

A Level Chemistry A

H432/02 Synthesis and analytical techniques

Practice paper – Set 1

Time allowed: 2 hours 15 minutes



You must have:

- the Data Sheet for Chemistry A

You may use:

- a scientific calculator
- a ruler (cm/mm)

First name											
Last name											
Centre number							Candidate number				

INSTRUCTIONS

- Use black ink. You may use an HB pencil for graphs and diagrams.
- Complete the boxes above with your name, centre number and candidate number.
- Answer **all** the questions.
- Write your answer to each question in the space provided. If additional space is required, use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the barcodes.

INFORMATION

- The total mark for this paper is **100**.
- The marks for each question are shown in brackets [].
- Quality of extended responses will be assessed in questions marked with an asterisk (*).
- This document consists of **32** pages.

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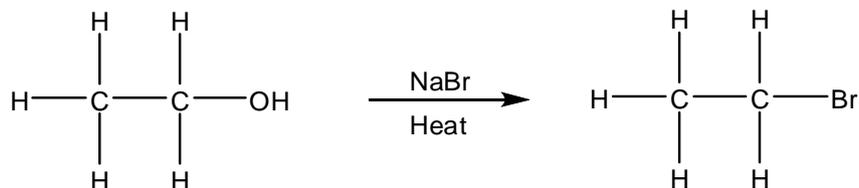
SECTION A

You should spend a maximum of 20 minutes on this section.

Write your answer to each question in the box provided.

Answer **all** the questions.

- 1 Bromoethane can be prepared by heating ethanol with NaBr.



What are the conditions for this reaction?

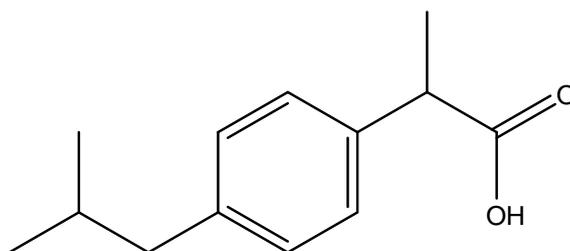
- A Acid catalyst
 B Ultraviolet radiation
 C Halogen carrier
 D Nickel catalyst

Your answer

[1]

- 2 Ibuprofen is a medicine used to relieve pain.

The structure of ibuprofen is shown below.



A standard tablet contains 200 mg of ibuprofen.

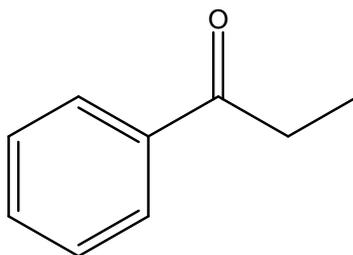
What is the amount, in moles, of ibuprofen in a standard tablet?

- A 9.62×10^{-4}
 B 9.71×10^{-4}
 C 9.62×10^{-1}
 D 9.71×10^{-1}

Your answer

[1]

- 3 A chemist reacts the following molecule with sodium borohydride, NaBH_4 .



Which functional group is formed in the reaction?

- A Carboxylic acid
- B Secondary alcohol
- C Primary alcohol
- D Aldehyde

Your answer

[1]

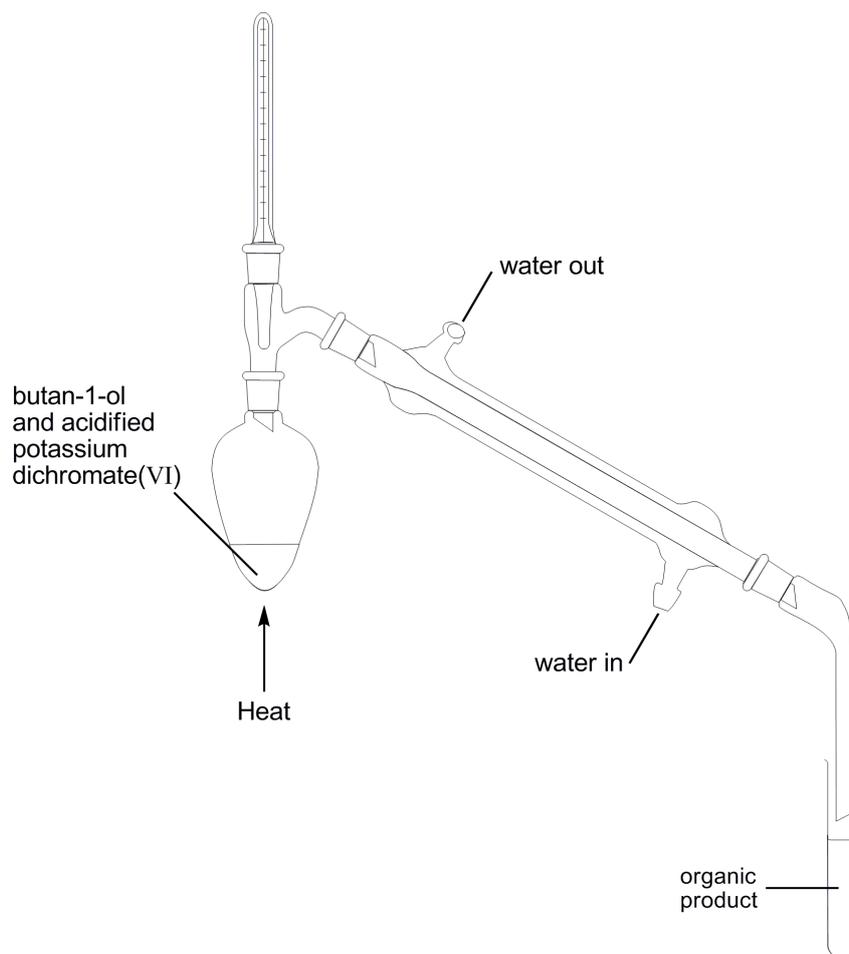
- 4 What is the mechanism for the nitration of benzene?

- A Nucleophilic addition
- B Nucleophilic substitution
- C Electrophilic addition
- D Electrophilic substitution

Your answer

[1]

- 5 Butan-1-ol is reacted with acidified potassium dichromate(VI) using the apparatus shown below.



What is the organic product of this reaction?

- A But-1-ene
- B Butanone
- C Butanal
- D Butanoic acid

Your answer

[1]

- 6 A student wants to remove an acid impurity from an organic liquid.

What should the student do?

- A Add $\text{Na}_2\text{CO}_3(\text{aq})$
- B Reflux the mixture
- C Add Br_2
- D Add MgSO_4

Your answer

[1]

- 7 A student adds bromine water to a solution of phenol.

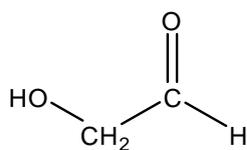
What would the student see during this reaction?

- A Bromine water goes from orange to green.
- B Bromine water goes from orange to colourless and a white precipitate is formed.
- C There is no reaction.
- D Bromine water goes from orange to colourless and the solution fizzes.

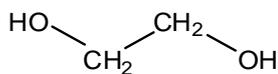
Your answer

[1]

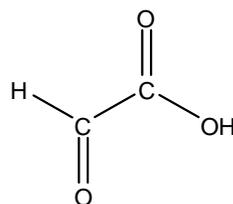
- 8 Which molecule is the most soluble in water?



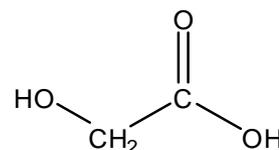
A



B



C



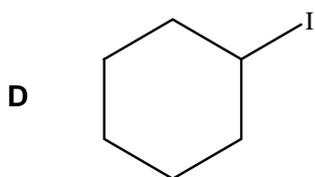
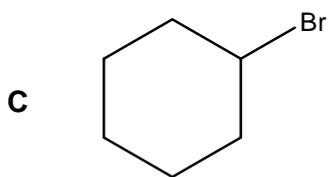
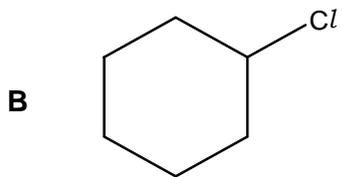
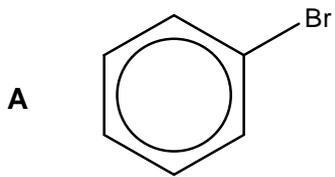
D

Your answer

[1]

- 9 An organic compound is heated with aqueous silver nitrate and ethanol. A cream solid forms.

Which structure is most likely to be the organic compound?

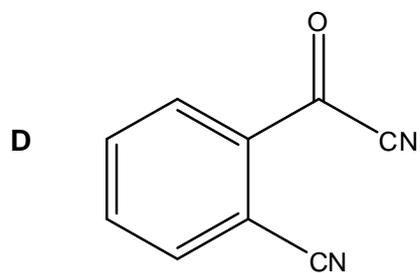
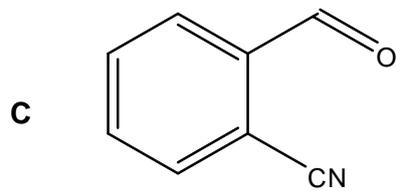
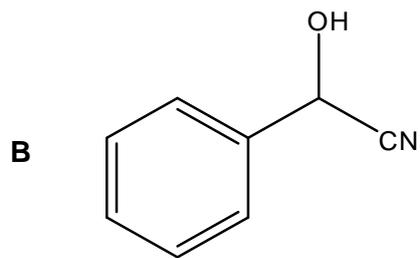
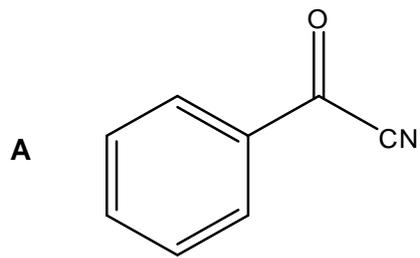


Your answer

[1]

10 Benzaldehyde, C_6H_5CHO , reacts with $NaCN(aq)/H^+(aq)$.

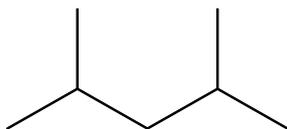
What is the organic product of this reaction?



Your answer

[1]

11 The skeletal formula of a hydrocarbon is shown below.



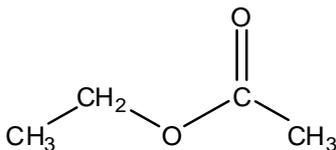
How many peaks would be seen in a ^1H NMR spectrum of this hydrocarbon?

- A 2
- B 3
- C 5
- D 7

Your answer

[1]

12 The structure of an ester is shown below.



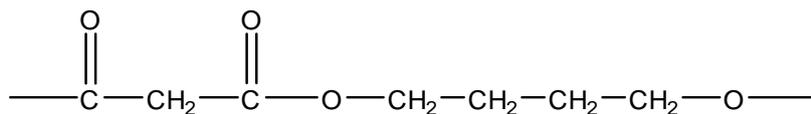
Which statement is most likely to be true about the mass spectrum of the ester?

- A The peak at $m/z = 45$ is due to the fragment $[\text{C}_2\text{H}_5\text{O}]^+$.
- B The peak at $m/z = 44$ is due to the fragment $[\text{C}_3\text{H}_8]^+$.
- C The peak at $m/z = 88$ is the $M+1$ peak.
- D There is no peak at $m/z = 43$.

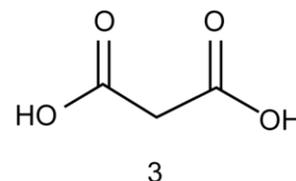
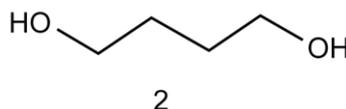
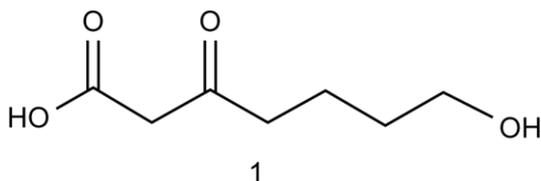
Your answer

[1]

13 A chemist synthesises the following polymer.



Which monomers could be used?

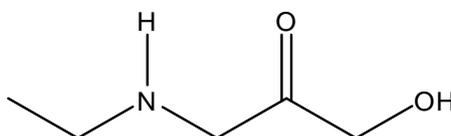


- A** 1, 2 and 3
B Only 1 and 2
C Only 2 and 3
D Only 1

Your answer

[1]

14 The skeletal formula of an organic molecule is shown below.



Which of the following statements is/are correct?

- 1:** The molecule contains an amine group.
2: The molecule contains a carboxylic acid group.
3: The molecule contains an amide group.
- A** 1, 2 and 3
B Only 1 and 2
C Only 2 and 3
D Only 1

Your answer

[1]

15 A chemist investigates the rate of hydrolysis of the haloalkanes.

Which of the following statements is/are true?

- 1: A fluoroalkane gives the slowest rate of hydrolysis.
- 2: The rate of reaction depends on the strength of the carbon–halogen bond.
- 3: The rate of reaction depends on the polarity of the carbon–halogen bond.
- A 1, 2 and 3
- B Only 1 and 2
- C Only 2 and 3
- D Only 1

Your answer

[1]

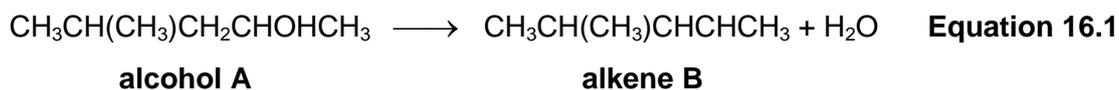
SECTION B

Answer **all** the questions.

16 This question is about alkenes.

(a) When alcohol **A** is heated with an acid catalyst, a reaction takes place forming alkene **B**.

The equation for this reaction is shown below as **Equation 16.1**.



(i) State the type of reaction in **Equation 16.1**.

..... [1]

(ii) Alkene **B** has two stereoisomers.

Explain what is meant by the term *stereoisomers*, and draw the **skeletal** formulae of the two stereoisomers of alkene **B**.

.....

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[3]

(iii) The reaction of **A** with an acid catalyst also forms another alkene, **C**.

Alkene **C** is a structural isomer of alkene **B**.

Suggest the structure of alkene **C**.

[1]

(b) Alkenes can be used to make polymers.

(i) Phenylethene, $C_6H_5CHCH_2$, undergoes addition polymerisation.

Write a balanced equation for the addition polymerisation of phenylethene.

You should show the structures of the monomer and polymer clearly.

[2]

(ii) Waste polymers are often put into landfill sites.

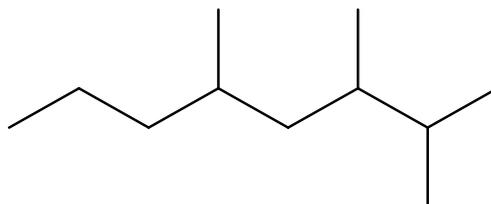
State **one** way of processing waste polymers usefully, other than landfill and recycling.

.....
..... [1]

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17 Hydrocarbon **D** is a structural isomer of $C_{11}H_{24}$ used in aviation fuel.

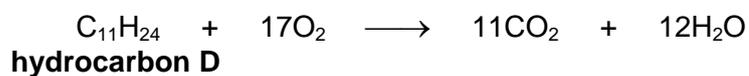


hydrocarbon **D**

(a) Name hydrocarbon **D**.

..... [1]

(b) When used in a jet engine, hydrocarbon **D** undergoes complete combustion as shown in the equation below:



(i) During a typical flight in the upper atmosphere:

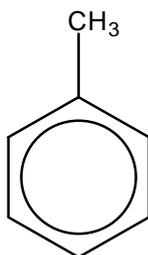
- the aircraft burns 80.4 tonnes of hydrocarbon **D**
- the temperature outside the aircraft is $-55\text{ }^\circ\text{C}$
- the pressure is 26.5 kPa

Calculate the volume, in m^3 , of CO_2 released during a typical aircraft flight.

Give your answer in **standard form** and to **three** significant figures.

volume of $\text{CO}_2 = \dots\dots\dots\text{m}^3$ [5]

- (b) A chemist investigates the chlorination of methylbenzene and finds that the methyl group has a 2- and 4- directing effect.



methylbenzene

4-Chloromethylbenzene is one of the products of the chlorination of methylbenzene.

Outline the mechanism for the formation of 4-chloromethylbenzene from methylbenzene and chlorine in the presence of the catalyst, $AlCl_3$.

Show how $AlCl_3$ behaves as a catalyst.

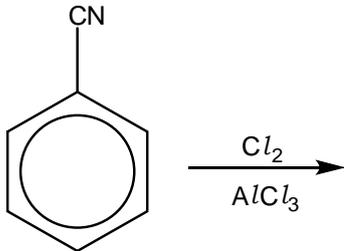
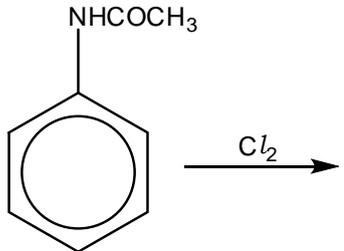
[5]

- (c) The chemist carries out further investigations into the reactions of substituted benzene compounds.

The table below shows the directing effects of different groups attached to a benzene ring.

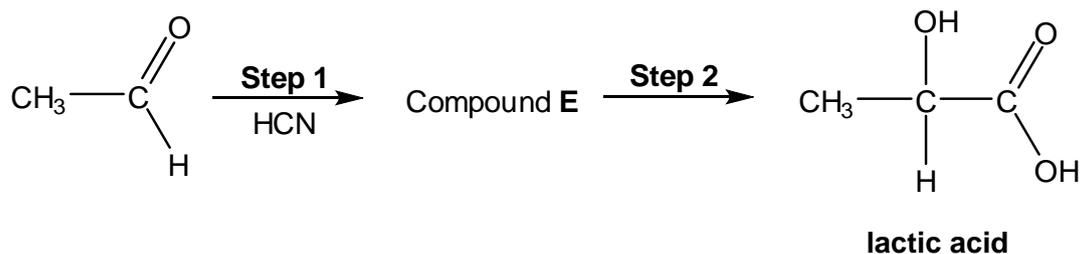
Group	Position to which new substituent is directed
-NO ₂	3
-OH	2, 4
-COCH ₃	3
-N(CH ₃) ₂	2, 4
-NHCOCH ₃	2, 4
-CN	3

- (i) Draw all of the organic products from monosubstitution reactions of the substituted benzene compounds shown below.

Reaction	Monosubstituted Product(s)
 <p>Reaction of benzonitrile (a benzene ring with a CN group) with Cl₂ and AlCl₃ catalyst.</p>	
 <p>Reaction of acetophenone (a benzene ring with an NHCOCH₃ group) with Cl₂.</p>	

[3]

- 19 Lactic acid is a naturally occurring chemical, which can be synthesised from ethanal, CH_3CHO , as shown in the steps below.



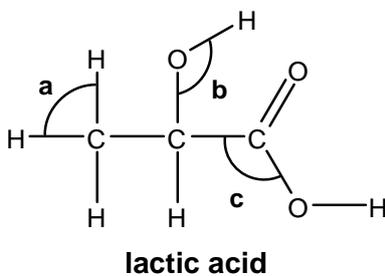
- (a) (i) Draw the structure for compound E.

[1]

- (ii) Suggest a reagent that could be used for **Step 2**.

..... [1]

- (iii) The displayed formula of lactic acid is shown below.



Suggest a value for each bond angle **a–c**.

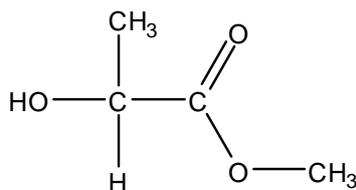
Bond angle **a**:

Bond angle **b**:

Bond angle **c**:

[2]

(b) Methyl lactate is an ester of lactic acid which is used as a solvent.



methyl lactate

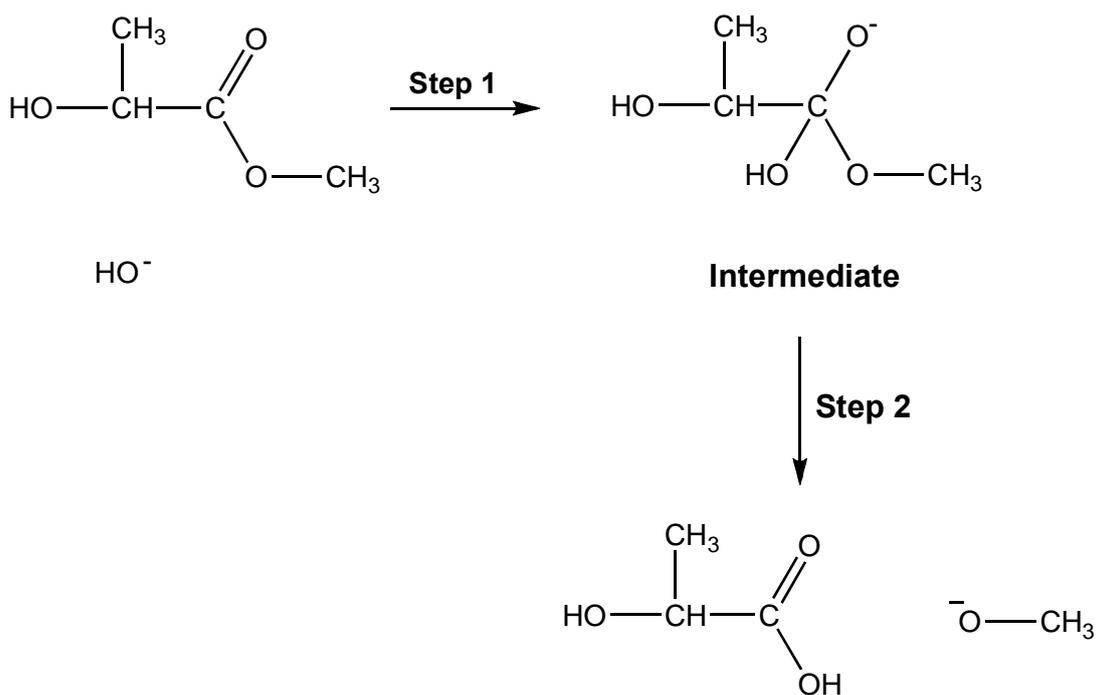
Methyl lactate can be hydrolysed by refluxing with sodium hydroxide solution.

In this reaction the hydroxide ion acts as a nucleophile.

(i) Suggest how the hydroxide ion can act as a nucleophile.

..... [1]

(ii) Part of the mechanism for the hydrolysis is shown below.

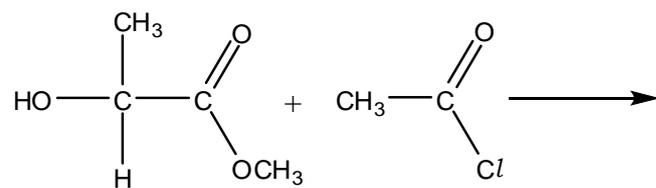


- Add relevant dipoles and curly arrows to show how the intermediate is formed in **Step 1** of the mechanism.
- Add curly arrows to show how the carboxylic acid and $\text{O}^- - \text{CH}_3$ ion are formed from the intermediate in **Step 2** of the mechanism.

[4]

(iii) Methyl lactate can also react with ethanoyl chloride.

Complete the equation for this reaction.

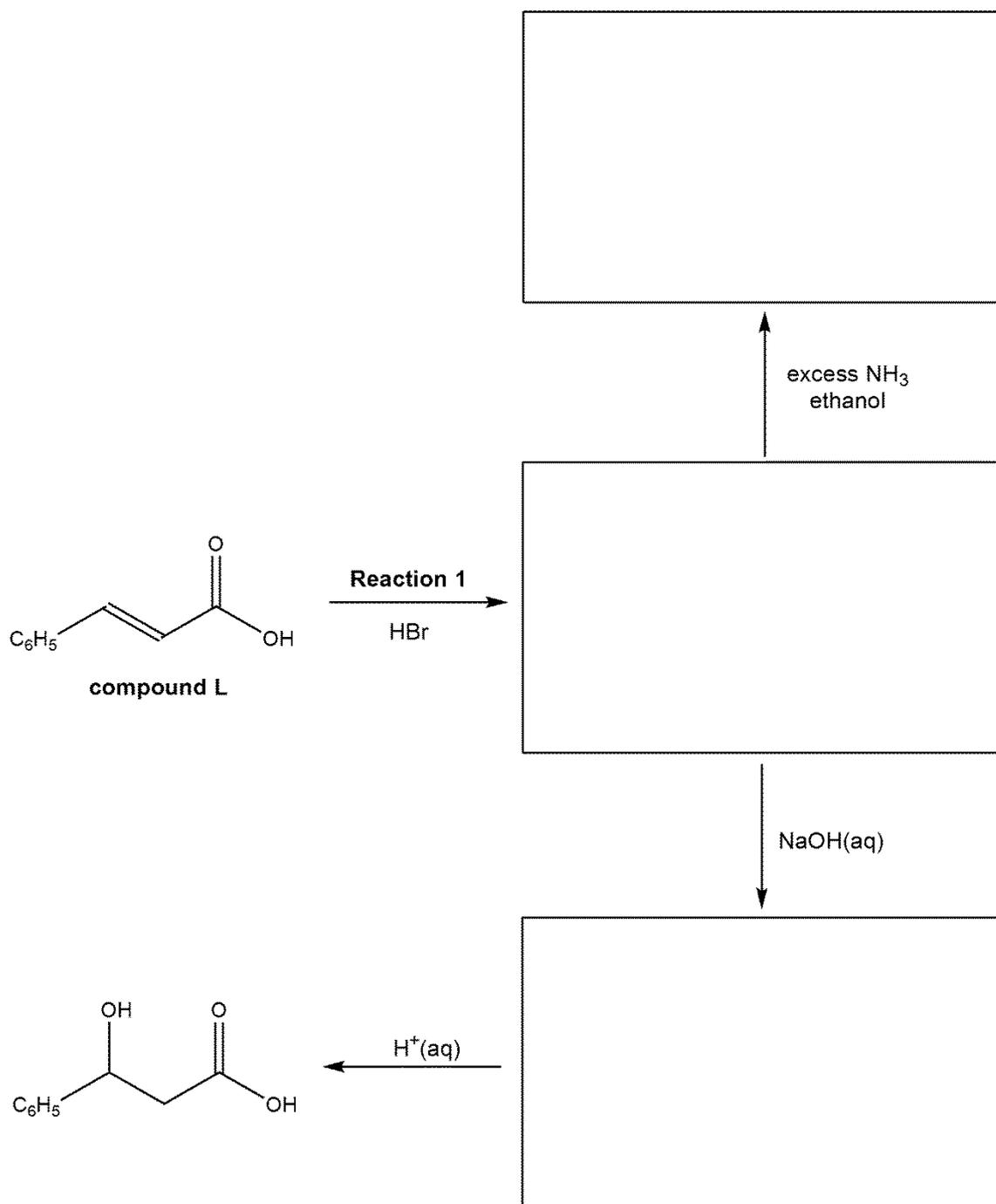


[2]

21 This question is about the reactions of compounds with more than one functional group.

(a) A chemist investigates some reactions of compound **L**, as shown in the flowchart below.

Complete the flowchart by showing the missing organic structures in the boxes.



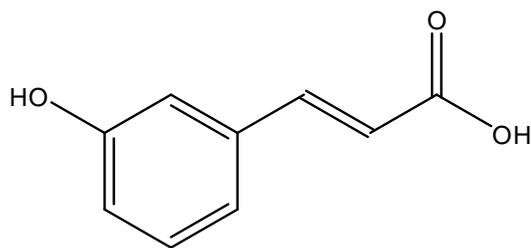
[3]

(b) Outline the mechanism that occurs in **Reaction 1**.

Include curly arrows, relevant dipoles and the name of the mechanism.

name of mechanism [4]

- (c) The chemist synthesises compound **M**, which can undergo both addition and condensation polymerisation.



compound M

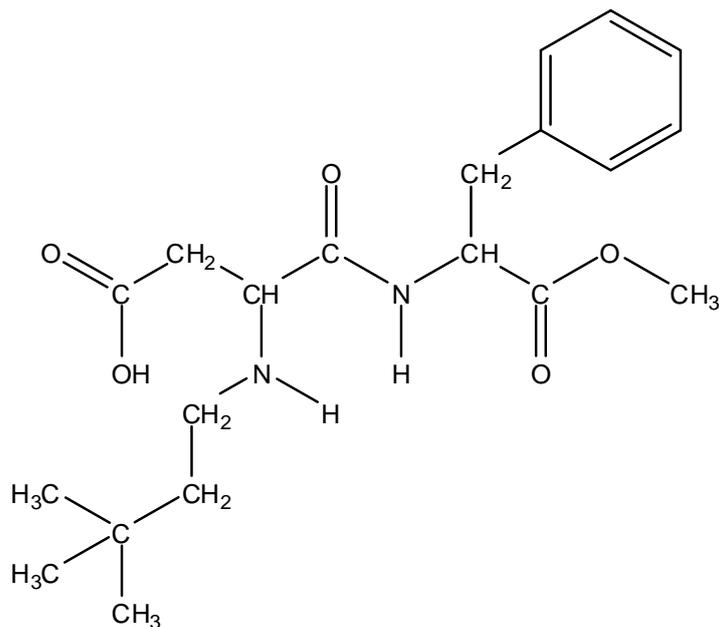
- (i) Draw the repeat unit of the **addition** polymer formed from compound **M**.

[1]

- (ii) Draw **two** repeat units of the **condensation** polymer formed from compound **M**.

[2]

(d) Neotame, an artificial sweetener, is broken down by acid hydrolysis.



neotame

Draw the structures of **all** the organic compounds formed.

[4]

22 A scientist analyses a compound that is present in a sample of ink.

The results are shown below:

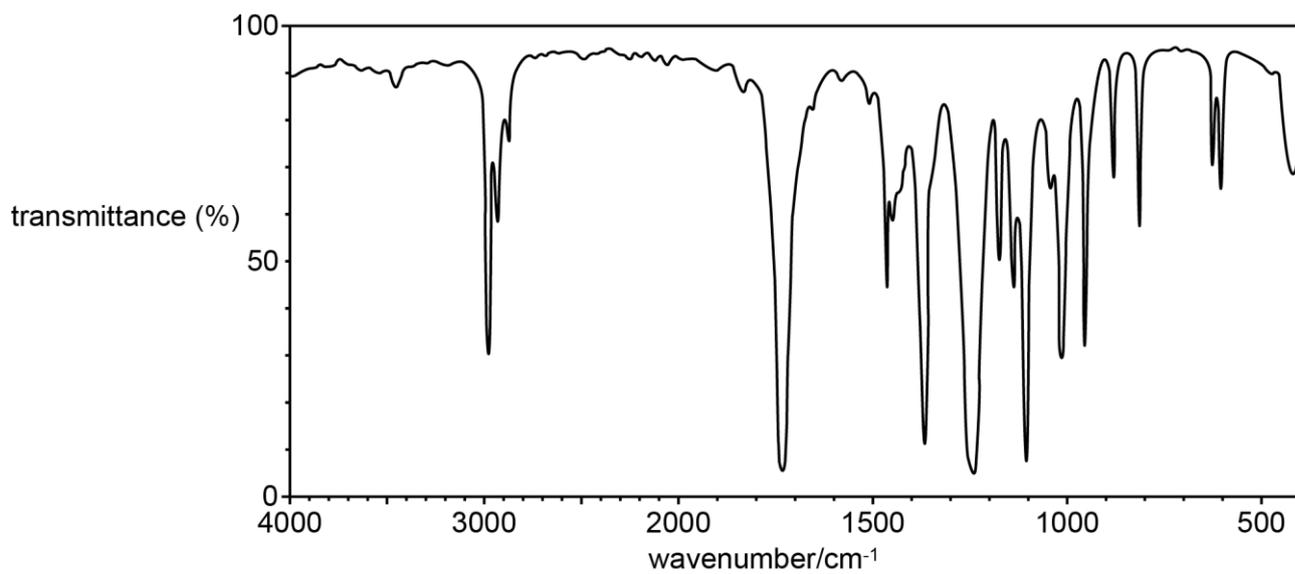
Elemental analysis by mass:

C: 58.80%; H: 9.87%; O: 31.33%

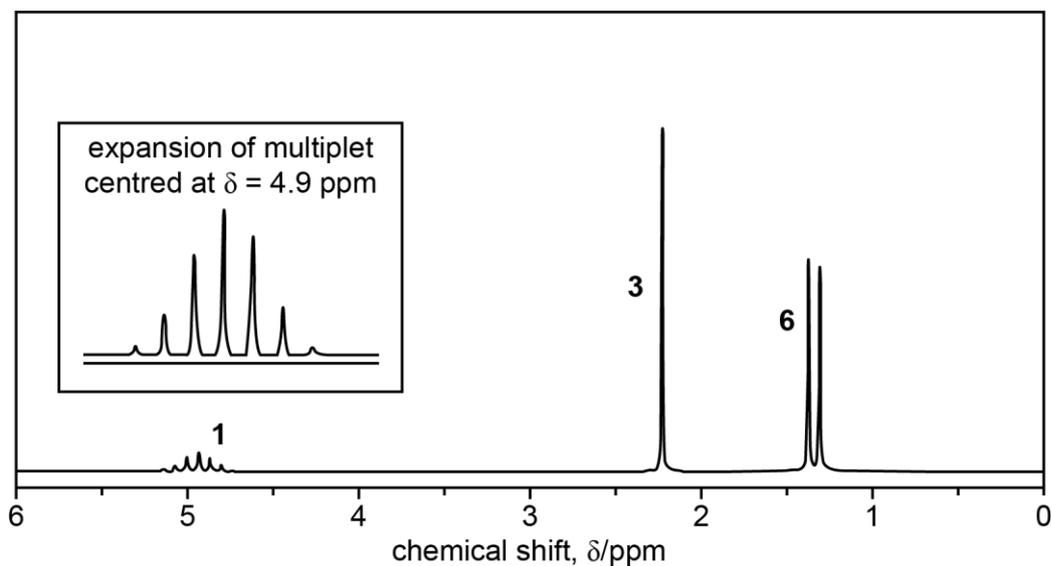
Mass spectrum

Molecular ion peak at $m/z = 102.0$

Infrared spectrum



^1H NMR spectrum



The numbers by the peaks are the relative peak areas.

From the *Data Sheet*, the peak centred at $\delta = 4.9$ ppm would be expected at a chemical shift value about 1 ppm to the right, i.e. 3.9 ppm.

