

CHAPTER 15 ALCOHOLS

1 Glucose, $C_6H_{12}O_6$, can be converted into ethanol. Ethanol can be used as a fuel or can be converted into ethene by acid-catalysed dehydration. Most of the ethene used by industry is formed by the thermal cracking of alkanes.

(a) (i) State **four** essential conditions for the conversion of glucose into ethanol.

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(4 marks)

(ii) Name the process

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(1 mark)

(iii) Give an equation for the reaction which takes place.

.....
(1 mark)

(iv) Write an equation for the complete combustion of ethanol.

.....
(1 mark)

(b) (i) Explain what is meant by the term *dehydration*.

.....
.....
(1 mark)

(ii) Identify a catalyst which could be used in the acid-catalysed dehydration of ethanol.

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(1 mark)

(iii) Write an equation for the reaction which takes place.

.....
(1 mark)

2 Consider the following pairs of structural isomers.

Molecular formula	Structure	Structure
$C_4H_{10}O$	<p>Isomer A</p> $\begin{array}{c} \text{CH}_3 \\ \\ \text{H}_3\text{C}-\text{C}-\text{CH}_3 \\ \\ \text{OH} \end{array}$	<p>Isomer B</p> $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$
	<p>Isomer C</p> $\begin{array}{c} \text{CH}_3\text{CH}_2-\text{C}=\text{O} \\ \\ \text{H} \end{array}$	<p>Isomer D</p> $\begin{array}{c} \text{H}_3\text{C}-\text{C}-\text{CH}_3 \\ \\ \text{O} \end{array}$
C_6H_{12}	<p>Isomer E</p> $\begin{array}{c} \text{CH}_2 \\ / \quad \backslash \\ \text{H}_2\text{C} \quad \text{CH}_2 \\ \quad \quad \\ \text{H}_2\text{C} \quad \text{CH}_2 \\ \backslash \quad / \\ \text{CH}_2 \end{array}$	<p>Isomer F</p> $\text{CH}_3\text{CH}_2\text{CH}=\text{CHCH}_2\text{CH}_3$

(a) (i) Explain what is meant by the term *structural isomers*.

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(ii) Complete the table to show the molecular formula of isomers C and D.

(iii) Give the empirical formula of isomers E and F.

.....
 (4 marks)

(b) A simple chemical test can be used to distinguish between separate samples of isomer A and isomer B. Suggest a suitable test reagent and state what you would observe in each case.

Test reagent

Observation with isomer A

Observation with isomer B

(3 marks)

- (c) A simple chemical test can be used to distinguish between separate samples of isomer **C** and isomer **D**. Suggest a suitable test reagent and state what you would observe in each case.

Test reagent

Observation with isomer **C**

Observation with isomer **D**

(3 marks)

- (d) A simple chemical test can be used to distinguish between separate samples of isomer **E** and isomer **F**. Suggest a suitable test reagent and state what you would observe in each case.

Test reagent

Observation with isomer **E**

Observation with isomer **F**

(3 marks)

- 3** (a) Pentanal, $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CHO}$, can be oxidised to a carboxylic acid.

- (i) Write an equation for this reaction. Use [O] to represent the oxidising agent.

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- (ii) Name the carboxylic acid formed in this reaction.

.....

(2 marks)

- (b) Pentanal can be formed by the oxidation of an alcohol.

- (i) Identify this alcohol.

.....

- (ii) State the class to which this alcohol belongs.

.....

(2 marks)

- 4 Some alcohols can be oxidised to form aldehydes, which can then be oxidised further to form carboxylic acids.
Some alcohols can be oxidised to form ketones, which resist further oxidation.
Other alcohols are resistant to oxidation.

(a) Draw the structures of the **two** straight-chain isomeric alcohols with molecular formula, $C_4H_{10}O$

(2 marks)

(b) (i) Draw the structures of the oxidation products obtained when the two alcohols from part (a) are oxidised separately by acidified potassium dichromate(VI).

(3 marks)

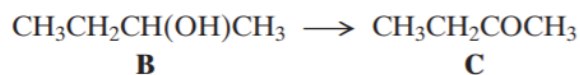
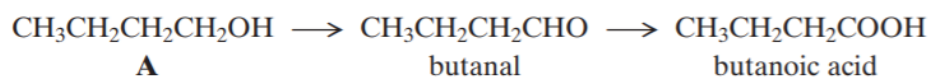
(ii) Write equations for any reactions which occur, using [O] to represent the oxidising agent.

(3 marks)

- (c) Draw the structure and give the name of the alcohol with molecular formula $C_4H_{10}O$ which is resistant to oxidation by acidified potassium dichromate(VI).

(2 marks)

- 5 Consider the following reaction schemes involving two alcohols, **A** and **B**, which are position isomers of each other.



- (a) State what is meant by the term *position isomers*.

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.....
.....

(2 marks)

- (b) (i) Name compound **A**

.....
(1 mark)

- (ii) Name the class of compounds to which **C** belongs.

.....
(1 mark)

(c) Each of the reactions shown in the schemes above is of the same type and uses the same combination of reagents.

(i) State the type of reaction.

.....

(ii) Identify a suitable combination of reagents.

.....

(iii) State how you would ensure that compound **A** is converted into butanoic acid rather than into butanal.

.....

.....

(iv) Draw the structure of an isomer of compound **A** which does not react with this combination of reagents.

(v) Draw the structure of the carboxylic acid formed by the reaction of methanol with this combination of reagents.

(6 marks)

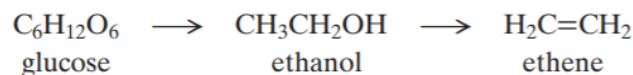
(d) (i) State a reagent which could be used to distinguish between butanal and compound **C**.

.....

(ii) Draw the structure of another aldehyde which is an isomer of butanal.

(2 marks)

- 6 Glucose can be used as a source of ethanol. Ethanol can be burned as a fuel or can be converted into ethene.



- (a) Name the types of reaction illustrated by the two reactions above.

Glucose to ethanol

Ethanol to ethene

(2 marks)

- (b) (i) State what must be added to an aqueous solution of glucose so that ethanol is formed.

.....

- (ii) Identify a suitable catalyst for the conversion of ethanol into ethene.

.....

(2 marks)

- (c) (i) State the class of alcohols to which ethanol belongs.

.....

- (ii) Give **one** advantage of using ethanol as a fuel compared with using a petroleum fraction.

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(2 marks)

- (d) Most of the ethene used by industry is produced when ethane is heated to 900°C in the absence of air. Write an equation for this reaction.

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(1 mark)