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General Certificate of Education

2022 Reserve Series

Centre Number

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Candidate Number

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# Life and Health Sciences

Assessment Unit A2 2

*assessing*

Organic Chemistry



AZ021

[AZ021]

THURSDAY 23 JUNE, MORNING

## TIME

1 hour 45 minutes.

## INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.

Answer **all five** questions.

Write your answers in the spaces provided in this question paper.

## INFORMATION FOR CANDIDATES

The total mark for this paper is 100.

Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.

Your attention is drawn to the Data leaflet which is used with the question paper.

You may use an electronic calculator.

Quality of written communication will be assessed in Question **5(a)**.

For Examiner's use only	
Question Number	Marks
1	
2	
3	
4	
5	

Total Marks	
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1 (a) Hydrocarbons can be classified as saturated or unsaturated.

Define the term **unsaturated hydrocarbon**.

\_\_\_\_\_ [2]

(b) Crude oil is a mixture of hydrocarbons.

(i) Name the process used to separate the hydrocarbons in crude oil.

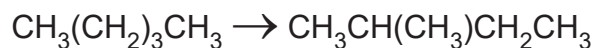
\_\_\_\_\_ [1]

(ii) Which physical property of the hydrocarbons in crude oil allows them to be separated?

\_\_\_\_\_ [1]

(c) Once separated, the hydrocarbons in crude oil can be further processed.

One processing reaction is shown below.



(i) Name the process occurring in the reaction above.

\_\_\_\_\_ [1]

(ii) State the IUPAC name of the reactant and the product.

$\text{CH}_3(\text{CH}_2)_3\text{CH}_3$  \_\_\_\_\_

$\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_2\text{CH}_3$  \_\_\_\_\_ [2]

Examiner Only

Marks

Remark



2 The five equations below show some organic reactions.

The letters **P**, **Q**, **R**, **S** and **T** represent different organic compounds.

Reaction	Equation
1	$C_{12}H_{26} \rightarrow C_7H_{16} + P$
2	ethanol $\rightarrow Q$ + water
3	$CH_2Cl_2 + Cl_2 \rightarrow R + HCl$
4	$CH_3CH_2CH_2CH_2OH + [O] \rightarrow S + H_2O$
5	pent-2-ene + hydrogen $\rightarrow T$

(a) Write the molecular formula for **P** in Reaction 1 and state its IUPAC name.

Molecular formula: \_\_\_\_\_

IUPAC name: \_\_\_\_\_ [2]

(b) Name the type of reaction occurring in Reaction 1.

\_\_\_\_\_ [1]

(c) Draw the structural formula of **Q** in Reaction 2 and state its IUPAC name.

Structural formula:

IUPAC name: \_\_\_\_\_ [2]

(d) Name the type of reaction occurring in Reaction 2.

\_\_\_\_\_ [1]

(e) Name a suitable catalyst for Reaction 2.

\_\_\_\_\_ [2]

Examiner Only

Marks Remark

- (f) Write the molecular formula for **R** in Reaction 3 and state its IUPAC name.

Molecular formula: \_\_\_\_\_

IUPAC name: \_\_\_\_\_ [2]

- (g) Name the type of reaction occurring in Reaction 3.

\_\_\_\_\_ [1]

- (h) State the IUPAC name of **S** in Reaction 4.

\_\_\_\_\_ [1]

- (i) Name a suitable reagent to carry out Reaction 4 and state the type of reaction occurring.

Reagent: \_\_\_\_\_

Type of reaction: \_\_\_\_\_ [3]

- (j) Draw the skeletal formula of pent-2-ene in Reaction 5.

[1]

- (k) Identify **T** in Reaction 5.

\_\_\_\_\_ [1]

- (l) Write a balanced symbol equation for Reaction 5.

\_\_\_\_\_ [1]

- (m) Name a suitable catalyst for Reaction 5.

\_\_\_\_\_ [1]

- (n) Suggest the name of the mechanism for Reaction 5.

\_\_\_\_\_ [2]

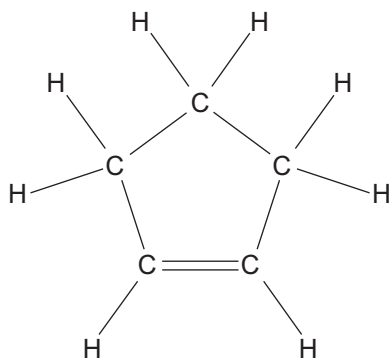
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Marks

Remark



- (d) The compound below is also unsaturated.  
It is a colourless liquid at room temperature.



- (i) State the IUPAC name of this compound.

\_\_\_\_\_ [1]

- (ii) Write the molecular formula for this compound.

\_\_\_\_\_ [1]

- (iii) Name the reagent that could be used to prove that this compound is unsaturated.

State the observations that would occur in this test.

Reagent: \_\_\_\_\_

Observations: \_\_\_\_\_

\_\_\_\_\_ [3]

- (e) The plastic polypropene can be made from the alkene propene.

- (i) Write a structural equation for the formation of polypropene from propene.

[2]

Examiner Only

Marks Remark

(ii) Name the type of reaction used to make plastics from alkenes.

\_\_\_\_\_ [2]

(iii) Explain why plastics, such as polythene, may cause environmental problems.

\_\_\_\_\_  
\_\_\_\_\_ [1]

(iv) State two ways in which chemists are attempting to limit the problems linked to disposal of plastics.

1. \_\_\_\_\_  
2. \_\_\_\_\_ [2]

Examiner Only	
Marks	Remark

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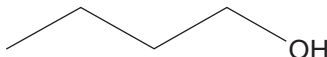
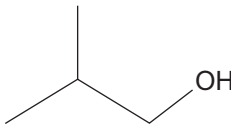
4 (a) Alcohols can be classified as primary, secondary and tertiary.

(i) Define the term **secondary alcohol**.

\_\_\_\_\_  
\_\_\_\_\_ [1]

(ii) There are four alcohols with the molecular formula  $C_4H_9OH$ .

Complete the table below for these alcohols.

Name	Skeletal formula	Classification
		Primary
butan-2-ol		Secondary
		
2-methylpropan-2-ol		

[6]

(b) Butan-2-ol (boiling point  $99^\circ\text{C}$ ) may be prepared by the repeated boiling and condensing of a mixture of 2-bromobutane (boiling point  $91^\circ\text{C}$ ) and sodium hydroxide solution.

(i) Write a balanced structural equation for the preparation of butan-2-ol from 2-bromobutane and sodium hydroxide.

\_\_\_\_\_ [2]

Examiner Only

Marks Remark



(c) An organic compound, Y, consists of atoms of carbon, hydrogen, and oxygen.

(i) Determine the empirical formula of compound Y using the following percentage composition by mass.

Element	Percentage composition by mass /%
carbon	73.85
hydrogen	13.85
oxygen	12.30

You are advised to show your working out.

Empirical formula = \_\_\_\_\_ [4]

(ii) Explain how the empirical formula shows that compound Y belongs to the homologous series of alcohols.

\_\_\_\_\_  
\_\_\_\_\_ [1]

Examiner Only	
Marks	Remark

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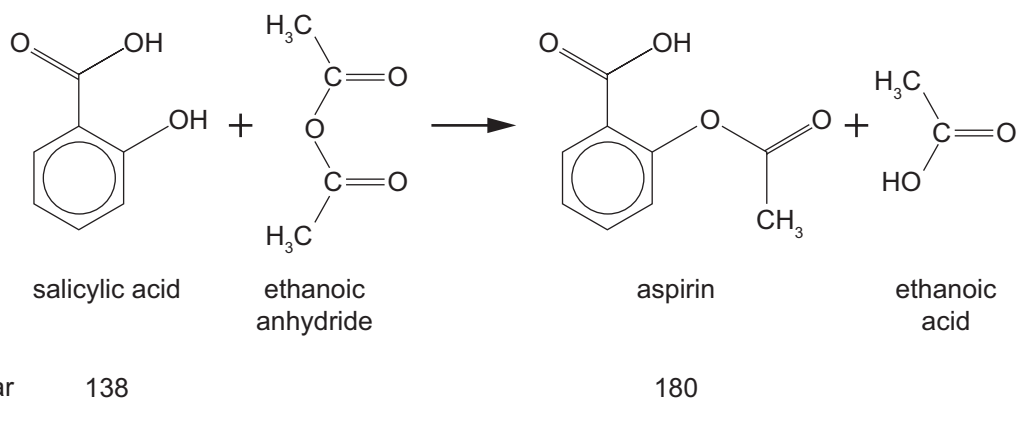


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**(Question 5 continues overleaf)**

- (b) A laboratory preparation produced an actual yield of 15.10 g of purified aspirin.

The equation for the reaction and some of the relative molecular masses are given below.



- (i) What is the molecular formula of aspirin?

\_\_\_\_\_ [1]

- (ii) The percentage yield of aspirin was found to be 72%.

Calculate the theoretical yield.

**Give your answer to 2 decimal places.**

Theoretical yield = \_\_\_\_\_ g [2]

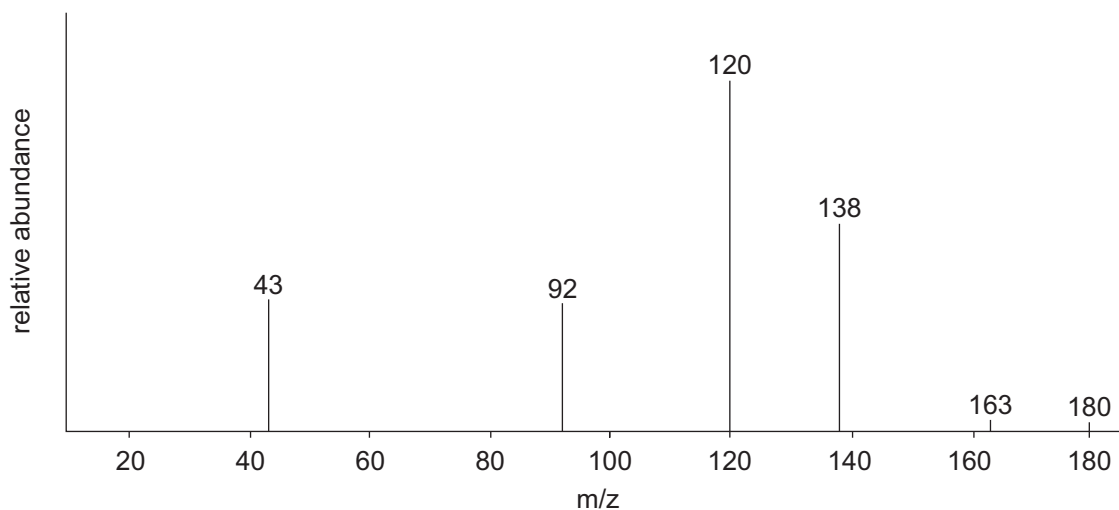
Examiner Only

Marks Remark

- (iii) Calculate the mass of salicylic acid that was needed to produce an actual yield of 15.10 g of purified aspirin in this laboratory preparation.

Mass of salicylic acid = \_\_\_\_\_ g [3]

- (c) A mass spectrum of an organic compound is shown below.



Source: Principal Examiner

- (i) Identify which organic compound, **aspirin** or **salicylic acid**, would produce this spectrum and explain your answer.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ [2]

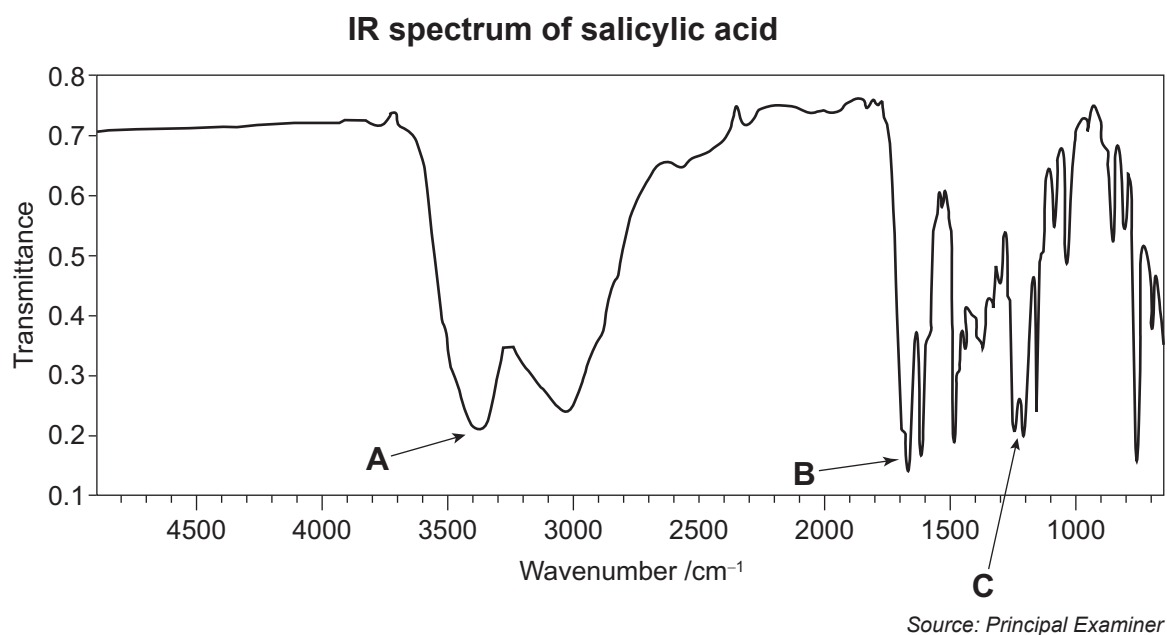
- (ii) What would the highest m/z value be on a mass spectrum of ethanoic anhydride ( $C_4H_6O_3$ )?

\_\_\_\_\_ [1]

Examiner Only

Marks Remark

- (d) The Infrared (IR) spectrum of salicylic acid and table of characteristic absorbances are shown below.



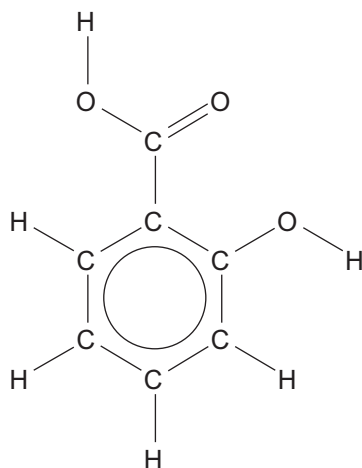
**Table of characteristic absorbances**

Wavenumber /cm <sup>-1</sup>	Bond
750 – 1100	C—C (alkanes, alkyl groups)
1000 – 1300	C—O (alcohols, carboxylic acids)
1650 – 1800	C=O (carboxylic acids, aldehydes, ketones)
2500 – 3200	O—H (carboxylic acid)
2750 – 2850	C—H (aldehydes)
2850 – 3000	C—H (alkanes, alkyl groups, alkenes)
3200 – 3600	O—H (alcohols)

Examiner Only

Marks Remark

(i) The structural formula of salicylic acid is given below.



Identify the bonds from the salicylic acid molecule that are responsible for the peaks labelled **A**, **B** and **C** in the Infrared (IR) spectrum of salicylic acid.

Bond responsible for:

Peak **A**: \_\_\_\_\_

Peak **B**: \_\_\_\_\_

Peak **C**: \_\_\_\_\_ [3]

(ii) How would the Infrared (IR) spectrum of salicylic acid differ if the sample used was impure?

\_\_\_\_\_

\_\_\_\_\_ [1]

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**THIS IS THE END OF THE QUESTION PAPER**

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