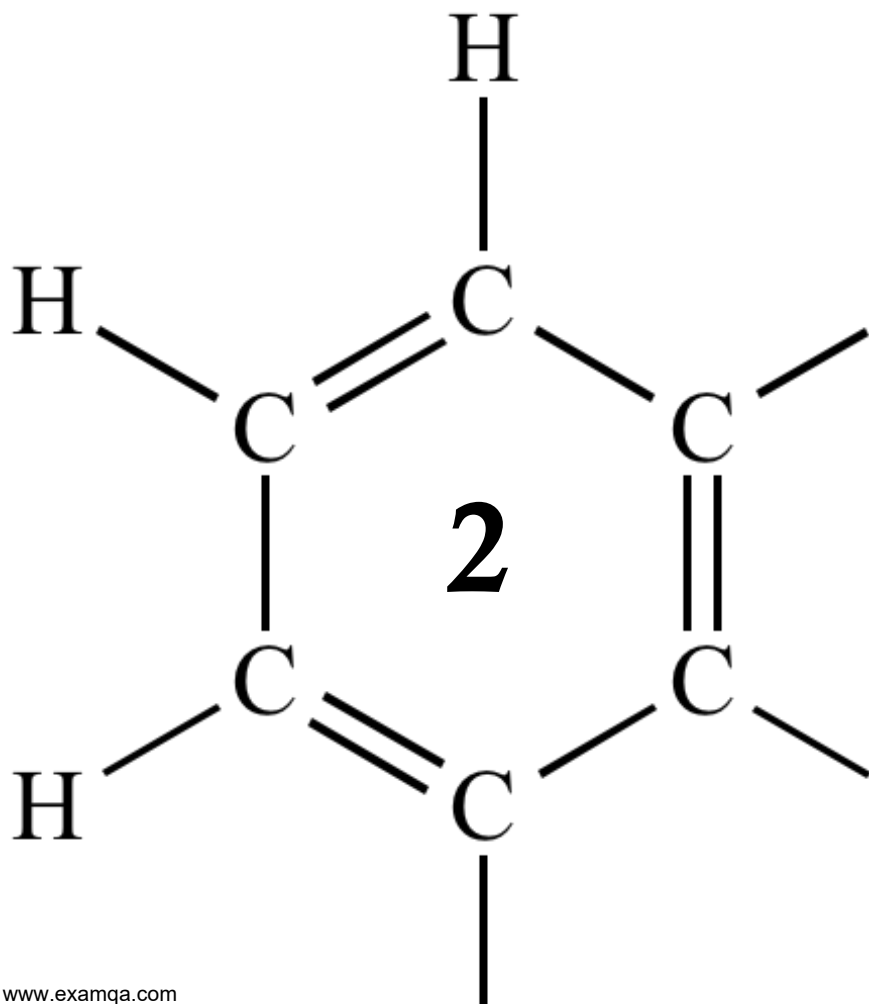


AQA A2 CHEMISTRY
ISOMERISM ~ CARBONYLS

ALCOHOLS



1

Ethanol can be oxidised by acidified potassium dichromate(VI) to ethanoic acid in a two-step process.



- (a) In order to ensure that the oxidation to ethanoic acid is complete, the reaction is carried out under reflux.

Describe what happens when a reaction mixture is refluxed and why it is necessary, in this case, for complete oxidation to ethanoic acid.

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(3)

- (b) Write a half-equation for the overall oxidation of ethanol into ethanoic acid.

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(1)

- (c) The boiling points of the organic compounds in a reaction mixture are shown in the following table.

Compound	ethanol	ethanal	ethanoic acid
Boiling point / °C	78	21	118

Use these data to describe how you would obtain a sample of ethanal from a mixture of these three compounds. Include in your answer a description of the apparatus you would use and how you would minimise the loss of ethanal. Your description of the apparatus can be either a description in words or a labelled sketch.

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(5)

- (d) Use your knowledge of structure and bonding to explain why it is possible to separate ethanal in this way.

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(2)

(e) A student obtained a sample of a liquid using the apparatus in part (c).

Describe how the student could use chemical tests to confirm that the liquid contained ethanal and did **not** contain ethanoic acid.

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(5)
(Total 16 marks)

2 Ethanoic acid, propyl ethanoate and propan-1-ol are all colourless liquids. Esters do **not** give a positive result with any of the usual tests for functional groups.

State how you could use chemical tests to show the presence of ethanoic acid and propan-1-ol in a mixture of the acid, the alcohol and the ester.

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(Total 4 marks)

3 (a) Propanoic acid can be made from propan-1-ol by oxidation using acidified potassium dichromate(VI). Propanal is formed as an intermediate during this oxidation.

(i) State the colour of the chromium species after the potassium dichromate(VI) has reacted.

.....

(1)

- (ii) Describe the experimental conditions and the practical method used to ensure that the acid is obtained in a high yield. Draw a diagram of the assembled apparatus you would use.

Conditions

.....

Apparatus

(4)

- (iii) Describe the different experimental conditions necessary to produce propanal in high yield rather than propanoic acid.

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(2)

- (b) Propan-1-ol is a volatile, flammable liquid.
Give **one** safety precaution that should be used during the reaction to minimise this hazard.

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(1)

- (c) A student followed the progress of the oxidation of propan-1-ol to propanoic acid by extracting the organic compounds from one sample of reaction mixture.

- (i) Give a chemical reagent which would enable the student to confirm the presence of propanal in the extracted compounds.
State what you would observe when propanal reacts with this reagent.

Reagent

Observation

.....

(2)

- (ii) Give a chemical reagent that would enable the student to confirm the presence of propanoic acid in the extracted compounds.

State what you would observe when propanoic acid reacts with this reagent.

Reagent

Observation

.....

(2)

- (d) Predict which **one** of the compounds, propan-1-ol, propanal and propanoic acid will have the highest boiling point. Explain your answer.

Prediction

Explanation

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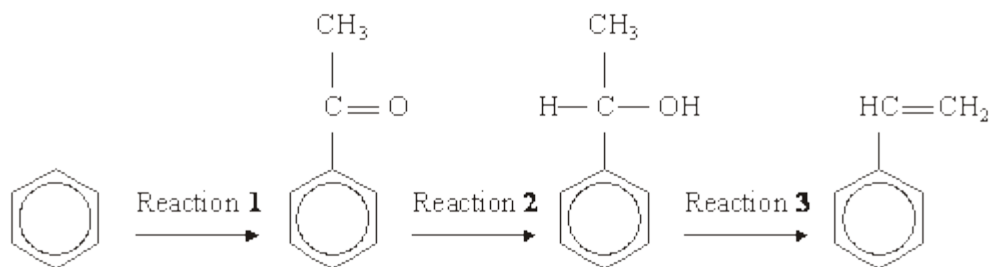
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(3)

(Total 15 marks)

4

A possible synthesis of phenylethene (*styrene*) is outlined below.



- (a) In Reaction 1, ethanoyl chloride and aluminium chloride are used to form a reactive species which then reacts with benzene.

Write an equation to show the formation of the reactive species.

Name and outline the mechanism by which this reactive species reacts with benzene.

(6)

- (b) NaBH_4 is a possible reagent for Reaction 2.
Name and outline the mechanism for the reaction with NaBH_4 in Reaction 2.
Name the product of Reaction 2.

(6)

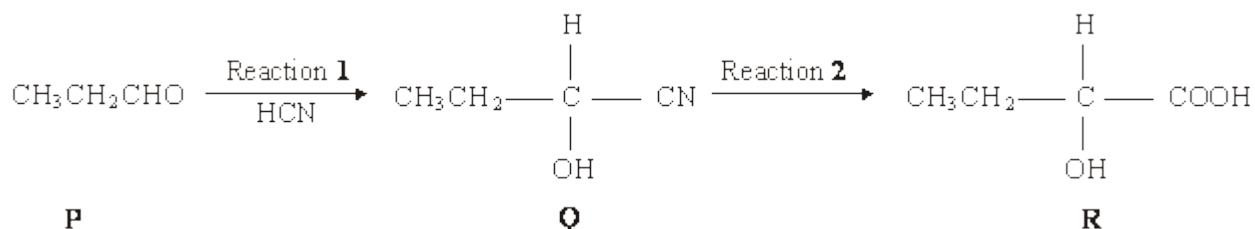
- (c) Name the type of reaction involved in Reaction 3 and give a reagent for the reaction.

(2)

(Total 14 marks)

5

Consider the sequence of reactions below.



- (a) Name and outline a mechanism for Reaction 1.

Name of mechanism

Mechanism

(5)

- (b) (i) Name compound **Q**

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- (ii) The molecular formula of **Q** is $\text{C}_4\text{H}_7\text{NO}$. Draw the structure of the isomer of **Q** which shows geometrical isomerism and is formed by the reaction of ammonia with an acyl chloride.

(3)

- (c) Draw the structure of the main organic product formed in each case when **R** reacts separately with the following substances:
- (i) methanol in the presence of a few drops of concentrated sulphuric acid;
- (ii) acidified potassium dichromate(VI);
- (iii) concentrated sulphuric acid in an elimination reaction.

(3)
(Total 11 marks)

6

This question concerns four isomers, **W**, **X**, **Y** and **Z**, with the molecular formula $C_5H_{10}O_2$

- (a) The proton n.m.r. spectrum of **W** shows 4 peaks. The table below gives the chemical shifts, δ values, for each of these peaks, together with their splitting patterns and integration values.

δ /ppm	2.18	2.59	3.33	3.64
Splitting pattern	singlet	triplet	singlet	triplet
Integration value	3	2	3	2

State what can be deduced about the structure of **W** from the presence of the following in its n.m.r. spectrum.

- (i) The singlet peak at $\delta = 2.18$

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(ii) The singlet peak at $\delta = 3.33$

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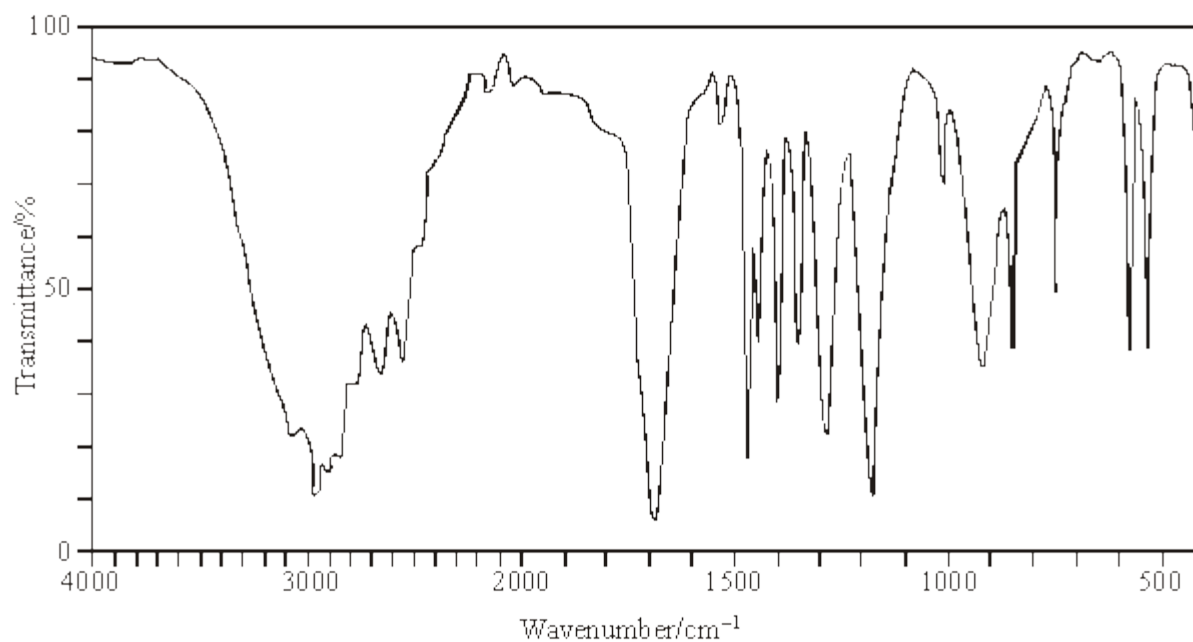
(iii) Two triplet peaks.

.....

(iv) Hence, deduce the structure of **W**.

(4)

(b) The infra-red spectrum of **X** is shown below.



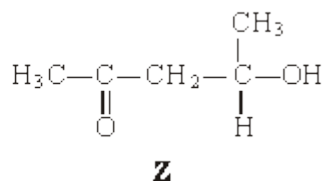
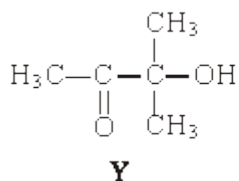
(i) What can be deduced from the broad absorption centred on 3000 cm^{-1} in the infra-red spectrum of **X**?

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- (ii) Given that the proton n.m.r. spectrum of **X** contains only two peaks with the integration ratio 9:1, deduce the structure of **X**.

(2)

- (c) Isomers **Y** and **Z** have the structures shown below.



Identify the two reagents you could use in a simple chemical test to distinguish between **Y** and **Z**. State what you would observe when each of **Y** and **Z** is tested with a mixture of these two reagents.

Reagents

Observation with **Y**

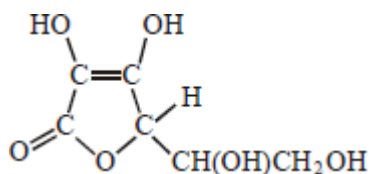
Observation with **Z**

(3)

(Total 9 marks)

7

Which one of the following is **not** a correct statement about vitamin C, shown below?



- A It is a cyclic ester.
- B It can form a carboxylic acid on oxidation.
- C It decolourises a solution of bromine in water.
- D It is a planar molecule.

(Total 1 mark)

8

Which one of the following reactions will produce an organic compound that has optical isomers?

- A dehydration of butan-2-ol by heating with concentrated sulphuric acid
- B reduction of pentan-3-one by warming with NaBH_4
- C addition of Br_2 to 3-bromopropene
- D reduction of 2,3-dimethylpent-2-ene with H_2 in the presence of a nickel catalyst

(Total 1 mark)

9

- (a) (i) Give a suitable reagent and state the necessary conditions for the conversion of propan-2-ol into propanone. Name the type of reaction.

Reagent

Conditions

Type of reaction

- (ii) Propanone can be converted back into propan-2-ol. Give a suitable reagent and write an equation for this reaction.
(Use [H] to represent the reagent in your equation.)

Reagent

Equation

.....

(5)

- (b) Propanal is an isomer of propanone.

- (i) Draw the structure of propanal.

- (ii) A chemical test can be used to distinguish between separate samples of propanone and propanal. Give a suitable reagent for the test and describe what you would observe with propanone and with propanal.

Test reagent

Observation with propanone

Observation with propanone

(4)
(Total 9 marks)