



GCE A LEVEL CHEMISTRY

S21-A410

Assessment Resource F

Organic Chemistry and Analysis

1. *N*-(phenylazo)phenylamine, $C_6H_5-N=N-NH-C_6H_5$, is prepared by reacting benzenediazonium chloride and phenylamine.

(a) State the reagents and conditions needed to prepare a solution of benzenediazonium chloride from phenylamine. [2]

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(b) In white light *N*-(phenylazo)phenylamine is seen as a yellow solid.

Explain why this compound is yellow in white light. [1]

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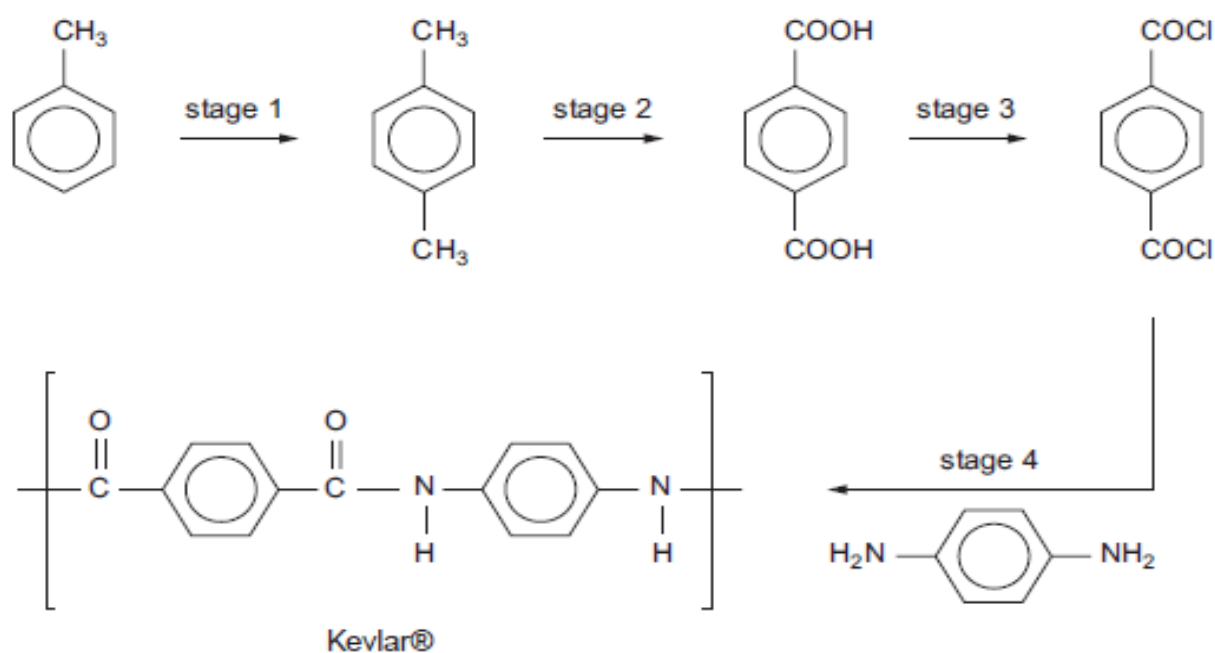
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2. A colourless solution contains either benzoic acid or 2-hydroxybenzaldehyde, $C_6H_4(OH)CHO$.

State **two** chemical tests, apart from using indicator paper, which can be used to identify which compound is present. [2]

	Reagent(s) used	Result with benzoic acid	Result with 2-hydroxybenzaldehyde
Test 1			
Test 2			

3. (a) A student was asked to propose a synthesis for the polyamide Kevlar®, starting from methylbenzene. He suggested the following sequence of reactions.



- (i) State the type of reaction mechanism occurring in stage 1. [1]

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- (ii) Suggest why the yield of 1,4-dimethylbenzene in stage 1 will be considerably less than 100%. Problems with the method should not be considered as part of the answer. [1]

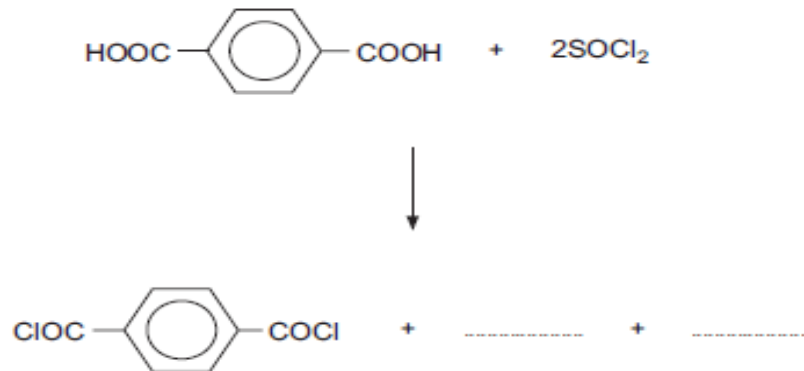
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- (iii) State the reagent(s) needed to convert 1,4-dimethylbenzene to benzene-1,4-dicarboxylic acid in Stage 2. [1]

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- (iv) In stage 3 the dicarboxylic acid is converted to the acid dichloride.
The student found that the preferred reagent for this reaction was sulfur dichloride oxide, SOCl_2 .

I. Complete the equation for this reaction. [1]



II. The conversion to the acid dichloride can also be carried out using PCl_3 or PCl_5 .

Suggest why the preferred reagent for this reaction is SOCl_2 . [1]

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III. Suggest why ethanol should not be used as a solvent for this reaction. [1]

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(v) In Stage 4 Kevlar® is produced.
State why this polymer is described as a polyamide. [1]

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(vi) Benzene-1,4-diamine, $\text{C}_6\text{H}_4(\text{NH}_2)_2$, used in stage 4, can be converted to benzene-1,4-diol, $\text{C}_6\text{H}_4(\text{OH})_2$.
Suggest a reagent(s) that can be used for this reaction. [1]

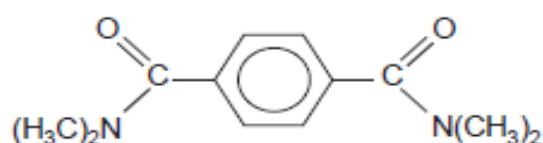
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- (vii) The student suggested that benzene-1,4-diol can react with the acid dichloride formed in stage 3 to give a different polymer.

Suggest a formula for this polymer, showing a repeating section.

[1]

- (viii) While researching a method for making Kevlar®, the student came across the compound below.



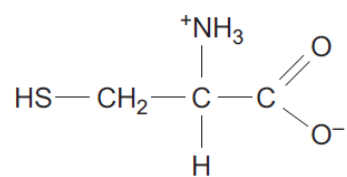
- I. Describe the low resolution ^1H NMR spectrum of this compound. Relative peak areas are required in your answer but not the position of each signal. [2]

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- II. Describe the ^{13}C NMR spectrum of this compound identifying the carbon atoms involved. The position of the signals is not required. [2]

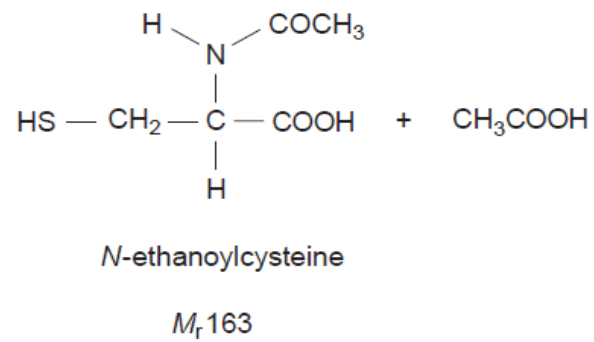
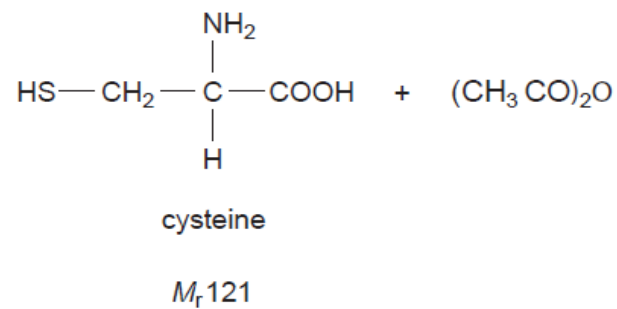
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- (b) (i) At pH 5.1 the α -amino acid cysteine exists as the zwitterion.



Write the structure of the organic species present when cysteine is added to an aqueous solution of pH 1.0. [1]

- (ii) *N*-ethanoylcysteine is used to treat an overdose of paracetamol.
It can be produced by the reaction of cysteine with ethanoic anhydride.



In an experiment 0.250 mol of cysteine reacts in a 1 : 1 ratio with ethanoic anhydride.

- I. Ethanoic anhydride has a density of 1.08 g cm^{-3} .

Calculate the volume of ethanoic anhydride needed.

[2]

Volume = cm^3

- II. After the reaction a 90% yield of *N*-ethanoylcysteine is formed.

Calculate the mass of *N*-ethanoylcysteine formed.

[1]

Mass = g

- (iii) Cysteine is an α -amino acid that contains a chiral centre.

Write the displayed formula of an α -amino acid that does **not** contain a chiral centre.

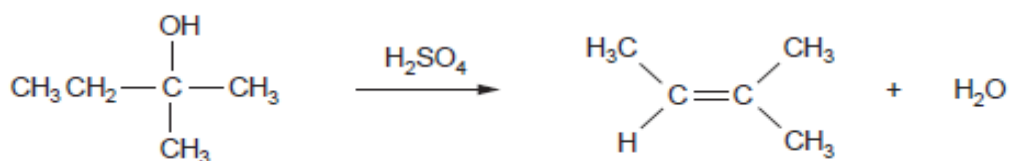
[1]

4.

(a) The boiling temperatures of five isomers of formula $C_5H_{12}O$ are shown in the table below.

Compound	Formula	Boiling temperature / °C
A	$\begin{array}{c} \text{H}_3\text{C} \\ \diagdown \\ \text{H}_3\text{C}-\text{C}-\text{O}-\text{CH}_3 \\ \diagup \\ \text{H}_3\text{C} \end{array}$	56
B	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2-\text{O}-\text{CH}_3$	71
C	$\begin{array}{c} \text{CH}_3 \\ \\ \text{CH}_3\text{CH}_2-\text{C}-\text{CH}_3 \\ \\ \text{OH} \end{array}$	102
D	$\begin{array}{c} \text{H} \\ \\ \text{CH}_3\text{CH}_2-\text{C}-\text{CH}_2\text{CH}_3 \\ \\ \text{OH} \end{array}$	116
E	$\begin{array}{c} \text{H} \\ \\ \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2-\text{C}-\text{OH} \\ \\ \text{H} \end{array}$	137

(b) The equation below shows the reaction of 2-methylbutan-2-ol with sulfuric acid.



(i) State why the sulfuric acid acts as a catalyst in this reaction. [1]

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(ii) In the first stage of the mechanism of this reaction, 2-methylbutan-2-ol acts as a base.

Suggest how it can react as a base. [1]

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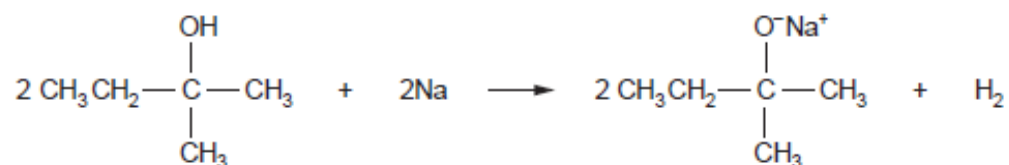
(iii) The main organic product of the reaction is 2-methylbut-2-ene but a small percentage of 2-methylbut-1-ene, $\text{CH}_3\text{CH}_2\text{C}(\text{CH}_3)=\text{CH}_2$ is also produced.

Suggest why this alkene is also a product. [1]

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- (iv) The mixture at the end of the reaction contains the two alkenes and a small quantity of unreacted 2-methylbutan-2-ol.

A student found that 2-methylbutan-2-ol reacts with sodium to give hydrogen as one of the products.

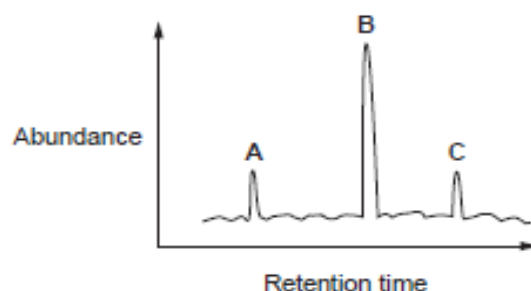


A 10.0 g sample of the mixture was reacted with an excess of sodium. This produced 125 cm³ of hydrogen measured at 298 K and 1 atm pressure.

Calculate the mass of 2-methylbutan-2-ol in the mixture. [2]

Mass = g

- (v) A sample of the product mixture from this reaction produced the following gas chromatogram.



- I. State, giving a reason, which of these peaks is given by 2-methylbut-2-ene. [1]

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- II. Suggest how you would confirm which one of the remaining two peaks is given by 2-methylbutan-2-ol. [1]

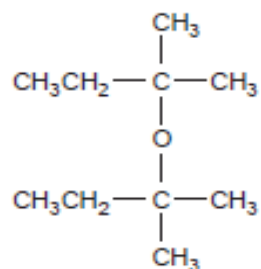
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- (vi) In this reaction the alcohol is added slowly to an excess of sulfuric acid. However, if sulfuric acid is added slowly to the alcohol, then the product below is also formed.



- Suggest how this compound can be formed in the reaction. [1]

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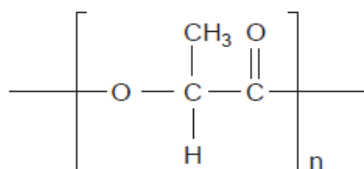
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- (c) (i) Many polymers persist in the environment for many years and are causing severe pollution problems. There is an increasing use of materials that lead to fewer environmental problems.

Some cardboard drinking cups have an impervious PLA lining. PLA is made from plants and is biodegradable.

The formula of the repeating section of PLA is shown below.



Give the structure of the monomer of PLA.

[1]

- (ii) Suggest **two** desirable properties of PLA if it is to be used for lining the cardboard of a cup used for hot drinks. [2]

1.
2.