Questions

Q1.

This question is about some carbonyl compounds with the molecular formula $C_5H_{10}O$.

An aldehyde with molecular formula $C_5H_{10}O$ has a ^{13}C NMR spectrum with three peaks.

The high resolution ^{1}H NMR spectrum of this aldehyde has two peaks and neither of them is split.

Deduce the **displayed** formula of this aldehyde.
Justify your answer by referring to both NMR spectra.

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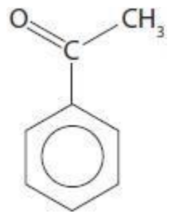
(Total for question = 4 marks)

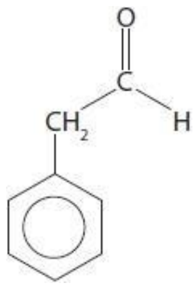
Q2.

Phenylethanone is an ingredient in many types of chewing gum.



One method for the production of phenylethanone involves the reaction of benzene with ethanoyl chloride, CH_3COCl.

Phenylethanone can be distinguished from its structural isomer, phenylethanal, in a number of different ways.



(i) Which would react with phenylethanone but **not** with phenylethanal?

(1)

☐ **A** acidified sodium dichromate(VI)

☐ **B** alkaline iodine solution

☐ **C** Fehling's solution

☐ **D** Tollens' reagent

(ii) Give the steps to show how 2,4-dinitrophenylhydrazine could be used to distinguish between phenylethanone and phenylethanal.

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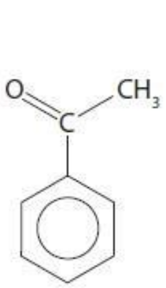
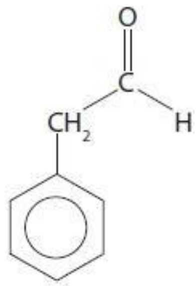
* (iii) Compare and contrast the high resolution proton NMR spectra of phenylethanone and phenylethanal.

You should use the Data Booklet.



Phenylethanone



Phenylethanal

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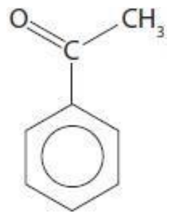
(Total for question = 11 marks)

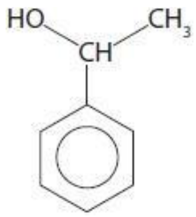
Q3.

Phenylethanone is an ingredient in many types of chewing gum.



One method for the production of phenylethanone involves the reaction of benzene with ethanoyl chloride, CH_3COCl.

The compound 1-phenylethanol can be formed from phenylethanone.



Give the reagent and conditions that would be used to form 1-phenylethanol.

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(Total for question = 2 marks)

Q4.

The table contains data on propanone and ethanoic acid.

Substance	Molar mass / $g\,mol^{-1}$	Boiling temperature / °C	Solubility in water
Propanone	58	56	completely miscible
Ethanoic acid	60	118	completely miscible

(i) Explain, by reference to the data and any intermolecular forces involved, the difference in the boiling temperatures.

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(ii) Explain, with the aid of a diagram, why propanone is completely miscible with water.

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(Total for question = 6 marks)

Q5.

This question is about some carbonyl compounds with the molecular formula $C_5H_{10}O$.

Describe a chemical test, and its result, to distinguish between pentan-2-one, $CH_3CH_2CH_2COCH_3$, and pentan-3-one, $CH_3CH_2COCH_2CH_3$.

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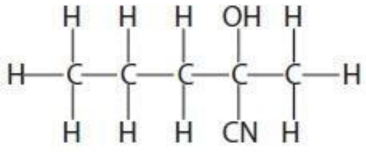
(Total for question = 2 marks)

Q6.

This question is about some carbonyl compounds with the molecular formula $C_5H_{10}O$.

Pentan-2-one reacts with hydrogen cyanide in the presence of cyanide ions to form 2-hydroxy-2-methylpentanenitrile.



2-hydroxy-2-methylpentanenitrile

(i) Draw the mechanism for the reaction between pentan-2-one and hydrogen cyanide in the presence of cyanide ions.

Include curly arrows and any relevant lone pairs.

(4)

(ii) The product of this reaction, 2-hydroxy-2-methylpentanenitrile, has a chiral centre. Explain why a racemic mixture of 2-hydroxy-2-methylpentanenitrile is formed in this reaction.

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(Total for question = 6 marks)

Q7.

This question is about some carbonyl compounds with the molecular formula $C_5H_{10}O$.

* Describe the oxidation and reduction reactions of pentanal and pentan-3-one.

Include the reagents and the structures of the organic products formed in any reactions that take place.

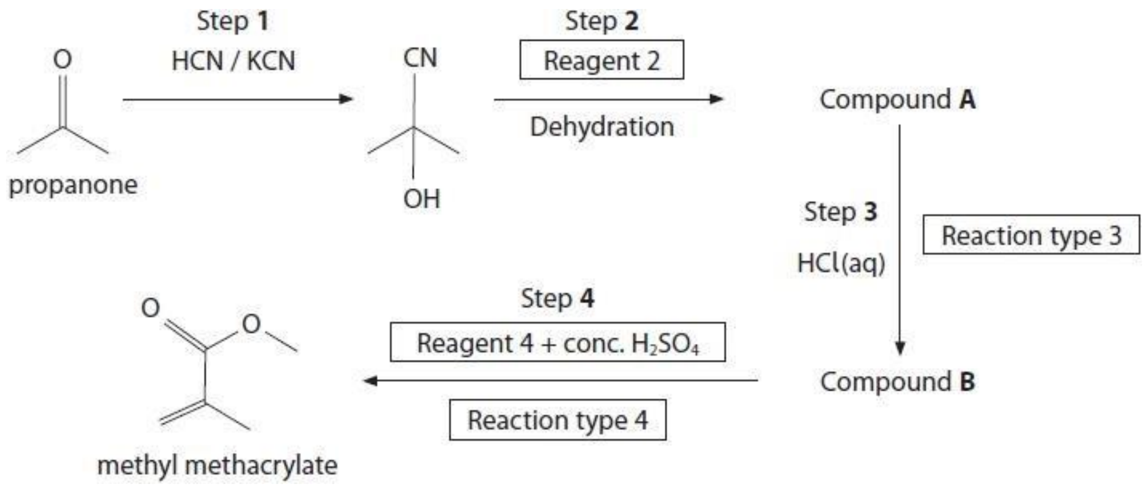
(6)

(Total for question = 6 marks)

Q8.

This question is about some reactions of carbonyl compounds.

Methyl methacrylate is the monomer used to make the polymer perspex. It can be synthesised from propanone using the reaction scheme shown.



(i) Draw the mechanism for the reaction in Step **1**.

Include curly arrows and any relevant lone pairs and dipoles.

(4)

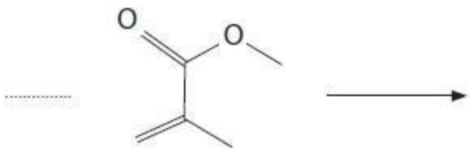
(ii) Complete the table to show the information missing from the reaction scheme.

(6)

Reagent 2	
Structure of compound **A**	
Reaction type 3	
Structure of compound **B**	
Reagent 4	
Reaction type 4	

(iii) Complete the equation for the formation of the polymer from methyl methacrylate.

(2)



(Total for question = 12 marks)

Q9.

Sodium tetrahydridoborate(III), $NaBH_4$, is used in organic chemistry.
It is an alternative reagent to lithium tetrahydridoaluminate(III) for the reduction of carbonyl compounds.

(i) Draw a dot-and-cross diagram of the BH_4^- ion.

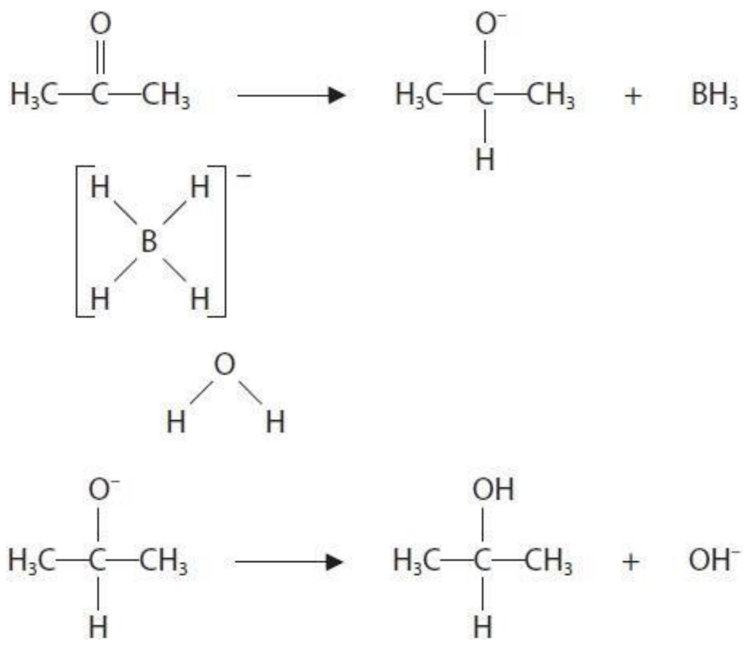
Use crosses (×) for the boron electrons, dots (•) for the hydrogen electrons and triangles (Δ) for the additional electron forming the negative ion.

(1)

(ii) The BH_4^- ions reduce carbonyl compounds to alcohols in aqueous solution.

Complete the mechanism for the reduction of propanone to propan-2-ol by adding curly arrows, and any relevant lone pairs and dipoles.

(4)



(Total for question = 5 marks)