

# Carboxylic Acids & Derivatives

## Question Paper 5

<b>Level</b>	International A Level
<b>Subject</b>	Chemistry
<b>Exam Board</b>	CIE
<b>Topic</b>	Carboxylic Acids & Derivatives
<b>Sub-Topic</b>	
<b>Paper Type</b>	Theory
<b>Booklet</b>	Question Paper 5

**Time Allowed:** 56 minutes

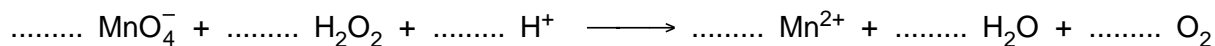
**Score:** /46

**Percentage:** /100

**Grade Boundaries:**

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

- 1 Potassium manganate(VII) can be used to estimate the percentage of hydrogen peroxide in household bleach. The following unbalanced equation represents the reaction between them.



- (a) Balance this equation by putting the appropriate numbers in the spaces above. [1]

- (b) Use data from the *Data Booklet* to calculate the  $E_{\text{cell}}^\ominus$  for the reaction.

.....[1]

- (c) When  $0.020 \text{ mol dm}^{-3}$   $\text{KMnO}_4(\text{aq})$  was added from a burette into an acidified  $25.0 \text{ cm}^3$  sample of  $\text{H}_2\text{O}_2$ ,  $15.0 \text{ cm}^3$  of  $\text{KMnO}_4$  was required to reach the end-point.

- (i) Describe what you would see during this titration, and also at the end-point.

.....  
.....

- (ii) Calculate the concentration of  $\text{H}_2\text{O}_2$  in the sample.

.....  
.....  
.....

[4]

[Total: 6]

2 Compound **Z**, an organic compound with **three** functional groups, has the molecular formula  $C_4H_6O_2$ . The functional groups can be confirmed by the following tests.

(a) Test for the first functional group.

**Z** decolourises aqueous bromine.

What functional group is shown to be present in **Z** by this test?

..... [1]

(b) Tests for the second functional group.

**Z** reacts with sodium to give hydrogen and a solid compound of formula  $C_4H_5O_2Na$ .

When **Z** is heated with ethanoic acid and a few drops of concentrated sulphuric acid, a sweet smelling liquid of molecular formula  $C_6H_8O_3$  is formed.

What functional group is shown to be present in **Z** by these tests?

..... [1]

(c) Tests for the third functional group.

A few drops of **Z** form a yellow/orange precipitate when added to 2,4-dinitrophenylhydrazine reagent.

When a few drops of **Z** are warmed with Tollens' reagent, a silver mirror is formed.

What functional group is shown to be present in **Z** by these tests?

..... [1]

(d) **Z** does **not** show *cis-trans* isomerism.

Draw the displayed formula of **Z**.

[2]

In parts (e) and (f) you may use R– to represent the part of the molecule that does not react.

(e) What is the organic compound formed by the reactions of **Z** in **each** of the tests in (b)?

with sodium

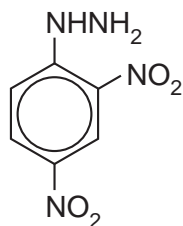
with ethanoic acid

[2]

(f) Draw the structure of the organic compound formed by **Z** in **each** of the tests in (c).

with Tollens' reagent

with 2,4-dinitrophenylhydrazine,



[2]

(g) But-2-enoic acid is an isomer of **Z** which shows *cis-trans* isomerism.

Draw a displayed formula of the *cis* isomer of this acid.

[2]

[Total: 11]

3 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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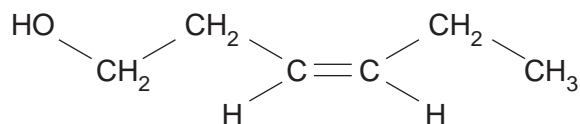
(ii) Write the equation for the hydrolysis of this ester.

.....

(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.  
.....  
.....  
.....  
.....

(ii) Suggest alternative compounds, which do not contain a halogen, for **two** of the uses you have given in (a).  
.....  
.....[5]

[Total : 11]

4 2-Hydroxypropanoic acid (lactic acid),  $\text{CH}_3\text{CH}(\text{OH})\text{CO}_2\text{H}$ , can be prepared in a two-stage synthesis from ethanal,  $\text{CH}_3\text{CHO}$ .

(a) In the first stage, ethanal reacts with hydrogen cyanide,  $\text{HCN}$ , in the presence of an  $\text{NaCN}$  catalyst to produce a cyanohydrin.

(i) Write an equation for the reaction of ethanal and  $\text{HCN}$ , giving the displayed formula of the product.

(ii) State what type of reaction this is.

.....

(iii) Describe the mechanism of this reaction.

[5]

(b) In the second stage, the product from (a) is converted into lactic acid.

(i) Write the equation for this stage.

.....

(ii) State what type of reaction this is.

.....[2]

- (c) In this synthesis 4.40 g of ethanal were used and at the end 5.40 g of lactic acid were obtained.

Calculate the percentage yield of lactic acid.

[3]

[Total : 10]



- 5 (a) (i) This question is about esters; esters occur naturally and are widely used. In the boxes below, draw the structural formulae of any **three** different esters that have the molecular formula  $C_5H_{10}O_2$ .

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- (ii) Write an equation for the hydrolysis of **one** of these esters by hot, aqueous sodium hydroxide.

.....[4]

- (b) State **two** general physical properties of esters.

(i) .....

(ii) .....[2]

- (c) State **two** commercial uses of esters.

(i) .....

(ii) .....[2]

[Total : 8]