

# 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

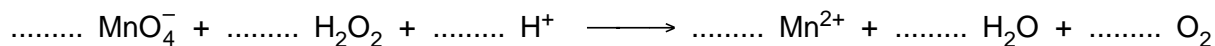
**Score:** /46

**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

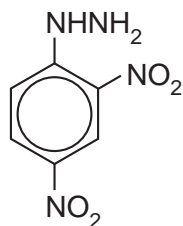
with ethanoic acid

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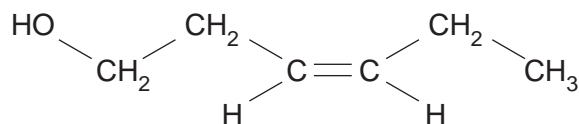
(ii) Write the equation for the hydrolysis of this ester.

.....

(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]

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]