OXFORD INTERNATIONAL AQA EXAMINATIONS

OXFORD AQA INTERNATIONAL A-LEVEL
CHEMISTRY
(9620)

PAPER 4

Specimen 2018 Morning Time allowed: 1 hour 30 minutes

Materials
For this paper you must have:
- a pencil
- a ruler
- a calculator
- a data booklet

Instructions
- use black ink or ball-point pen
- answer **all** questions
- show all your working.

Information
- The marks for questions are shown in brackets
- The maximum mark for this paper is 80 marks

Please write clearly, in block capitals, to allow character computer recognition.

Centre number ☐☐☐☐☐ Candidate number ☐☐☐☐

Surname

Forename(s)

Candidate signature __________

Answer **all** questions in the spaces provided.

0 1 . 1 The data in Table 1 were obtained in two experiments about the rate of the reaction between substances **A** and **B** at a constant temperature.

Table 1

Experiment	Initial concentration of **A** / mol dm^{-3}	Initial concentration of **B** / mol dm^{-3}	Initial rate / mol dm^{-3} s^{-1}
1	3.4×10^{-2}	4.6×10^{-2}	9.5×10^{-5}
2	6.8×10^{-2}	7.6×10^{-2}	To be calculated

The rate equation for this reaction is known to be

$$\text{rate} = k[\mathbf{A}][\mathbf{B}]^2$$

Use the data from **Experiment 1** to calculate a value for the rate constant *k* at this temperature and deduce its units.

[3 marks]

Calculation ______________________________

____

____

____

____

____

Units ______________________________

____

____

____

0 1 . 2 The data in Table 2 were obtained in a series of experiments about the rate of the reaction between substances **C** and **D** at a constant temperature.

Table 2

Experiment	Initial concentration of **C** / mol dm^{-3}	Initial concentration of **D** / mol dm^{-3}	Initial rate / mol dm^{-3} s^{-1}
3	0.17	0.24	0.23×10^{-3}
4	0.51	0.24	2.07×10^{-3}
5	1.02	0.48	8.28×10^{-3}

Deduce the order of reaction with respect to **C**.

Tick (✓) one box.

[1 mark]

Zero ☐

First ☐

Second ☐

0 1 . 3 Deduce the order of reaction with respect to **D**.

Tick (✓) one box.

[1 mark]

Zero ☐

First ☐

Second ☐

0 1 . 4 A reaction has a rate constant $k = 1.84 \times 10^{-4}\ s^{-1}$ at 750K.

Use the Arrhenius equation, $k = Ae^{-Ea/RT}$, to calculate a value in $kJ\ mol^{-1}$ for the activation energy of this reaction.

The Arrhenius constant, $A = 1.94 \times 10^{15}\ s^{-1}$
The gas constant, $R = 8.31\ J\ K^{-1}\ mol^{-1}$

[3 marks]

0 1 . 5 The compound $(CH_3)_3CBr$ reacts with aqueous sodium hydroxide as shown in the following equation.

$$(CH_3)_3CBr + OH^- \longrightarrow (CH_3)_3COH + Br^-$$

This reaction was found to be first order with respect to $(CH_3)_3CBr$ but zero order with respect to hydroxide ions.

The following two-step process was suggested.

Step **1** $(CH_3)_3CBr \longrightarrow (CH_3)_3C^+ + Br^-$

Step **2** $(CH_3)_3C^+ + OH^- \longrightarrow (CH_3)_3COH$

Explain how the rate data helps to support the suggested mechanism

[1 mark]

0 1 . 6 Outline a mechanism for Step 1 using a curly arrow.

[1 mark]

0 1 . 7 Suggest how the rate of the reaction between $(CH_3)_3CCl$ would compare with the rate of the reaction in Question 01.6. Explain your answer.

[2 marks]

___

___

___

0 2 . 1 The carbonyl compound $CH_3COCH_2CH_3$ reacts very slowly with HCN.

Name and outline a mechanism for the reaction of $CH_3COCH_2CH_3$ with HCN

[5 marks]

Name of mechanism ____

Mechanism

0 2 . 2 The reaction in Question **2.0** produces a pair of enantiomers.

Draw the structure of each enantiomer to show clearly how they are related to each other.

[2 marks]

0 2 . 3 State and explain how you could distinguish between the two enantiomers.

[2 marks]

0 2 . 4 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.

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

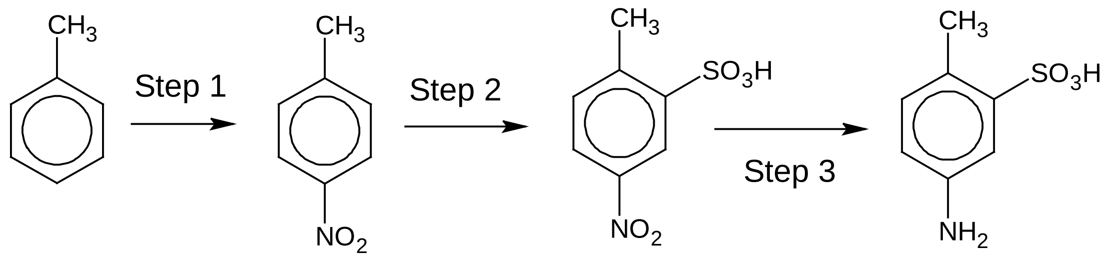
Acrylonitrile can be formed from propene.

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% propene monomer.

[1 mark]

3 5-amino-2-methylbenzenesulphonic acid can be prepared from methylbenzene in a three-step synthesis:



0 3 . 1 State the type of reaction taking place in Step 1 and give suitable reagent(s) for this step.

[3 marks]

Type of Reaction ____

Reagent(s) ____

0 3 . 2 Write an equation for the formation of the reactive inorganic species involved in the mechanism for Step 1.

[1 mark]

____

0 3 . 3 Identify the reactive inorganic species involved in the mechanism in Step 2 and outline the mechanism.

[5 marks]

Reactive species ____

Mechanism

0 3 . 4 $LiAlH_4$ can be used as the reagent for Step 3.
Write an equation for this reaction.
You should use [H] to represent the reducing agent in your equation.

[1 mark]

Equation ____

____

0 3 . 5 Explain why ethylamine ($C_2H_5NH_2$) is a stronger base than 5-amino-2-methylbenzenesulphonic acid.

[3 marks]

0 4 . 1 The amide or peptide link is found in synthetic polyamides and also in naturally-occurring proteins.

Draw the repeating unit of the polyamide formed by the reaction of butanedioic acid with hexane-1,6-diamine.

[2 marks]

0 4 . 2 In terms of the intermolecular forces between the polymer chains, explain why polyamides can be made into fibres suitable for use in sewing and weaving, whereas polyalkenes usually produce fibres that are too weak for this purpose.

[3 marks]

0 4 . 3 Write an equation for the reaction of ethanoic anhydride with CH_3NH_2 and give the name of the product containing an amide linkage that is formed in this reaction

[3 marks]

Equation ____

Name of product ____

0 5 . 1 A bottle was discovered that was labelled propan-2-ol. A chemist showed, using infrared spectroscopy, that the propan-2-ol was contaminated with propanone. The chemist separated the two compounds using column chromatography. The column contained silica gel, a polar stationary phase.

The contaminated propan-2-ol was dissolved in hexane and poured into the column. Pure hexane was added slowly to the top of the column. Samples of the eluent (the solution leaving the bottom of the column) were collected.

- Suggest the chemical process that would cause a sample of propan-2-ol to become contaminated with propanone.
- Explain how the infrared spectrum showed the presence of propanone.
- Suggest why propanone was present in samples of the eluent collected first (those with shorter retention times), whereas samples containing propan-2-ol were collected later.

[4 marks]

0 6 . 1 The amine $CH_3CH_2NH_2$ can be prepared by two different routes.

Route **A** is a two-stage process and starts from CH_3Br

Route **B** is a one-stage process and starts from CH_3CH_2Br

[7 marks]

0 6 . 2 Give **one** disadvantage of Route **A** and **one** disadvantage of Route **B**.

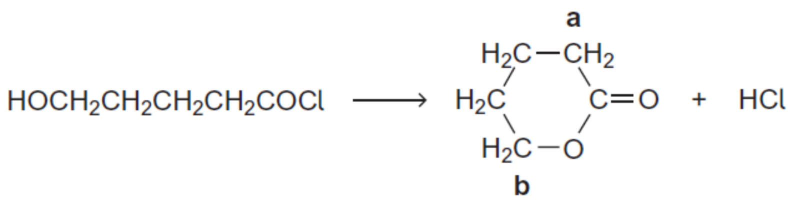
[2 marks]

Turn over for the next question

0 7 . 1 This question is about three esters H, I, J.

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

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

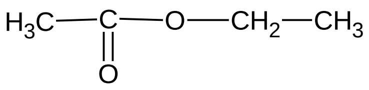


H

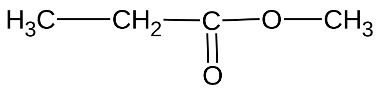
Name and outline a mechanism for this reaction.
Use **Table C** on the Data Sheet to give the ^{13}C n.m.r. ∂ (chemical shift) value for the carbon atom labelled **a** and the ∂ value for the carbon atom labelled **b**.

[7 marks]

0 7 . 2 Ester I and Ester J were studied by [1]H n.m.r. spectroscopy.

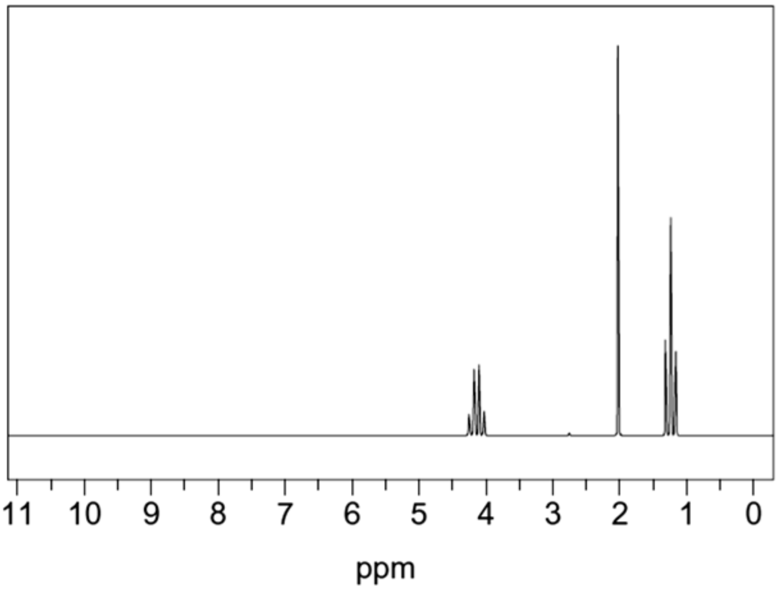


Ester I



Ester J

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 δ = 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.

[4 marks]

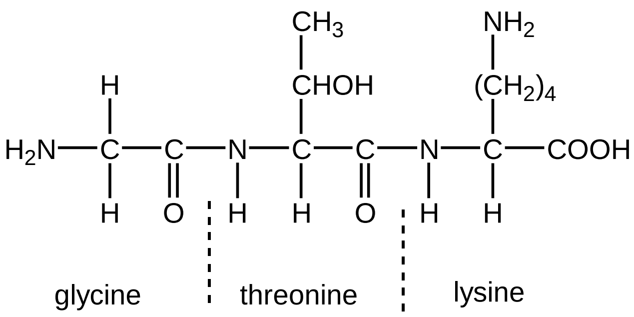
0 8 . 1 A chemist discovered four unlabelled bottles of liquid, each of which contained a different pure organic compound. The compounds were known to be propan-2-ol, propanal, propanoic acid and 1-chloropropane.

Describe four **different** test-tube reactions, one for each compound, that could be used to identify the four organic compounds.
Your answer should include the name of the organic compound, the reagent(s) used and the expected observation for each test.

[8 marks]

The tripeptide shown in **Figure 4** is formed from the amino acids glycine, threonine and lysine.

Figure 4



0 9 . 1 Draw a separate circle around **each** of the asymmetric carbon atoms in the tripeptide in **Figure 4**.

[1 mark]

0 9 . 2 Draw the zwitterion of glycine.

[1 mark]

0 9 . 3 Draw the structure of the species formed when glycine reacts with an excess of bromomethane.

[1 mark]

0 9 . 4 Deduce the IUPAC name of threonine.

[1 mark]

____

0 9 . 5 Draw the structure of the species formed by lysine at low pH.

[1 mark]

END OF QUESTIONS