Q1. Butanone is reduced in a two-step reaction using $NaBH_4$ followed by dilute hydrochloric acid.

(a) Write an overall equation for the reduction of butanone using [H] to represent the reductant.

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(1)

(b) By considering the mechanism of the reaction, explain why the product has **no** effect on plane polarised light.

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(6)
(Total 7 marks)

Q2. The carbonyl compound CH_3CH_2CHO reacts very slowly with HCN

(a) Name and outline a mechanism for the reaction of CH_3CH_2CHO 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.

$$H_2C = CH - C \equiv N$$

(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. Suggest **one** reason why Tollens' reagent is used as the oxidising agent in the specific test for aldehydes rather than the less expensive acidified potassium dichromate(VI).

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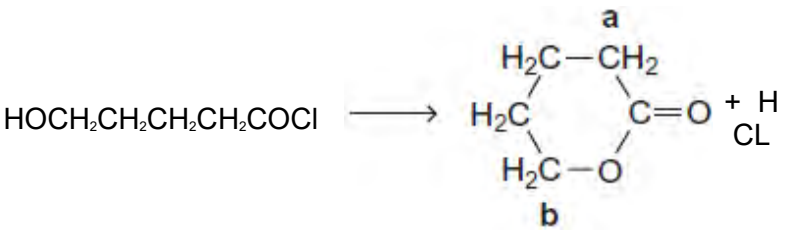
(Total 1 mark)

Q4. This question is about some isomers of $C_5H_8O_2$

(a) Compound **H** is a cyclic ester that can be prepared as shown.

On the structure of **H**, two of the carbon atoms are labelled.



H

(i) Name and outline a mechanism for this reaction.

Use **Table C** on the Data Sheet to give the ^{13}C n.m.r. δ value for the carbon atom labelled **a** and the δ value for the carbon atom labelled **b**.

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(7)

(ii) $HOCH_2CH_2CH_2CH_2COCl$ can also react to form a polyester in a mechanism similar to that in part (i).

Draw the repeating unit of the polyester and name the type of polymerisation involved.

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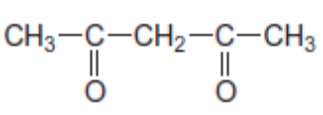
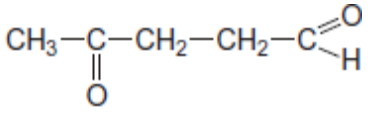
(2)

(b) State how you could distinguish between compounds **J** and **K** by a simple test-tube reaction.

State how you could distinguish between **J** and **K** by giving the number of peaks in the ^1H n.m.r. spectrum of each compound.



J



K

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(5)

(c) Draw the structure of each of the following isomers of $C_5H_8O_2$
Label each structure you draw with the correct letter **L**, **M**, **N**, **P** or **Q**.

L is methyl 2-methylpropenoate.

M is an ester that shows E-Z stereoisomerism.

N is a carboxylic acid with a branched carbon chain and does **not** show stereoisomerism.

P is an optically active carboxylic acid.

Q is a cyclic compound that contains a ketone group and has only two peaks in its ^{1}H n.m.r. spectrum.

(5)
(Total 19 marks)

Q5. Ethanol can be oxidised by acidified potassium dichromate(VI) to ethanoic acid in a two-step process.

ethanol ⟶ ethanal ⟶ ethanoic acid

(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)

Q6. Which alcohol could **not** be produced by the reduction of an aldehyde or a ketone?

A 2-methylbutan-1-ol ⬭

B 2-methylbutan-2-ol ⬭

C 3-methylbutan-1-ol ⬭

D 3-methylbutan-2-ol ⬭

(Total 1 mark)