**Q1.** (a) An alcohol containing carbon, hydrogen and oxygen only has 64.9% carbon and 13.5% hydrogen by mass. Using these data, show that the empirical formula of the alcohol is $C_4H_{10}O$

.....

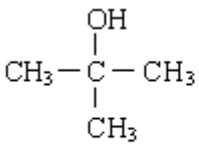
.....

.....

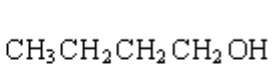
.....

**(3)**

(b) The structural formulae of two of the four possible alcohols of molecular formula $C_4H_{10}O$ are shown below.



*Isomer 1*



*Isomer 2*

(i) What type of alcohol is Isomer 1? Suggest a reason why this type of alcohol is not easily oxidised.

*Type of alcohol* .....

*Reason* .....

(ii) Draw the structural formulae of the two remaining alcohols of molecular formula $C_4H_{10}O$

*Isomer 3* *Isomer 4*

**(4)**

(c) Isomer 2 was oxidised by adding it dropwise to acidified potassium dichromate(VI) solution and immediately distilling off the product. When this product was treated with Fehling's solution, a red precipitate was formed.

(i) State the type of product distilled off during the oxidation by acidified potassium dichromate(VI) solution.

.....

(ii) Write an equation for the oxidation by potassium dichromate(VI), showing clearly the structure of the organic product. Use [O] to represent the oxidising agent.

.....

(iii) Name and draw a structure for the organic product formed by the reaction with Fehling's solution.

*Name* .....

*Structure* .....

**(5)**

(d) State **one** advantage and **one** disadvantage of the production of ethanol by the hydration of ethene compared to the fermentation of glucose.

*Advantage* .....

*Disadvantage* .....

**(2)**

(e) Outline a mechanism for the dehydration of ethanol to form ethene in the presence of an acid catalyst.

**(4)**
**(Total 18 marks)**

**Q2.** Ethanol is produced commercially by fermentation of aqueous glucose, $C_6H_{12}O_6$

State **two** conditions, other than temperature, which are necessary for fermentation.

Explain why neither a low temperature nor a high temperature is suitable for this reaction.

Give **two** advantages of this method of production over that by the direct hydration of ethene.

Write an equation for the production of ethanol by fermentation and an equation for the complete combustion of ethanol.

**(Total 8 marks)**

**Q3.** Which one of the following is **not** a suitable method for the preparation of ethanol?

**A** oxidation of ethane

**B** hydration of ethene

**C** reduction of ethanal

**D** hydrolysis of bromoethane

**(Total 1 mark)**