Q1. The following pairs of compounds can be distinguished by observing what happens in test-tube reactions.
For each pair, give a suitable aqueous reagent that could be added separately to each compound.
Describe what you would observe in each case.

(a) NaF(aq) and NaCl(aq)

Reagent .....

Observation with NaF(aq) .....

Observation with NaCl(aq) .....

(3)

(b) $BaCl_2(aq)$ and $MgCl_2(aq)$

Reagent .....

Observation with $BaCl_2(aq)$ .....

Observation with $MgCl_2(aq)$ .....

(3)

(c) AgCl(s) and AgI(s)

Reagent .....

Observation with AgCl(s) .....

Observation with AgI(s) .....

(3)

(d) Butan-2-ol(l) and 2-methylpropan-2-ol(l)

Reagent ….....

Observation with butan-2-ol(l) .....

Observation with 2-methylpropan-2-ol(l) .....

(3)
(Total 12 marks)

Q2. Ethanol can be oxidised slowly to ethanal. State how a sample of ethanol could be tested to confirm the presence of ethanal. State what you would observe.

Test .....

Observation .....

(Total 2 marks)

Q3. A student devised an experiment to investigate the enthalpies of combustion of some alcohols. The student chose the following series of primary alcohols.

Name	Formula
Methanol	CH_3OH
Ethanol	CH_3CH_2OH
Propan-1-ol	$CH_3CH_2CH_2OH$
Butan-1-ol	$CH_3CH_2CH_2CH_2OH$
Pentan-1-ol	$CH_3CH_2CH_2CH_2CH_2OH$
Alcohol **X**	$CH_3CH_2CH_2CH_2CH_2CH_2OH$
Heptan-1-ol	$CH_3CH_2CH_2CH_2CH_2CH_2CH_2OH$

(a) (i) Name alcohol **X**.

.....

(1)

(ii) State the general name of the type of series shown by these primary alcohols.

.....

(1)

(iii) Draw the displayed formula of the position isomer of butan-1-ol.

(1)

(iv) Using [O] to represent the oxidising agent, write an equation for the oxidation of butan-1-ol to form an aldehyde.

.....

(1)

(v) Draw the displayed formula of a functional group isomer of this aldehyde.

(1)

(b) The student carried out a laboratory experiment to determine the enthalpy change when a sample of butan-1-ol was burned.
The student found that the temperature of 175 g of water increased by 8.0 °C when 5.00×10^{-3} mol of pure butan-1-ol was burned in air and the heat produced was used to warm the water.

Use the student's results to calculate a value, in kJ mol^{-1}, for the enthalpy change when one mole of butan-1-ol is burned.
(The specific heat capacity of water is 4.18 J K^{-1} g^{-1})

.....

.....

.....

.....

.....

.....

.....

.....

(3)

(c) (i) Give the meaning of the term *standard enthalpy of combustion*.

.....

.....

.....

.....

.....

(3)

(ii) Use the standard enthalpy of formation data from the table and the equation for the combustion of butan-1-ol to calculate a value for the standard enthalpy of combustion of butan-1-ol.

	$CH_3CH_2CH_2CH_2OH(l)$	$O_2(g)$	$CO_2(g)$	$H_2O(l)$
$\Delta H_f^{\ominus}$ / kJ mol^{-1}	–327	0	–394	–286

$$CH_3CH_2CH_2CH_2OH(l) + 6O_2(g) \longrightarrow 4CO_2(g) + 5H_2O(l)$$

.....

.....

.....

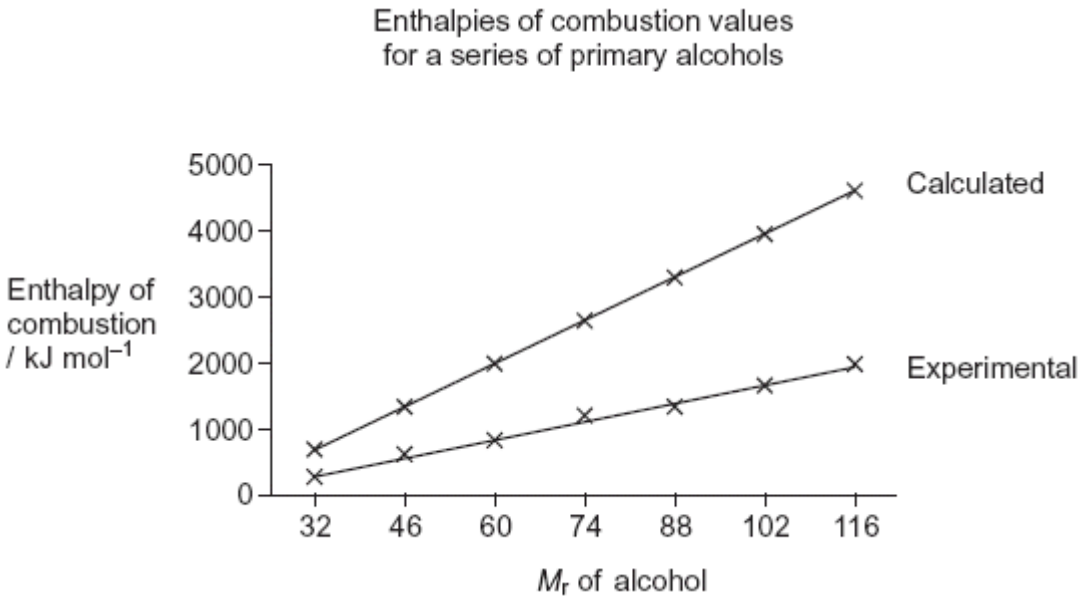
.....

.....

.....

(3)

(d) The student repeated the experiment described in part (b) and obtained an experimental value for the enthalpy of combustion for each alcohol in this series. These experimental values were then compared with calculated values from standard enthalpies of formation, as shown in the graph below.



(i) In terms of bonds broken and bonds formed, explain why the calculated values of enthalpies of combustion of these alcohols, when plotted against M_r, follow a straight line.

.....

.....

.....

.....

(2)

(ii) Give **two** reasons why the experimental values obtained by the student are lower than the calculated values using the enthalpy of formation data.

.....

.....

.....

.....

(2)

(Total 18 marks)

Q4. Sulfuric acid is an important chemical in many industrial and laboratory reactions. Consider the following three reactions involving sulfuric acid.

Reaction **1** $Mg(OH)_2 + H_2SO_4 \rightarrow MgSO_4 + 2H_2O$

Reaction **2** The reaction of solid sodium bromide with concentrated sulfuric acid

Reaction **3** $H_2C{=}CH_2 + H_2O \xrightarrow{\text{conc. } H_2SO_4} CH_3CH_2OH$

(a) Give a use for magnesium hydroxide in medicine.

.....

(1)

(b) Sulfuric acid behaves as an oxidising agent in Reaction **2**.

(i) In terms of electrons, state the meaning of the term oxidising agent.

.....

(1)

(ii) Give the formula of the oxidation product that is formed from sodium bromide in Reaction **2**.

.....

(1)

(iii) Deduce the half-equation for the reduction of H_2SO_4 to SO_2 in Reaction **2**.

.....

(1)

(c) The formation of ethanol in Reaction **3** uses concentrated sulfuric acid and proceeds in two stages according to the following equations.

Stage **1** $H_2C{=}CH_2 + H_2SO_4 \longrightarrow CH_3CH_2OSO_2OH$

Stage **2** $CH_3CH_2OSO_2OH + H_2O \longrightarrow CH_3CH_2OH + H_2SO_4$

(i) State the overall role of sulfuric acid in Reaction **3**.

.....

(1)

(ii) Outline a mechanism for Stage **1** of this reaction.

(4)

(iii) State the class of alcohols to which ethanol belongs.

.....

(1)

(iv) Draw the displayed formula of the carboxylic acid formed when ethanol is oxidised by an excess of acidified potassium dichromate(VI) solution.

(1)
(Total 11 marks)

Q5.(a) Propanoic acid can be made from propan-1-ol by oxidation using acidified potassium dichromate(VI). Propanal is formed as an intermediate during this oxidation.

(i) State the colour of the chromium species after the potassium dichromate(VI) has reacted.

.....

(1)

(ii) Describe the experimental conditions and the practical method used to ensure that the acid is obtained in a high yield. Draw a diagram of the assembled apparatus you would use.

Conditions .....

.....

Apparatus

(4)

(iii) Describe the different experimental conditions necessary to produce propanal in high yield rather than propanoic acid.

.....

.....

(2)

(b) Propan-1-ol is a volatile, flammable liquid.
Give **one** safety precaution that should be used during the reaction to minimise this hazard.

.....

(1)

(c) A student followed the progress of the oxidation of propan-1-ol to propanoic acid by extracting the organic compounds from one sample of reaction mixture.

(i) Give a chemical reagent which would enable the student to confirm the presence of propanal in the extracted compounds.

State what you would observe when propanal reacts with this reagent.

Reagent .....

Observation .....

.....

(2)

(ii) Give a chemical reagent that would enable the student to confirm the presence of propanoic acid in the extracted compounds.
State what you would observe when propanoic acid reacts with this reagent.

Reagent .....

Observation .....

.....

(2)

(d) Predict which **one** of the compounds, propan-1-ol, propanal and propanoic acid will have the highest boiling point. Explain your answer.

Prediction .....

Explanation .....

.....

.....

.....

.....

(3)
(Total 15 marks)