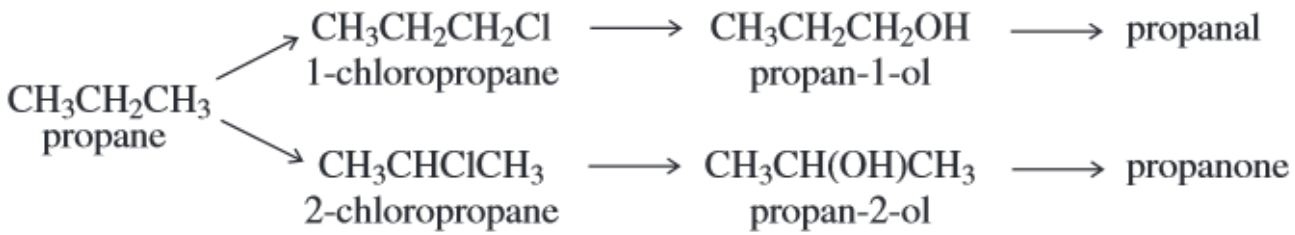
Q1. Consider the following scheme of reactions.



(a) State the type of structural isomerism shown by propanal and propanone.

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(1)

(b) A chemical test can be used to distinguish between separate samples of propanal and propanone.

Identify a suitable reagent for the test.
State what you would observe with propanal and with propanone.

Test reagent.....

Observation with propanal.....

Observation with propanone.....

(3)

(c) State the structural feature of propanal and propanone which can be identified from their infrared spectra by absorptions at approximately 1720 cm^{-1}.

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(1)

(d) The reaction of chlorine with propane is similar to the reaction of chlorine with methane.

(i) Name the type of mechanism in the reaction of chlorine with methane.

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(1)

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(ii) Write an equation for each of the following steps in the mechanism for the reaction of chlorine with propane to form l-chloropropane ($CH_3CH_2CH_2Cl$).

Initiation step

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First propagation step

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Second propagation step

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A termination step to form a molecule with the empirical formula C_3H_7

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(4)

(e) High resolution mass spectrometry of a sample of propane indicated that it was contaminated with traces of carbon dioxide.

Use the data in the table to show how precise M_r values can be used to prove that thesample contains both of these gases.

Atom	Precise relative atomic mass
^{12}C	12.00000
^{1}H	1.00794
^{16}O	15.99491

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(2)
(Total 12 marks)

Q2. There are **seven** isomeric carbonyl compounds with the molecular formula $C_5H_{10}O$. The structures and names of some of these isomers are given below.

Structure	Name

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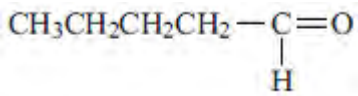
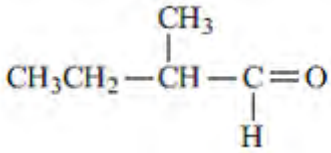
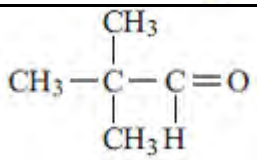
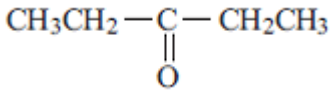
	pentanal
	2-methybutanal
	2, 2-dimethypropanal
	
	pentan-2-one

(a) (i) Complete the table.

(ii) **Two** other isomeric carbonyl compounds with the molecular formula $C_5H_{10}O$ are not shown in the table. One is an aldehyde and one is a ketone. Draw the structure of each.

isomeric aldehyde *isomeric ketone*

(4)

(b) Pentanal, $CH_3CH_2CH_2CH_2CHO$, can be oxidised to a carboxylic acid.

(i) Write an equation for this reaction. Use [O] to represent the oxidising agent.

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(ii) Name the carboxylic acid formed in this reaction.

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(2)

(c) Pentanal can be formed by the oxidation of an alcohol.

(i) Identify this alcohol.

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(ii) State the class to which this alcohol belongs.

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(2)
(Total 8 marks)

Q3. In an investigation of the chemical properties of alcohols, a mixture of ethanol and acidified potassium dichromate(VI) is heated in a conical flask in a water bath.

(a) Explain why a water bath is used to heat the mixture.

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(1)

(b) Describe the colour change which would be observed.

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(1)
(Total 2 marks)

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Q4. There are **four** isomeric alcohols with the molecular formula $C_4H_{10}O$

(a) Two of these are butan-l-ol ($CH_3CH_2CH_2CH_2OH$) and butan-2-ol.
The other two isomers are alcohol **X** and alcohol **Y**.

Draw the displayed formula for butan-2-ol.

Alcohol **X** does not react with acidified potassium dichromate(VI) solution.
Give the structure of alcohol **X**.

Name the fourth isomer, alcohol **Y**.

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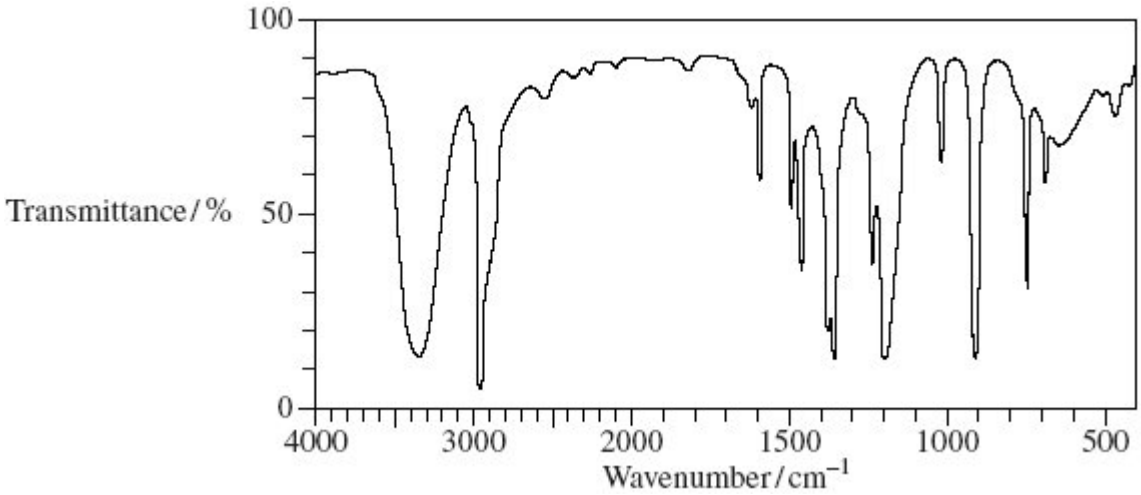
(3)

(b) The infrared spectrum of one of these isomeric alcohols is given below.



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Identify **one** feature of the infrared spectrum which supports the fact that this is an alcohol. You may find it helpful to refer to **Table 1** on the Data Sheet.

Explain how infrared spectroscopy can be used to identify this isomeric alcohol.

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(3)

(c) British scientists have used bacteria to ferment glucose and produce the biofuel butan-1-ol.

Write an equation for the fermentation of glucose ($C_6H_{12}O_6$) to form butan-1-ol, carbon dioxide and water only.

State **one** condition necessary to ensure the complete combustion of a fuel in air.

Write an equation for the complete combustion of butan-1-ol and state why it can be described as a *biofuel*.

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(4)

(d) Butan-1-ol reacts with acidified potassium dichromate(VI) solution to produce two organic compounds.

State the class of alcohols to which butan-1-ol belongs.

Draw the displayed formula for **both** of the organic products.

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State the type of reaction that occurs and the change in colour of the potassium dichromate(VI) solution.

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(5)
(Total 15 marks)

Q5. (a) Alcohols can be classed as primary, secondary or tertiary. Draw possible structures for a primary, a secondary and a tertiary alcohol which have the molecular formula C_4H_8O.
Which of the structures you have drawn cannot be oxidised by potassium dichromate in acid solution?

(4)

(b) Explain what is meant by the fingerprint region of an infra-red spectrum. State how it is used to confirm the identity of organic molecules such as the primary, secondary and tertiary alcohols of molecular formula C_4H_8O.

(2)

(c) Each of the parts below concerns a different pair of isomers. Deduce one possible structural formula for each of the species **A** to **F**. Use, where appropriate, the table of infra-red absorption data given on the data sheet.

(i) **A** and **B** have the molecular formula C_3H_8O. **A** has a broad absorption band at 3300 cm^{-1} in its infra-red spectrum, but **B** does not.

(ii) **C** and **D** have the molecular formula C_5H_{10}. **C** has a weak absorption band at 1650 cm^{-1} in its infra-red spectrum, but **D** does not.

(iii) **E** and **F** have the molecular formula C_3H_6O and both have strong absorption

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bands at about 1700 cm^{-1} in their infra-red spectra. **E** reacts with Tollens' reagent but **F** does not.

(6)
(Total 12 marks)

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