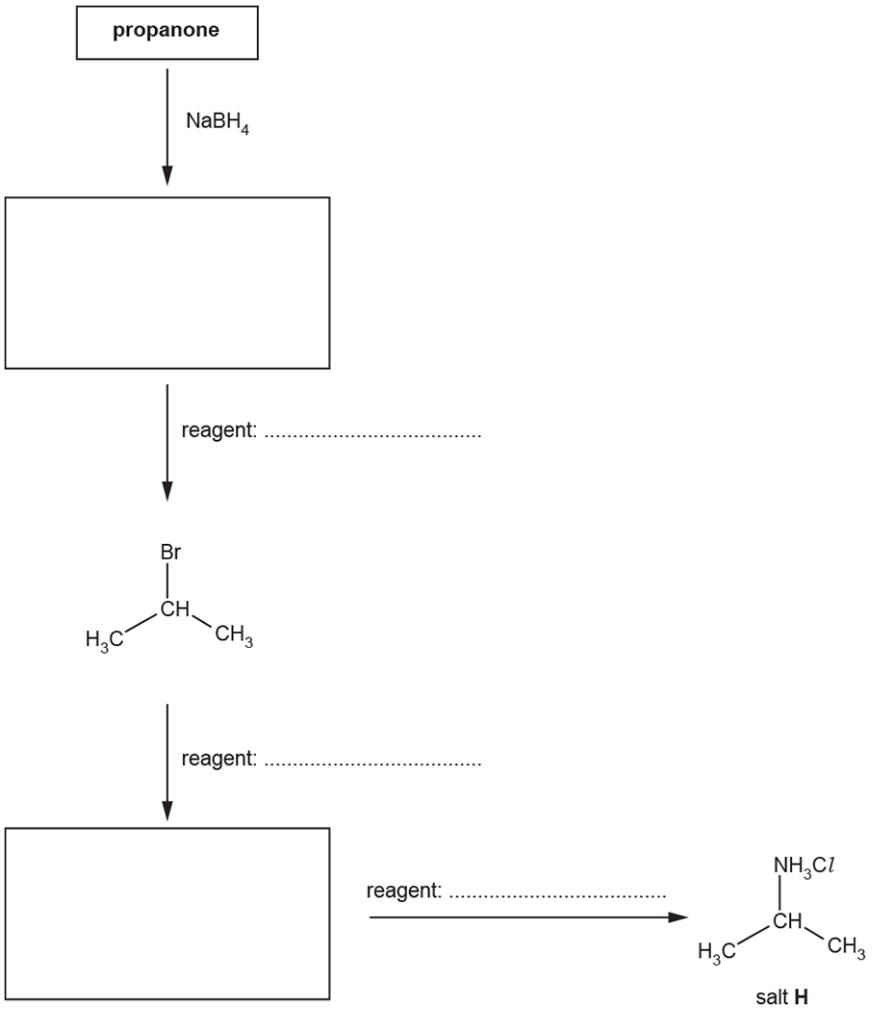
Amines

1. This question is about organic compounds containing nitrogen.

Salt **H**, $(CH_3)_2CHNH_3Cl$, is used in the manufacture of garden weedkillers.

The flowchart shows the synthesis of the salt **H** from propanone.

Complete the flowchart.
Show structures for organic compounds.



[5]

2. This question is about organic compounds containing nitrogen.

Sodium cyanide, NaCN, can be reacted with many organic compounds to increase the length of a carbon chain.

i. 1-Chloropropane, $CH_3CH_2CH_2Cl$, reacts with ethanolic sodium cyanide by nucleophilic substitution.

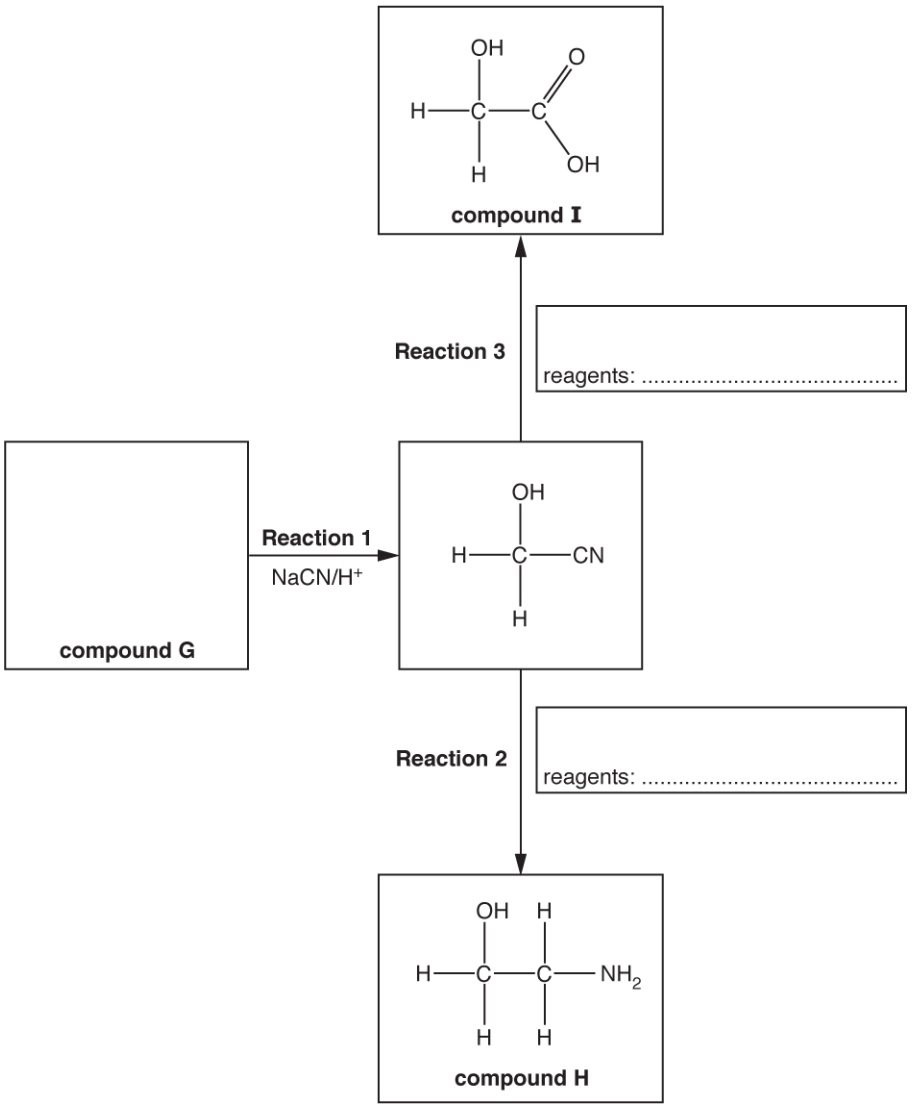
Outline the mechanism for this reaction.

Include curly arrows, relevant dipoles and the structure of the organic product.

[3]

ii. Compound **G** is used to synthesise compounds **H** and **I** as shown in the flowchart below.

Complete the flowchart showing the structure of compound **G** and the **formulae** of the reagents for **Reaction 2** and **Reaction 3**.



[3]

iii. Compound **H** reacts with dilute hydrochloric acid to form a salt.

Explain why compound **H** can react with dilute hydrochloric acid and suggest a structure for the salt formed.

Explanation

Structure

[2]

iv. Compound **I** is the monomer for the biodegradable polymer **J**.
Draw **two** repeat units of polymer **J** and suggest a reason why it is biodegradable.

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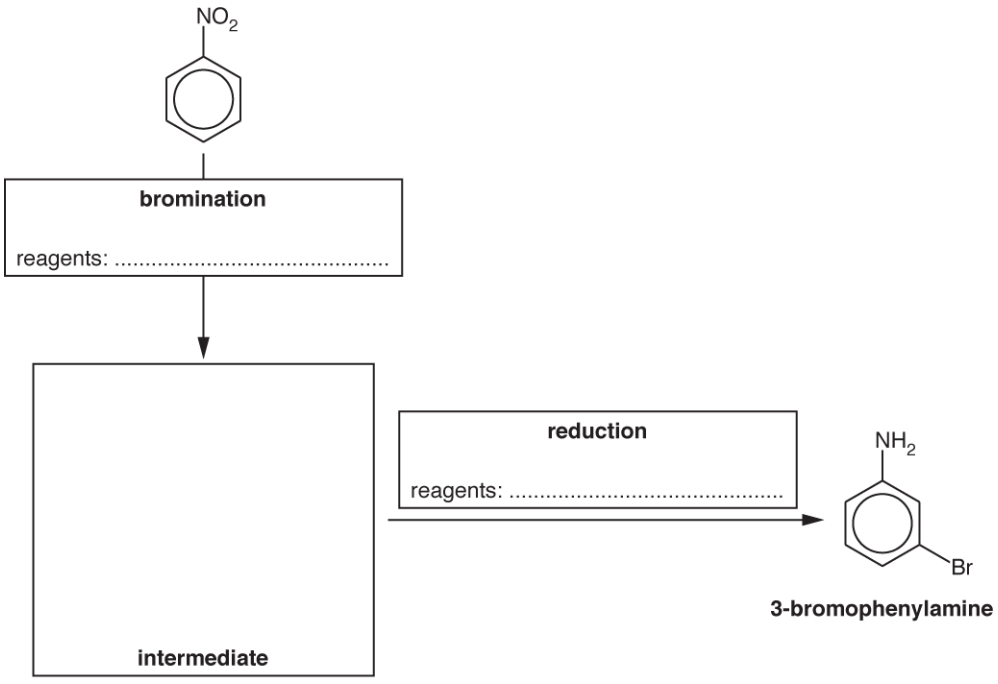
[3]

3. A student synthesises 3-bromophenylamine, shown below, starting from nitrobenzene.

i. Complete the flowchart showing the structure of the intermediate and the **formulae** of the reagents for each stage.



[3]

ii. Another student attempts the same synthesis but carries out reduction **before** bromination. The student was surprised to find that two structural isomers of 3-bromophenylamine had been formed instead of the desired organic product.

Explain this result and suggest the structures of the two isomers that formed.

Explanation

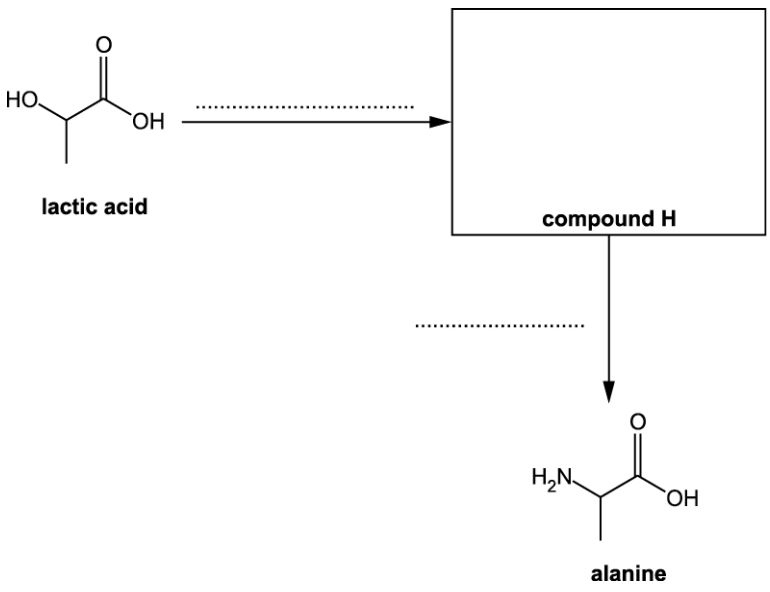
Structures

[3]

4. A student plans a two-stage synthesis of alanine from lactic acid, $CH_3CH(OH)COOH$.

The synthesis first prepared compound **H**, as shown in the flowchart.

Draw the structure of compound **H** in the box and add the formulae of the reagents for each stage on the dotted lines.



[3]

5(a). A chemistry teacher carries out an experiment to synthesise 2-aminopropan-1-ol, $CH_3CH(NH_2)CH_2OH$.

The teacher asks a university chemistry department to test the 2-aminopropan-1-ol using proton NMR spectroscopy and mass spectrometry.

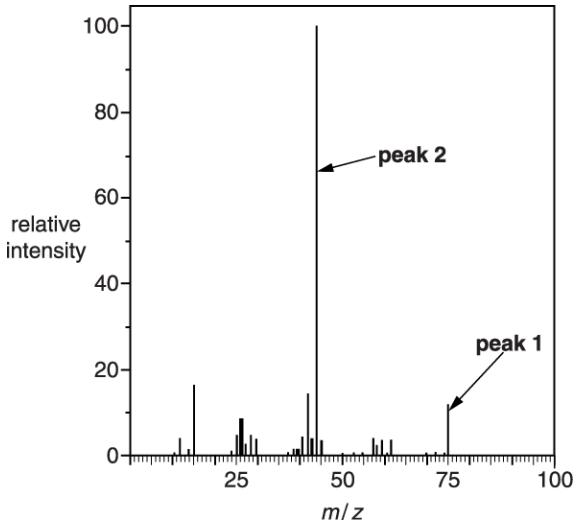
i. For the ^1H NMR analysis, the sample was dissolved in D_2O.

Complete the table to predict the ^1H NMR spectrum of $CH_3CH(NH_2)CH_2OH$ after dissolving in D_2O.

^1H NMR spectrum for $CH_3CH(NH_2)CH_2OH$, dissolved in D_2O		
Chemical shift, δ/ ppm	**Relative peak area**	**Splitting pattern**

[3]

ii. The mass spectrum for $CH_3CH(NH_2)CH_2OH$ is shown below.



Give the formulae for the species responsible for **peak 1** and **peak 2** in the mass spectrum.

peak 1

peak 2

[2]

(b). The teacher synthesises 2-aminopropan-1-ol, $CH_3CH(NH_2)CH_2OH$, from 2-chloropropan-1-ol, $CH_3CHC/\ CH_2OH$.

i. State the reagents and conditions required for this synthesis.

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[1]

ii. The sample prepared by the teacher from 2-chloropropan-1-ol is not pure. It also contains compound **D**.

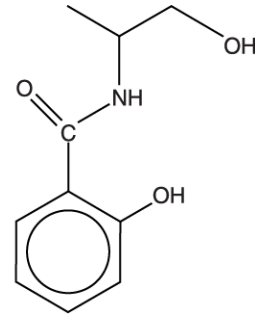
Compound **D** has a molecular formula of $C_6H_{15}NO_2$.

Suggest the structure of compound **D**.

Compound **D**

[1]

(c). In a separate experiment, the chemistry teacher prepares compound **E** from 2-aminopropan-1-ol.



compound E

i. One of the functional groups in compound **E** is a phenol.

Name the other functional groups in compound **E**.

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[1]

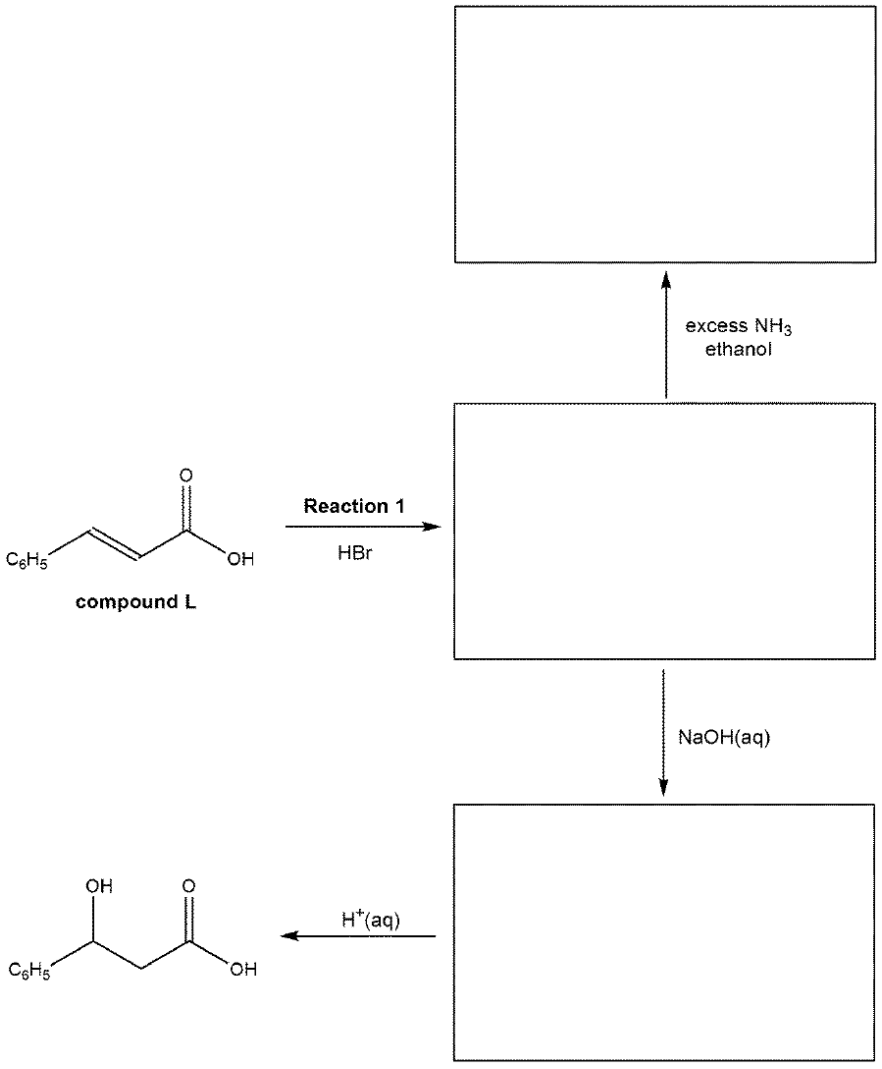
ii. Draw the structures of the **two** organic products formed when compound **E** is heated under reflux with dilute hydrochloric acid.

[2]

6(a). This question is about the reactions of compounds with more than one functional group.

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.

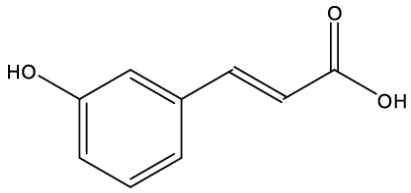


[3]

(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

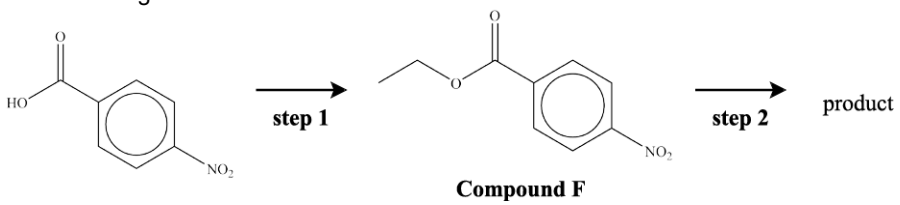
i. Draw the repeat unit of the **addition** polymer formed from compound **M**.

[1]

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

[2]

7. 4-Nitrobenzoic acid is an important compound in chemical synthesis. The flowchart below shows a synthesis involving 4-nitrobenzoic acid.



Compound F

i. State suitable reactant(s) and conditions for **step 1**.

[1]

ii. In **step 2**, the $-NO_2$ group in compound **F** is reduced by tin and concentrated hydrochloric acid.

Write an equation for the reduction of compound **F**.

Show the structures of any organic compounds involved.

[2]

END OF QUESTION PAPER