Carbonyl Compounds,Carboxylic Acids, Esters & Polyesters A Level only

Question Paper 1

Level	A Level
Subject	Chemistry
Exam Board	OCR
Module	Organic Chemistry & Analysis
Topic	Carbonyl Compounds, Carboxylic Acids, Esters & Polyesters
Paper	A Level only
Booklet	Question Paper 1

Time allowed: **84 minutes**

Score: **/62**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E
>85%	73%	60%	47%	34%	21%

The functional group in an organic compound, **W**, was identified by carrying out two chemical tests. The results of the tests are shown below.

Heating with acidified sodium dichromate(VI)(aq)	**Addition of 2,4-dinitrophenylhydrazine(aq)**
orange solution turns green	yellow/orange precipitate formed

Which compound could be **W**?

A. $CH_3CH_2CH_2OH$

B. CH_3COCH_3

C. $CH_3CH(OH)CH_3$

D. CH_3CH_2CHO

[1]

Question 2

Which alcohol could be used to prepare $HCOOCH(CH_3)_2$?

A Propan-1-ol

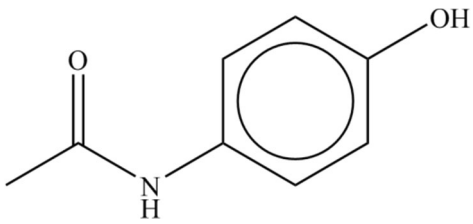
B Propan-2-ol

C 2-Methylpropan-2-ol

D Methanol

[1]

The structure of a molecule that is used as a pain reliever is shown below.



Which statement about this molecule is **not** true?

A It has the molecular formula $C_8H_9NO_2$.

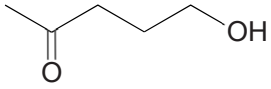
B It reacts with bases to form salts.

C It has a ketone functional group.

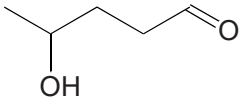
D It can be hydrolysed with aqueous acid.

[1]

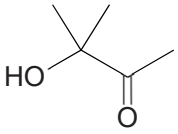
The following three carbonyl compounds are structural isomers of $C_5H_{10}O_2$.



compound C



compound D



compound E

(a) Describe chemical tests that you could carry out in test-tubes to distinguish between compounds **C**, **D** and **E**.

Include appropriate reagents and any relevant observations. Also include equations showing structures for the organic compounds involved. [4]

(b) Aldehydes and ketones are both reduced by $NaBH_4$. When used in the presence of a $CeCl_3$ catalyst, $NaBH_4$ only reduces ketones.

Compound **F** has the structural formula $CH_3COCH_2CH_2CHO$. It is reduced by $NaBH_4$ in the presence of a $CeCl_3$ catalyst to form one of the compounds **C**, **D** or **E**.

Show the mechanism for this reduction of compound **F** and identify the product that is formed.

Use curly arrows and show relevant dipoles.

You do not need to show the role of the $CeCl_3$ catalyst. [4]

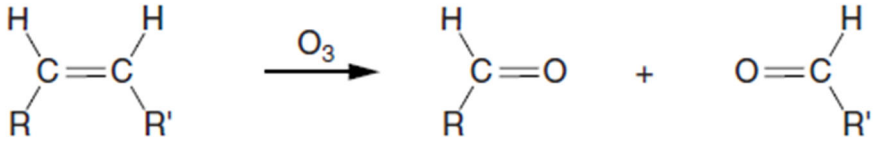
(c) Predict the number of peaks in the ^{13}C NMR spectra of compounds **C**, **D** and **E**.

Compound	**C**	**D**	**E**
Number of peaks			

[1]

(d) 'Ozonolysis' is a technique used in organic chemistry to break open a C=C double bond.

During ozonolysis, an alkene reacts with ozone, O_3. The products are carbonyl compounds, as shown below.



(i) Draw the structures of the products you would expect from the complete ozonolysis of the following alkenes.

- pent-2-ene
- hexa-2,4-diene

[3]

(ii) In another ozonolysis reaction, organic compound **G** reacted to form **only** hexane-1,6-dial.

Compound **G** has six carbon atoms.

Draw the structure of compound **G**.

[1]

[Total 13 Marks]

This question is about different organic compounds containing C, H and O.

(a) A technician found an unlabelled bottle in a chemical store cupboard. The technician thinks that the bottle contains pentan-2-one, pentan-3-one or pentanal.

(i) Describe a series of chemical tests that the technician could use to confirm that the compound in the bottle is a ketone. Include appropriate reagents and any relevant observations. [2]

(ii) Describe how the technician could use the product of one of the tests in **(i)** to show whether the bottle contains pentan-2-one or pentan-3-one.

The method used should **not** involve spectroscopy. [2]

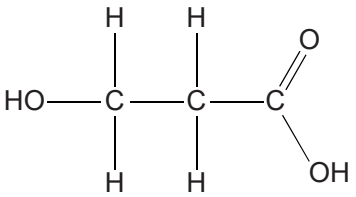
(b) 3-Hydroxypropanoic acid, $HOCH_2CH_2COOH$, can be produced microbiologically from sugars in corn. $HOCH_2CH_2COOH$ can be used as a 'green' starting material for the synthesis of many organic compounds including some important polymers.

Three synthetic routes are shown below for converting $HOCH_2CH_2COOH$, **A**, into different polymers.

The names of the processes for each synthetic step are given.

(i) In the boxes below, give the structures of the organic compounds formed.

Synthesis 1

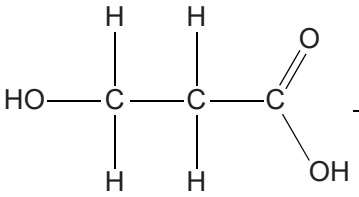


A

polymerisation

one repeat unit

Synthesis 2

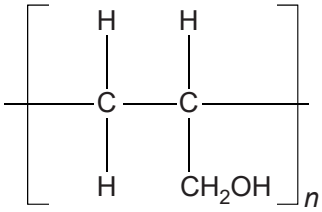


A

elimination of H_2O

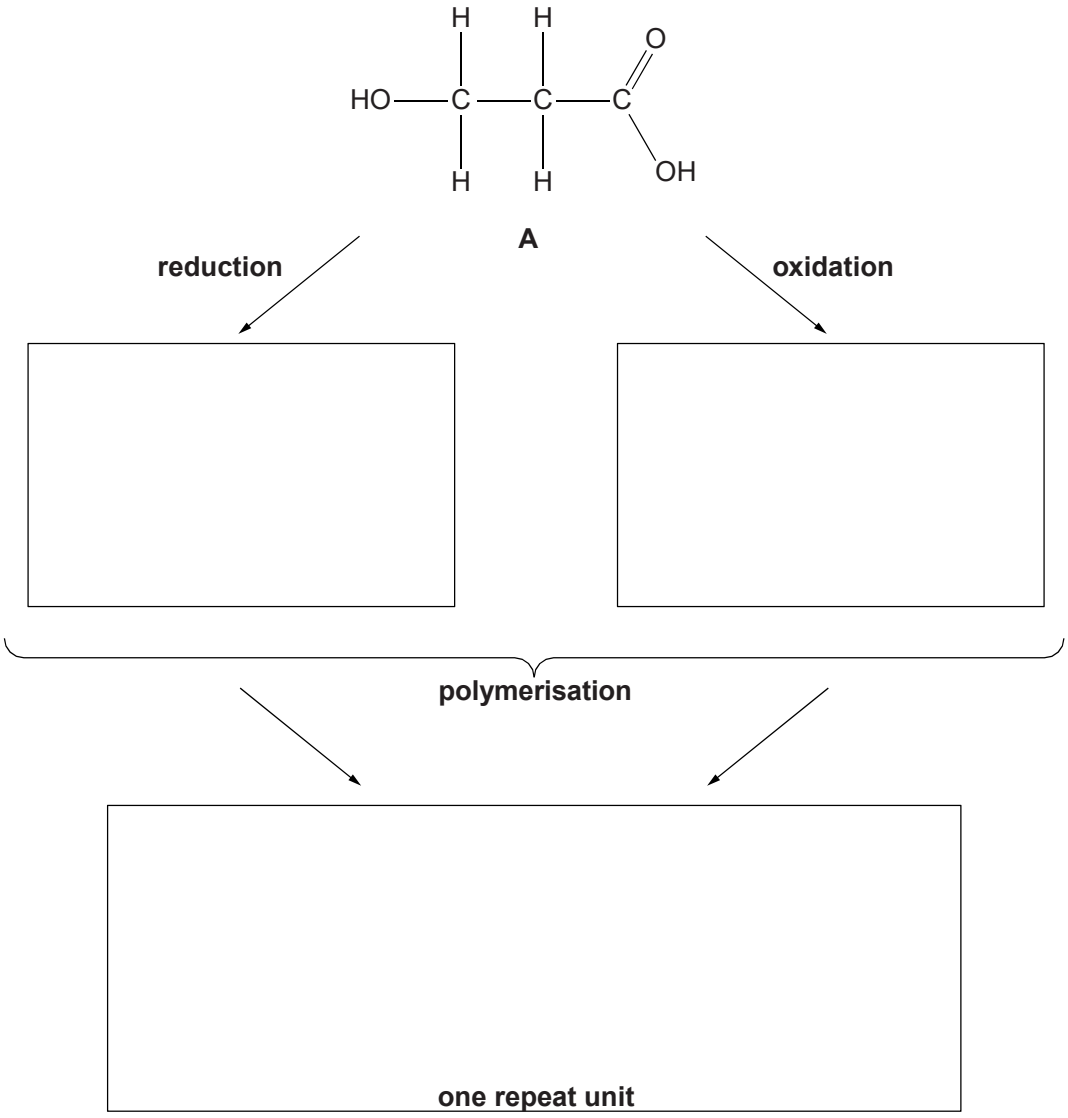
reduction

polymerisation



PVA, used in adhesives

Synthesis 3



[6]

(ii) State the type of polymerisation taking place in each synthetic route.

Synthesis 1:

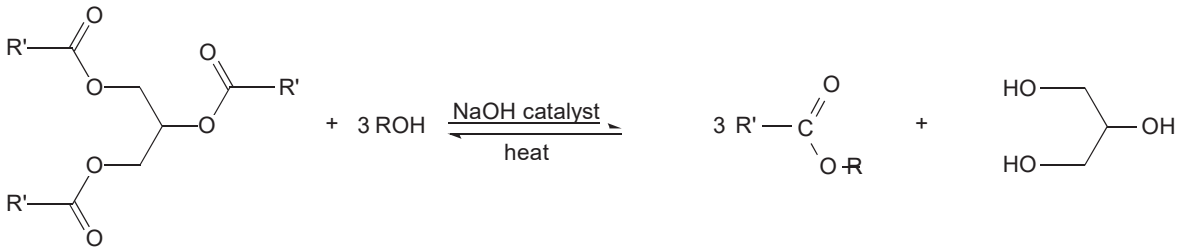
Synthesis 2:

Synthesis 3:

[1]

[Total 11 Marks]

Esters of fatty acids are used as biodiesels. These esters can be produced from triglycerides by the transesterification process below.



triglyceride **biodiesel** **glycerol**

(a) Give the systematic name of glycerol [1]

(b) (i) Suggest a suitable alcohol, ROH, that could be used industrially to make biodiesel.

Justify your answer. [1]

(ii) The alcohol, ROH, is added in excess.

Suggest why the alcohol has to be in excess. [1]

(c) Esters can also be made by reacting an alcohol with either a carboxylic acid or with an acid anhydride.

Write equations for the formation of ethyl propanoate, $CH_3CH_2COOCH_2CH_3$, starting from:

- a carboxylic acid and an alcohol,
- an acid anhydride and an alcohol. [2]

(d) Compound **A**, $C_4H_8O_3$, can lose water to form either:

compound **B**, a cyclic ester
OR
compound **C**, a polyester.

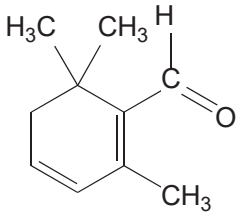
Identify compounds **A**, **B** and **C**.

compound **A**	compound **B**
compound **C**	

[3]

[Total 8 Marks]

Safranal, shown below, is an aldehyde which contributes to the aroma of saffron.



safranal

An undergraduate chemist investigated some reactions of safranal.

(a) She prepared a solution of Tollens' reagent and added a few drops of safranal. She then warmed the mixture for about 5 minutes in a water bath.

Describe what you would expect the chemist to see.

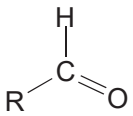
State the type of reaction that the safranal undergoes.

Draw the structure of the organic product formed in this reaction. [3]

(b) The chemist then reduced safranal using an aqueous solution of $NaBH_4$.

Outline the mechanism for this reaction.

Use curly arrows and show any relevant dipoles.



can be used to represent safranal. [4]

(c) Suggest one reaction of safranal that does **not** involve the aldehyde group.

State the reagent, observation (if any) and draw the organic product. [3]

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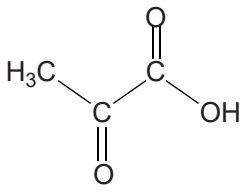
[Total 10 Marks]

Pyruvic acid, shown below, is an organic compound that has a smell similar to ethanoic acid. It is extremely soluble in water.



pyruvic acid

(a) Explain why pyruvic acid is soluble in water.

Use a labelled diagram to support your answer. [2]

(b) Pyruvic acid can be prepared in the laboratory by reacting propane-1,2-diol with excess acidified potassium dichromate(VI). The reaction mixture is heated under reflux.

Write an equation for this oxidation.

Use **[O]** to represent the oxidising agent and show structural formulae for organic compounds.

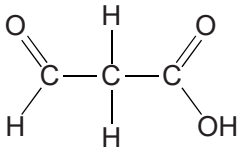
[2]

(c) Pyruvic acid can also be reduced by $NaBH_4$ to form $CH_3CH(OH)COOH$.

Outline the mechanism for this reduction.

Use curly arrows and show relevant dipoles. [4]

(d) Compound **A**, shown below, is a structural isomer of pyruvic acid.



compound A

Describe a chemical test that could be carried out in a laboratory to distinguish between samples of pyruvic acid and compound **A**.

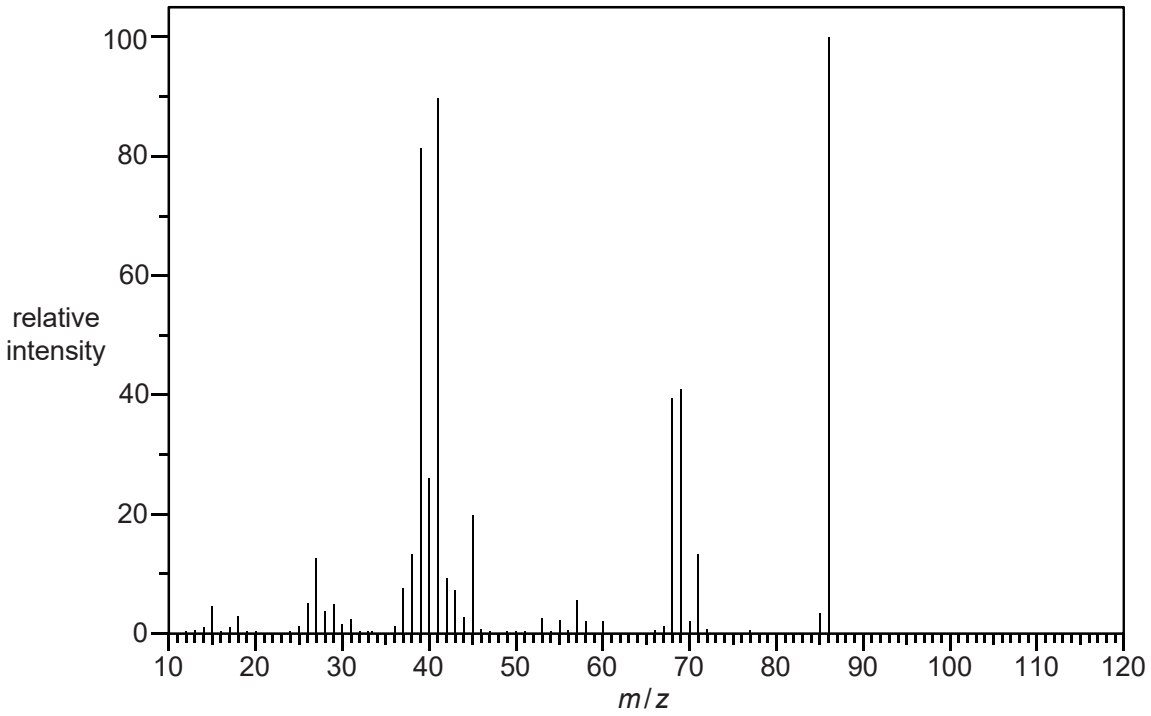
Your answer should include reagents, observations, the type of reaction and the organic product formed.

In your answer, you should use appropriate technical terms, spelled correctly. [3]

(e) Compound **B** is an organic compound used to make some cosmetics.

Compound **B** contains C, H and O only. Elemental analysis shows that **B** has the percentage composition by mass: C, 55.81%; H, 7.02%; O, 37.17%.

The mass spectrum of compound **B** is shown below.



(i) Determine the **molecular** formula of compound **B**.

Show all of your working. [2]

(ii) Compound **B** is an *E*-stereoisomer.

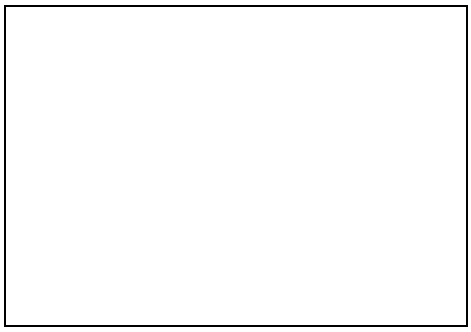
Compound **B** effervesces with aqueous Na_2CO_3 to form organic compound **C**.

Compound **B** decolourises Br_2 to form compound **D**.

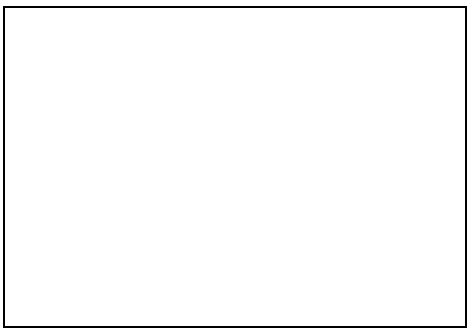
Compound **B** polymerises to form polymer **E**.

In the boxes below:

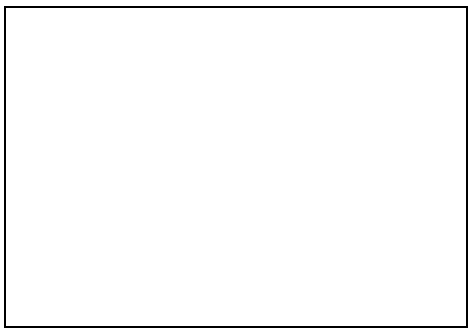
- draw structures for compounds **B**, **C** and **D**.
- draw **one** repeat unit for polymer **E**.



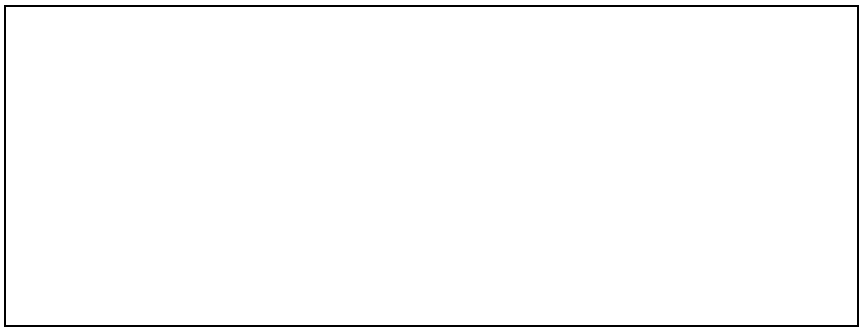
compound B



compound C



compound D



one repeat unit of polymer E

[4]

[Total 17 Marks]