


Q1. The following table gives the names and structures of some structural isomers with the molecular formula C_5H_{10} .

	Name of isomer	Structure
Isomer 1	pent-2-ene	$CH_3CH = CHCH_2CH_3$
Isomer 2	cyclopentane	
Isomer 3	3-methylbut-1-ene	$(CH_3)_2CHCH = CH_2$
Isomer 4	2-methylbut-2-ene	$(CH_3)_2C = CHCH_3$
Isomer 5	2-methylbut-1-ene	$H_2C = C(CH_3)CH_2CH_3$

(a) Isomer 1 exists as E and Z stereoisomers.

(i) State the meaning of the term **stereoisomers**.

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(2)

(ii) Draw the structure of the E stereoisomer of Isomer 1.

(1)

- (b) A chemical test can be used to distinguish between separate samples of Isomer 1 and Isomer 2.

Identify a suitable reagent for the test.

State what you would observe with Isomer 1 and with Isomer 2.

Reagent.....

Observation with Isomer 1.....

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Observation with Isomer 2.....

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(3)

- (c) Use **Table A** on the Data Sheet when answering this question.
Isomer 3 and Isomer 4 have similar structures.

- (i) State the infrared absorption range that shows that Isomer 3 and Isomer 4 contain the same functional group.

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(1)

- (ii) State **one** way that the infrared spectrum of Isomer 3 is different from the infrared spectrum of Isomer 4.

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(1)

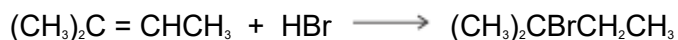
- (d) Two alcohols are formed by the hydration of Isomer 4.

Draw the **displayed formula** for the alcohol formed that is oxidised readily by acidified potassium dichromate(VI).

(1)

(e) Isomer **4** reacts with hydrogen bromide to give two structurally isomeric bromoalkanes.

(i) Name and outline a mechanism for the reaction of Isomer **4** with hydrogen bromide to give 2-bromo-2-methylbutane as the major product.



Name of mechanism.....

Mechanism

(5)

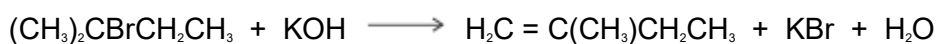
(ii) The minor product in this reaction mixture is 2-bromo-3-methylbutane.

Explain why this bromoalkane is formed as a minor product.

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(2)

(f) Name and outline a mechanism for the following reaction to form Isomer **5**. State the role of the hydroxide ion in this reaction.



Name of mechanism

Mechanism

Role of hydroxide ion

(5)
(Total 21 marks)

Q2. 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)

- (d) In practice, KCN rather than HCN is added to the carbonyl compound.

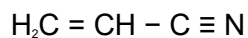
Given that K_a for HCN = 4.0×10^{-10} mol dm⁻³, suggest why the reaction with HCN is very slow.

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(2)

- (e) Acrylic fibres are used as a substitute for wool. Acrylics are copolymers of acrylonitrile with other compounds.

Acrylonitrile is the common name for the following compound.



- (i) Acrylonitrile can be formed from propene.

Write an equation for the reaction of propene with ammonia and oxygen to form acrylonitrile and one other product.

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(1)

- (ii) The term copolymer is used to describe the product obtained when two or more different monomers form a polymer.

Draw the repeating unit of the acrylic copolymer that contains 75% acrylonitrile monomer and 25% chloroethene monomer.

(1)

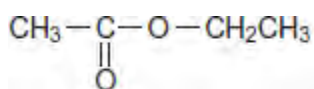
(iii) Name the type of polymerisation involved in part (ii)

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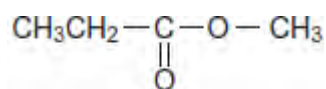
(1)

(Total 15 marks)

Q3.(a) Ester 1 and Ester 2 were studied by ^1H n.m.r. spectroscopy.

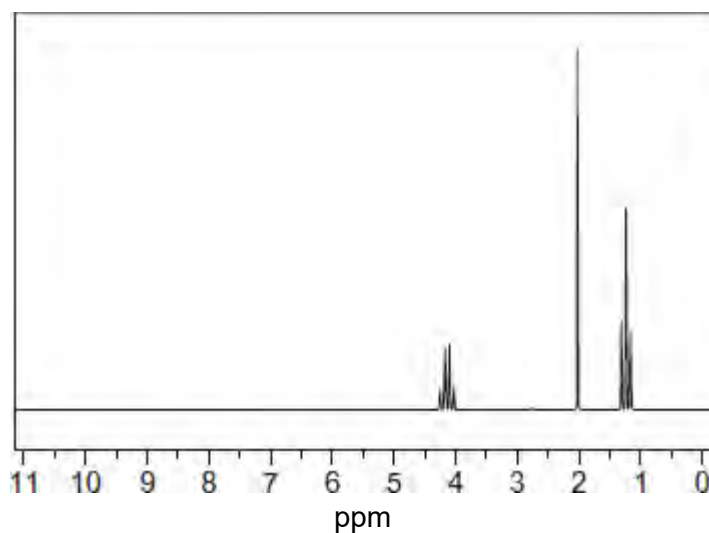


Ester 1



Ester 2

One of the two esters produced this spectrum.



Deduce which of the two esters produced the spectrum shown. In your answer, explain the position and splitting of the quartet peak at $\delta = 4.1$ ppm in the spectrum.

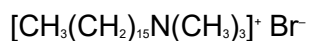
Predict the δ value of the quartet peak in the spectrum of the other ester.

Use **Table B** on the Data Sheet.

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(4)

- (b) Cetrimide is used as an antiseptic.



cetrimide

Name this type of compound.

Give the reagent that must be added to $\text{CH}_3(\text{CH}_2)_{15}\text{NH}_2$ to make cetrimide and state the reaction conditions.

Name the type of mechanism involved in this reaction.

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(4)

- (c) Give a reagent that could be used in a test-tube reaction to distinguish between benzene and cyclohexene.
Describe what you would see when the reagent is added to each compound and the

test tube is shaken.

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(3)
(Total 11 marks)

Q4. Chlorination of ethane follows a free-radical substitution mechanism. This mechanism is similar to that which occurs when methane is chlorinated. The overall equation for the reaction of ethane to form chloroethane is given below.



State the conditions and outline a mechanism for this reaction. Show how butane can be formed in this reaction.

(Total 5 marks)

Q5. Chlorine can be used to make chlorinated alkanes such as dichloromethane.

(a) Write an equation for each of the following steps in the mechanism for the reaction of chloromethane (CH_3Cl) with chlorine to form dichloromethane (CH_2Cl_2).

Initiation step

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First propagation step

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Second propagation step

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The termination step that forms a compound with empirical formula CH₂Cl.
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(4)

- (b) When chlorinated alkanes enter the upper atmosphere, carbon-chlorine bonds are broken. This process produces a reactive intermediate that catalyses the decomposition of ozone. The overall equation for this decomposition is



- (i) Name the type of reactive intermediate that acts as a catalyst in this reaction.

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(1)

- (ii) Write **two** equations to show how this intermediate is involved as a catalyst in the decomposition of ozone.

Equation 1.....

Equation 2.....

(2)

(Total 7 marks)