

Alcohols

Question Paper 5

Level	International A Level
Subject	Chemistry
Exam Board	CIE
Topic	Hydroxy Compounds
Sub-Topic	Alcohols
Paper Type	Theory
Booklet	Question Paper 5

Time Allowed: 74 minutes

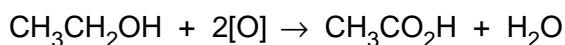
Score: /61

Percentage: /100

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	77.5%	70%	62.5%	57.5%	45%	<45%

- 1 Ethanoic acid, $\text{CH}_3\text{CO}_2\text{H}$, is formed as vinegar by the bacterial oxidation of ethanol present in wine and other solutions.



Ethanoic acid can also be formed in the laboratory by the oxidation of ethanol.

- (a) (i) What oxidising agent is used for this laboratory reaction?

.....

- (ii) What colour change would be observed?

from to

[2]

When ethanoic acid is prepared in this way in the laboratory, the reagents are heated under reflux for some time before the ethanoic acid is separated.

- (b) (i) Why is the reaction carried out by heating under reflux?

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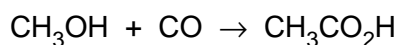
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- (ii) What would be the main organic compound formed if, instead of heating under reflux, the reagents were heated together and the products immediately distilled off?

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[2]

- (c) Ethanoic acid is manufactured from methanol, CH_3OH , by reacting it with carbon monoxide in the presence of a catalyst containing rhodium metal and iodide ions.



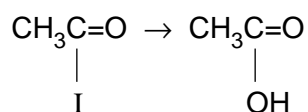
The reaction proceeds in a number of stages.

- (i) One stage in this process is the reaction of methanol with hydrogen iodide.

What organic compound is formed in this reaction?

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- (ii) A later stage involves the conversion of an intermediate compound.

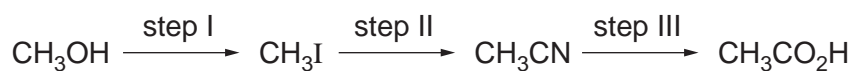


What type of reaction is this?

.....

[2]

- (d) Methanol can be converted into ethanoic acid in the laboratory in a three-stage process.



What reagent(s) and conditions are used in each step of the conversion?

step I

reagent(s)

conditions

step II

reagent(s)

conditions

step III

reagent(s)

conditions

[6]

[Total: 12]

2 Compounds containing the allyl group, $\text{CH}_2=\text{CHCH}_2-$, have pungent smells and are found in onions and garlic.

Allyl alcohol, $\text{CH}_2=\text{CHCH}_2\text{OH}$, is a colourless liquid which is soluble in water.

(a) Allyl alcohol behaves as an alkene and as a primary alcohol.

Give the structural formula of the organic compound formed when allyl alcohol is

(i) reacted with Br_2 ,

(ii) heated under reflux with an acidified solution of $\text{Cr}_2\text{O}_7^{2-}$ ions.

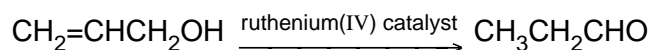
[2]

(b) When allyl alcohol is reacted with MnO_2 at room temperature, propenal, $\text{CH}_2=\text{CHCHO}$ is formed.

What type of reaction is this?

.....[1]

(c) Allyl alcohol may be converted into propanal, $\text{CH}_3\text{CH}_2\text{CHO}$, by using a ruthenium(IV) catalyst in water.

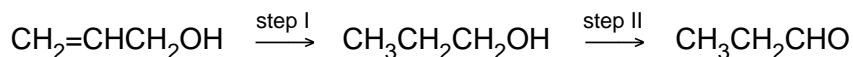


The reactant and the product are isomers.

What form of isomerism do they display?

.....[1]

- (d) Allyl alcohol can be converted into propanal in two steps **without** the use of a ruthenium(IV) catalyst.



What reagents and conditions would be used for **each** step?

step I

reagent(s)

condition(s)

step II

reagent(s)

condition(s)[4]

- (e) By considering your answers to (b) and (d), suggest what is unusual about the single-step reaction in (c).

.....

.....[1]

- (f) Suggest the structural formula of the organic compound formed when allyl alcohol is

(i) reacted with cold, dilute MnO_4^- ions,

(ii) heated under reflux with acidified MnO_4^- ions.

[3]

[Total: 12]

3 (a) (i) State the electronic configuration of the iron atom.

.....

(ii) Apart from its electronic structure, state **two** properties of iron or its compounds that are characteristic of a transition element.

.....

.....

[3]

(b) Acidified solutions of iron(II) salts can be titrated using a dilute solution of potassium manganate(VII), KMnO_4 .

(i) Use the *Data Booklet* to calculate the standard cell potential and to write a balanced ionic equation for the reaction that takes place during the titration.

.....

.....

.....

(ii) Explain why no indicator is required for this titration. What colour change would you see at the end point?

.....

.....

.....

[4]

(c) Use the reaction between Fe^{3+} ions and water molecules to explain the meanings of the terms *ligand* and *complex formation*.

.....

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.....

[2]

(d) An important biological molecule containing iron is haemoglobin.

(i) What is the role of haemoglobin in the body?

.....

(ii) Use your answer to (i) to explain why carbon monoxide is poisonous.

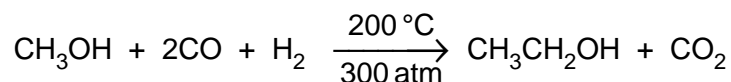
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[2]

(e) In a possible industrial synthesis of ethanol, the complex $\text{Fe}(\text{CO})_5$ catalyses the reaction between carbon monoxide, hydrogen and methanol according to the following equation.



Describe a test (reagents and observations) that would distinguish ethanol from methanol.

reagents

observation with methanol

observation with ethanol..... [2]

[Total: 13]

4 Esters are compounds which provide the flavour of many fruits and the perfumes of many flowers.

(a) The ester $\text{CH}_3(\text{CH}_2)_2\text{CO}_2\text{CH}_3$ contributes to the aroma of apples.

(i) State the reagents and conditions needed for the hydrolysis of this ester.

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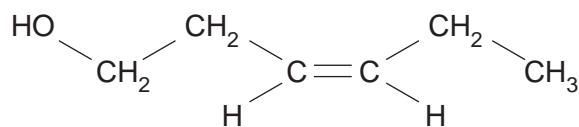
(ii) Write the equation for the hydrolysis of this ester.

.....

(iii) Apart from their use as perfumes and food flavourings, state **one** major commercial use of esters.

.....[3]

(b) Leaf alcohol is a stereoisomer that can form when insects such as caterpillars eat green leaves.



(i) Draw the other stereo-isomer of leaf alcohol.

(ii) Draw the structure for the ester formed when leaf alcohol reacts with ethanoic acid. Show **all** the bonds in the ester group.

[3]

(c) (i) Deduce the relative molecular mass, M_r , for leaf alcohol.

- (ii) Leaf alcohol was reacted to form a product with an M_r value 18 units less.

Suggest a structure for this product and deduce the type of reaction that took place.

structure of product.

type of reaction[3]

- (d) Describe a simple chemical test to distinguish between leaf alcohol and your product in (c)(ii).

test

observation[2]

[Total : 11]

- 5 A number of organic compounds containing the halogens fluorine and/or chlorine are commercially important because of their chemical inertness.

- (a) Name **three** such compounds, and for each state a use where its inertness is important.

(i)

.....

(ii)

.....

(iii)

.....[6]

- (b) Under certain conditions in the upper atmosphere, some of these compounds break down.

- (i) Explain how this happens and what effects this has, in chemical terms.

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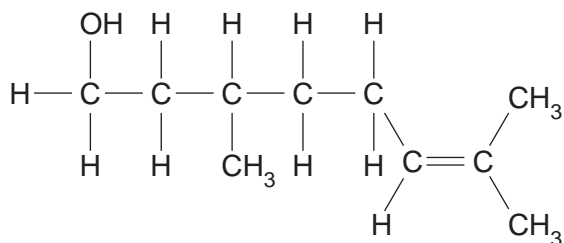
- (ii) Suggest alternative compounds, which do not contain a halogen, for **two** of the uses you have given in (a).

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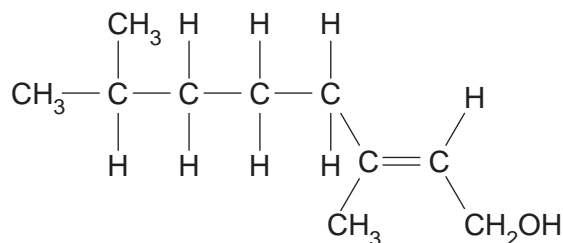
.....[5]

[Total : 11]

- 5 Some perfumes and scents of flowers and fruit contain compounds which are structural isomers. Two such examples are citronellol and geraniol.



citronellol



geraniol

- (a) Confirm that citronellol and geraniol are isomers by calculating their molecular formula and their relative molecular mass, M_r .

(i) Molecular formula

(ii) M_r [2]

- (b) Name two functional groups present in **both** molecules.

(i)

(ii) [3]

Citronellol and geraniol also show stereo isomerism.

- (c) On the diagram of the structure of citronellol above, draw a circle around a chiral carbon atom. [1]

(d) (i) Draw the other *cis-trans* isomer of geraniol. [In parts (d) and (f) use R – to represent a part of the molecule.]

(ii) Explain why geraniol has no optical isomers.

.....
.....[2]

(e) State what you would expect to see if citronellol was reacted with aqueous bromine.

.....
.....[1]

(f) Draw structures of the organic products when geraniol reacts with each of the following reagents.

(i) an excess of $\text{H}^+/\text{Cr}_2\text{O}_7^{2-}$ under reflux

(ii) ethanoic acid in the presence of an acidic catalyst

(iii) hydrogen bromide, HBr

[4]

[Total : 13]