

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

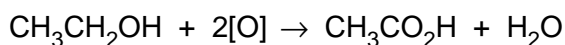
Score: /61

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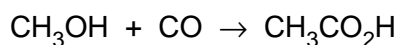
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- (ii) What would be the main organic compound formed if, instead of heating under reflux, the reagents were heated together and the products immediately distilled off?

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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.



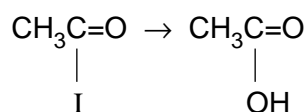
The reaction proceeds in a number of stages.

- (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.

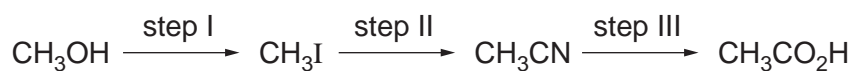


What type of reaction is this?

.....

[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.

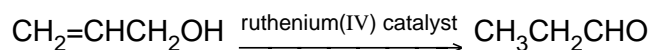
[2]

(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.

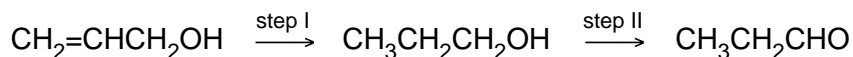


The reactant and the product are isomers.

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.

.....

.....

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(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?

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

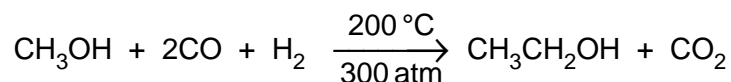
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[2]

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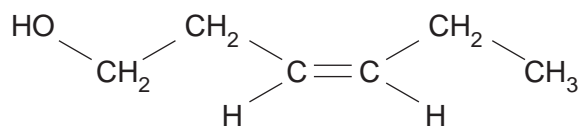
(ii) Write the equation for the hydrolysis of this ester.

.....

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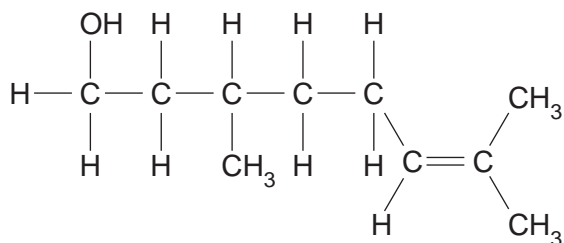
- (ii) Suggest alternative compounds, which do not contain a halogen, for **two** of the uses you have given in (a).

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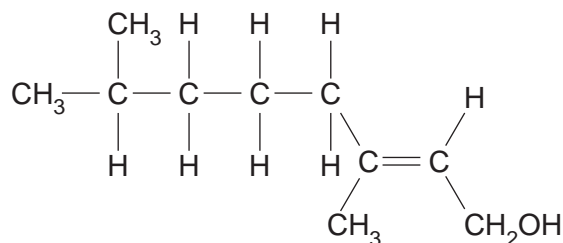
.....[5]

[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]