410

Assessment Resource E

Energy, Rate and Carbon Compounds

1. Name the compound whose formula is shown below. [1]



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2. Name an element that contaminates many hydrocarbon fuels and that burns to form an oxide that contributes to acid rain. [1]

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3. Complete the equation for the reaction between propanoic acid and sodium carbonate. [1]

$2C_2H_5COOH + Na_2CO_3 \longrightarrow$ .....

4. *(a)* Biogas refers to a mixture of different gases produced by the breakdown of organic matter in the absence of oxygen. Its main component is methane.

Suggest why burning biogas is considered to be more environmentally friendly than burning natural gas. [2]

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(b) Ethanol is widely used as a biofuel in some countries.

(i) Write the equation to represent the standard molar enthalpy change of formation of ethanol. [2]

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(ii) The equation for its combustion is given below.

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

I. A student calculated the enthalpy change for this reaction as –1031 kJ mol^{-1} using the average bond enthalpy values given in the table.

Calculate the average bond enthalpy for the C—O bond. [3]

Bond	Average bond enthalpy / kJ mol^{-1}
C—C	348
C—H	412
O—H	463
O=O	496
C=O	743

Average bond enthalpy of C—O = ... kJ mol^{-1}

II. The literature value for the enthalpy change of this reaction is –1370 kJ mol^{-1}.

State why the values are different. [1]

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(c) Ethanol is the main alcohol present in alcoholic drinks. When driving in England, the legal limit for alcohol in the blood is 80 mg per 100 cm^3 of blood.

Calculate the concentration of ethanol in blood at this level in mol dm^{-3}. [2]

Concentration = ... mol dm^{-3}

(d) A fluorocarbon has a relative molecular mass which is twice that of its empirical formula. 9.56 g of this compound contains 6.73 g of fluorine.

Find its molecular formula. [3]

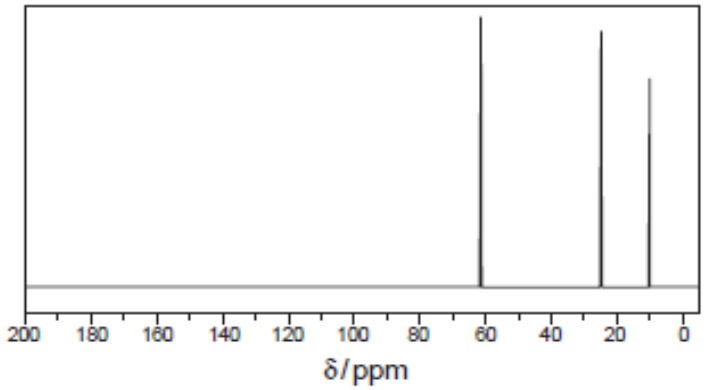
Molecular formula .....

5. *(a)* Compound **X** is an alcohol. When compound **X** is warmed with acidified potassium dichromate(VI) there is a colour change.

In the mass spectrum of compound **X**

- the molecular ion peak is at m/z 74
- the peak with the greatest relative intensity is at m/z 43 and is due to a secondary carbocation

Compound **X** has the following ^{13}C NMR spectrum.



Explain what can be deduced from each piece of information and identify the structure of compound **X**. [7]

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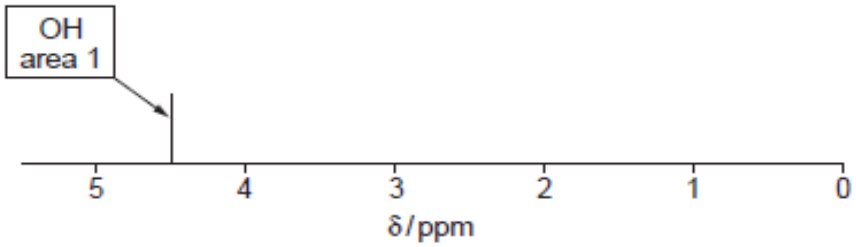
Structure of compound **X**

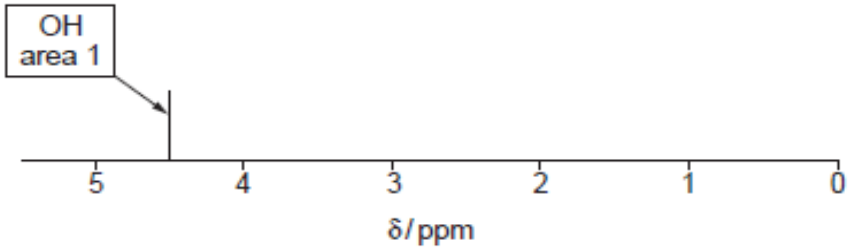
(b) Complete the sketches of the **low resolution** ^{1}H NMR spectra for propan-1-ol and propan-2-ol.

Identify which protons are responsible for each peak giving the approximate chemical shift (ppm) and the relative area of each peak. [4]

Propan-1-ol, $CH_3CH_2CH_2OH$



Propan-2-ol, $CH_3CH(OH)CH_3$



6. *(a)* (i) Describe how you would carry out an experiment to determine the enthalpy change of the reaction between magnesium oxide and hydrochloric acid.

Your answer should include details of the apparatus to be used, the measurements to be taken and the way in which you would use your results to determine the enthalpy change. [6 QER]

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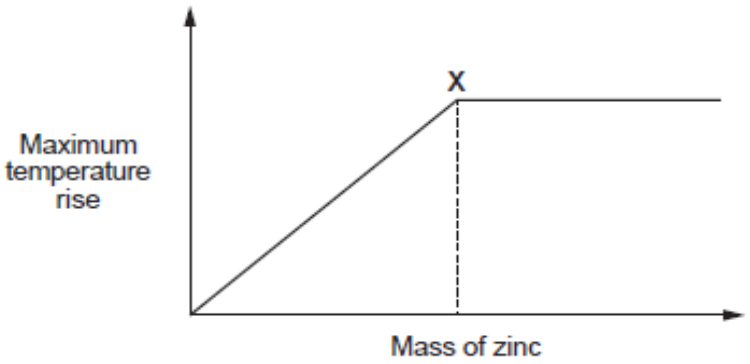
(ii) A student carried out this experiment and calculated the enthalpy change of reaction to be $-115\,kJ\,mol^{-1}$.

He used 0.900 g of magnesium oxide and $50.0\,cm^3$ of $2.00\,mol\,dm^{-3}$ hydrochloric acid.

Show that the acid is in excess and hence calculate the maximum temperature rise the student recorded. [4]

Maximum temperature rise = ... °C

(b) The graph below shows the maximum temperature rise as different masses of zinc react with separate samples of $50.0\,cm^3$ of $0.100\,mol\,dm^{-3}$ hydrochloric acid.



$$Zn(s) + 2HCl(aq) \longrightarrow ZnCl_2(aq) + H_2(g)$$

Calculate the mass of zinc at the position labelled **X**. [3]

Mass of zinc = ... g