



A LEVEL CHEMISTRY

TOPIC 16 – ALDEHYDES, KETONES AND OPTICAL ISOMERISM

ASSESSED HOMEWORK

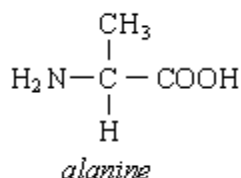
Answer all questions

Max 80 marks

Name		
Mark/80%	Grade

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1. The structures of the amino acid *alanine* is shown below:



Alanine exists as a pair of stereoisomers.

- (i) Explain the meaning of the term *stereoisomers*.

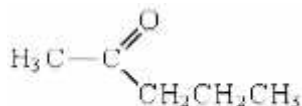
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- (ii) State how you could distinguish between the stereoisomers.

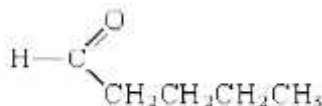
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(Total 4 marks)

2. (a) Consider the following pair of isomers.



E



F

- (i) Name compound **E**.

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- (ii) Identify a reagent which could be used in a test-tube reaction to distinguish between **E** and **F**. In each case, state what you would observe.

Reagent

Observation with **E**

Observation with **F**.....

(4)

- (b) Draw the structure of the chain isomer of **F** which shows optical isomerism.

3. Many synthetic routes need chemists to increase the number of carbon atoms in a molecule by forming new carbon-carbon bonds. This can be achieved in several ways including the reaction of an aldehyde with hydrogen cyanide.

Consider the reaction of propanal with HCN

- (i) Write an equation for the reaction of propanal with HCN and name the product.

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(2)

- (ii) Name and outline a mechanism for the reaction of propanal with HCN

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(5)

- (iii) The rate-determining step in the mechanism in part (b) (ii) involves attack by the nucleophile.
Suggest how the rate of reaction of propanone with HCN would compare with the rate of reaction of propanal with HCN
Explain your answer.

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(2)

(Total 9 marks)

4. Chemists have to design synthetic routes to convert one organic compound into another.

Propanone can be converted into 2-bromopropane by a three-step synthesis.

Step 1: propanone is reduced to compound **L**.

Step 2: compound **L** is converted into compound **M**.

Step 3: compound **M** reacts to form 2-bromopropane.

Deduce the structure of compounds **L** and **M**.

For each of the three steps, suggest a reagent that could be used and name the mechanism.

Equations and curly arrow mechanisms are **not** required.

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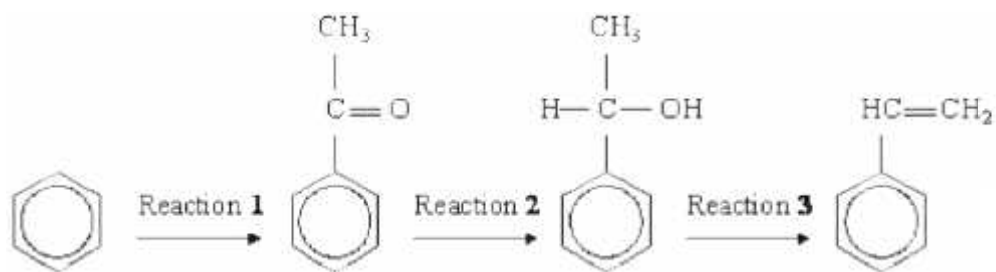
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(Total 8 marks)

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



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

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(5)

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

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(2)

(Total 7 marks)

6. Lactic acid, $\text{CH}_3\text{CH}(\text{OH})\text{COOH}$, is formed in the human body during metabolism and exercise. This acid is also formed by the fermentation of carbohydrates such as sucrose, $\text{C}_{12}\text{H}_{22}\text{O}_{11}$.

(a) (i) Give the IUPAC name for lactic acid.

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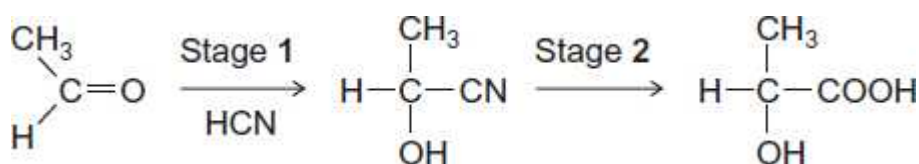
(1)

(ii) Write an equation for the formation of lactic acid from sucrose and water.

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(1)

(b) A molecule of lactic acid contains an asymmetric carbon atom. The lactic acid in the body occurs as a single enantiomer. A racemic mixture (racemate) of lactic acid can be formed in the following two-stage synthesis.



(i) Name and outline a mechanism for Stage 1.

Name of mechanism

Mechanism

(5)

(ii) Give the meaning of the term *racemic mixture (racemate)*.

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(1)

(iii) Explain how you could distinguish between a racemic mixture (racemate) of lactic acid and one of the enantiomers of lactic acid.

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(2)

(Total 10 marks)

7. The carbonyl compound $\text{CH}_3\text{CH}_2\text{CHO}$ reacts very slowly with HCN

(a) Name and outline a mechanism for the reaction of $\text{CH}_3\text{CH}_2\text{CHO}$ with HCN

Name of mechanism

Mechanism

(5)

(b) The reaction in part (a) produces a pair of enantiomers.

(i) Draw the structure of each enantiomer to show how they are related to each other.

(2)

(ii) State and explain how you could distinguish between the two enantiomers.

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(2)

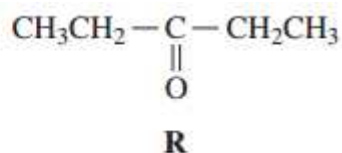
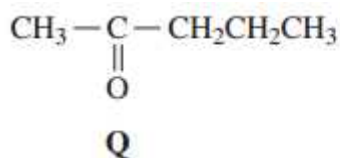
(c) Give the IUPAC name of the product of the reaction in part (a).

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(1)

(Total 10 marks)

8. Two isomeric ketones are shown below.



- (a) Name and outline a mechanism for the reaction of compound **Q** with HCN and name the product formed.

Name of mechanism

Mechanism

Name of product

(6)

- (b) Some students were asked to suggest methods to distinguish between isomers **Q** and **R**.

One student suggested testing the optical activity of the products formed when **Q** and **R** were reacted separately with HCN.

By considering the optical activity of these products formed from **Q** and **R**, explain why this method would **not** distinguish between **Q** and **R**.

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(3)

(Total 9 marks)

9. (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

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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

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(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

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(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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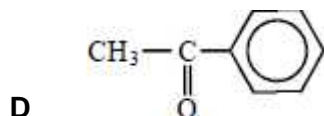
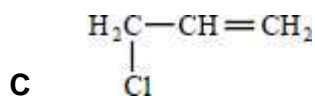
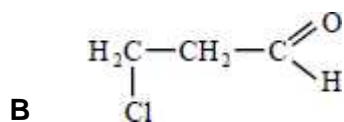
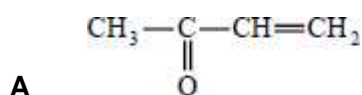
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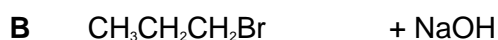
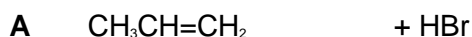
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10. Which one of the following can react both by nucleophilic addition and by nucleophilic substitution?



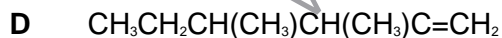
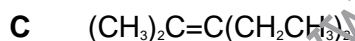
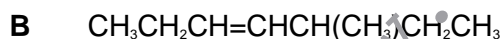
(Total 1 mark)

11. Which one of the following reaction mixtures would give a product capable of exhibiting optical isomerism?



(Total 1 mark)

12. Which one of the following can exhibit both geometrical and optical isomerism?



(Total 1 mark)