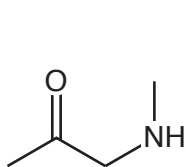
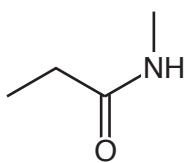


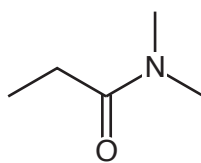
- 1 Which molecule is a secondary amine?



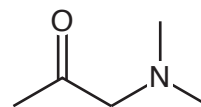
A



B



C



D

Your answer

[1]

2 Which reagents could be used to prepare $\text{CH}_3\text{CH}_2\text{CONHCH}_3$?

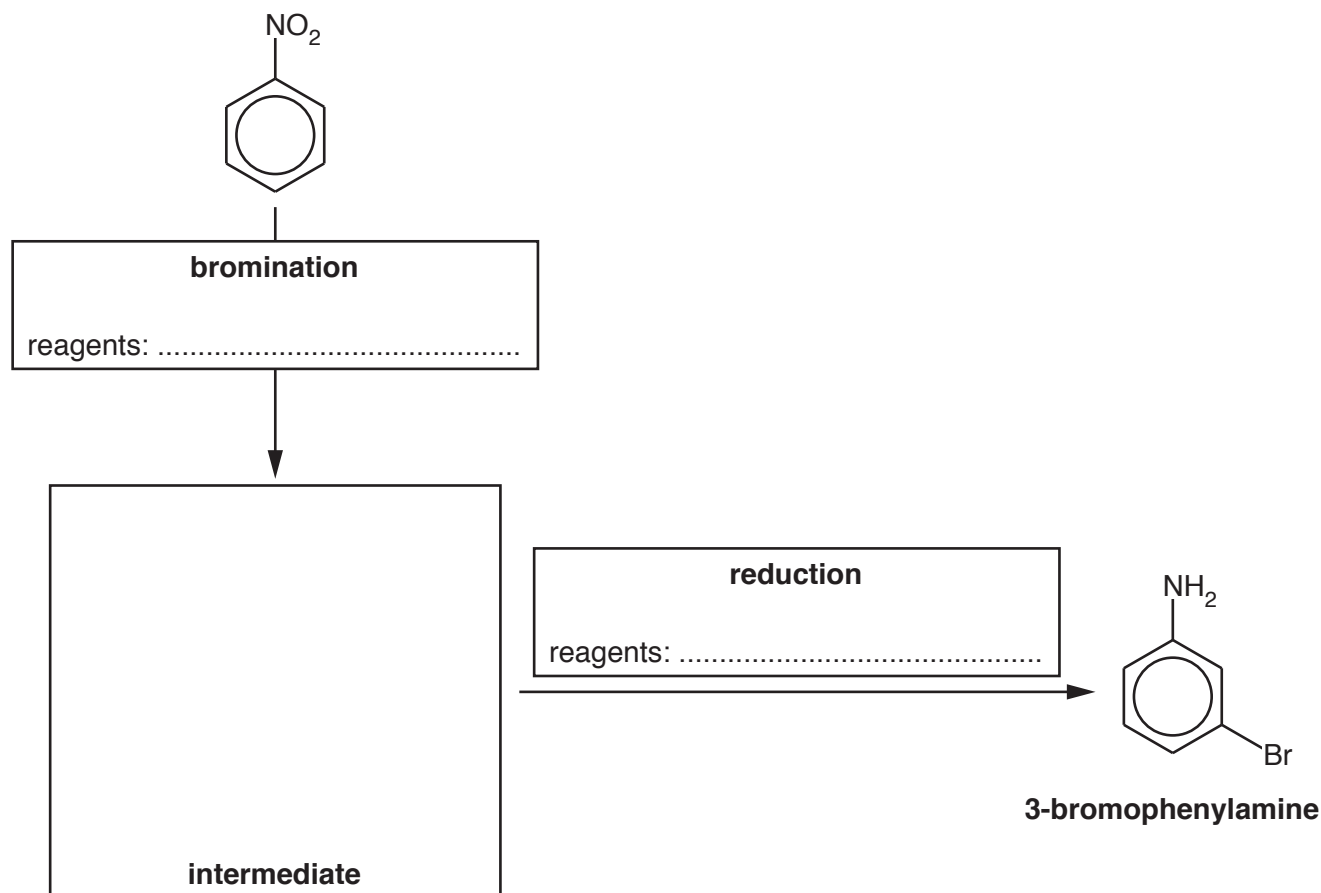
- A** $\text{CH}_3\text{CH}_2\text{COCl} + \text{CH}_3\text{NH}_2$
- B** $\text{CH}_3\text{CH}_2\text{CONH}_2 + \text{CH}_3\text{Br}$
- C** $\text{CH}_3\text{CH}_2\text{COONa} + \text{CH}_3\text{NH}_2$
- D** $\text{CH}_3\text{CH}_2\text{COCH}_3 + \text{NH}_3$

Your answer ☐

[1]

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

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.

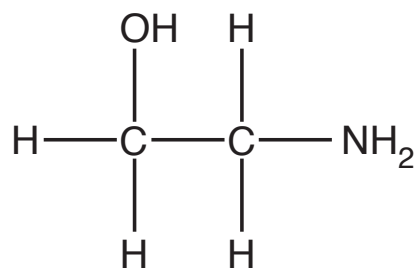
Explanation

.....

.....

Structures

[3]



compound H

- 4 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

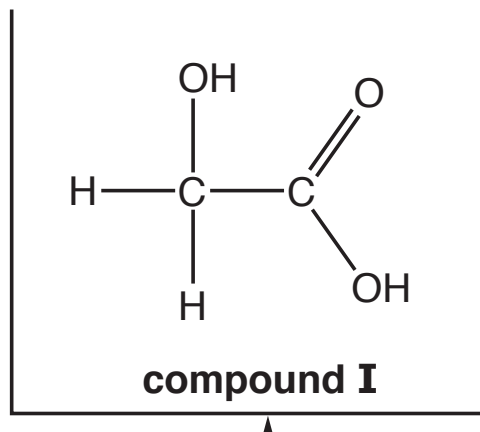
.....

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.....

Structure

[2]



- 5 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.

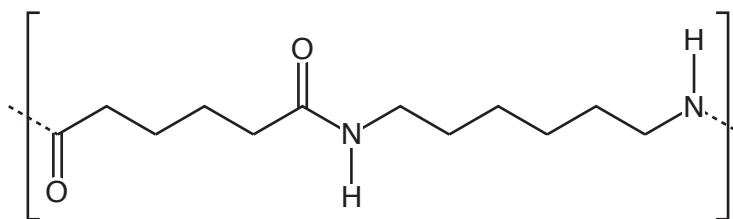
.....

.....

.....

..... **[3]**

- 6 The repeat unit of Nylon 6,6 is shown below.



Nylon 6,6

- (i) Draw the structures of **two** monomers that can be used to form Nylon 6,6.

[2]

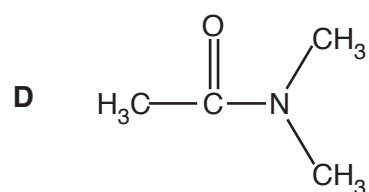
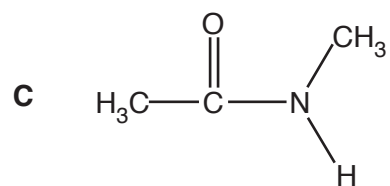
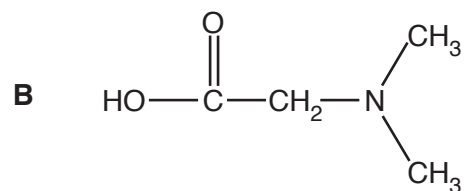
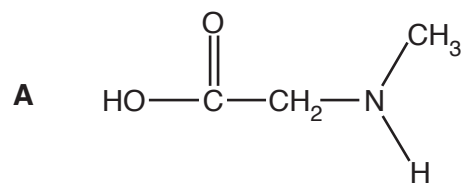
- (ii) A sample of Nylon 6,6 has a relative molecular mass of 21500.

Estimate the number of repeat units in the sample.

Give your answer as a **whole** number.

number of repeat units = ... [1]

7 Which compound is a secondary amide?



Your answer

[1]

The general formula of an α -amino acid is $\text{RCH}(\text{NH}_2)\text{COOH}$.

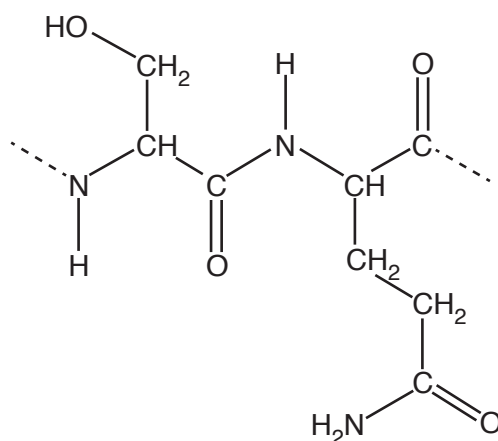
- 8 The α -amino acid lysine ($\text{R} = (\text{CH}_2)_4\text{NH}_2$) reacts with an excess of dilute hydrochloric acid to form a salt.

Draw the structure of the salt formed in this reaction.

[2]

- 9 α -Amino acids can react to form proteins.

A short section of a protein chain is shown below.

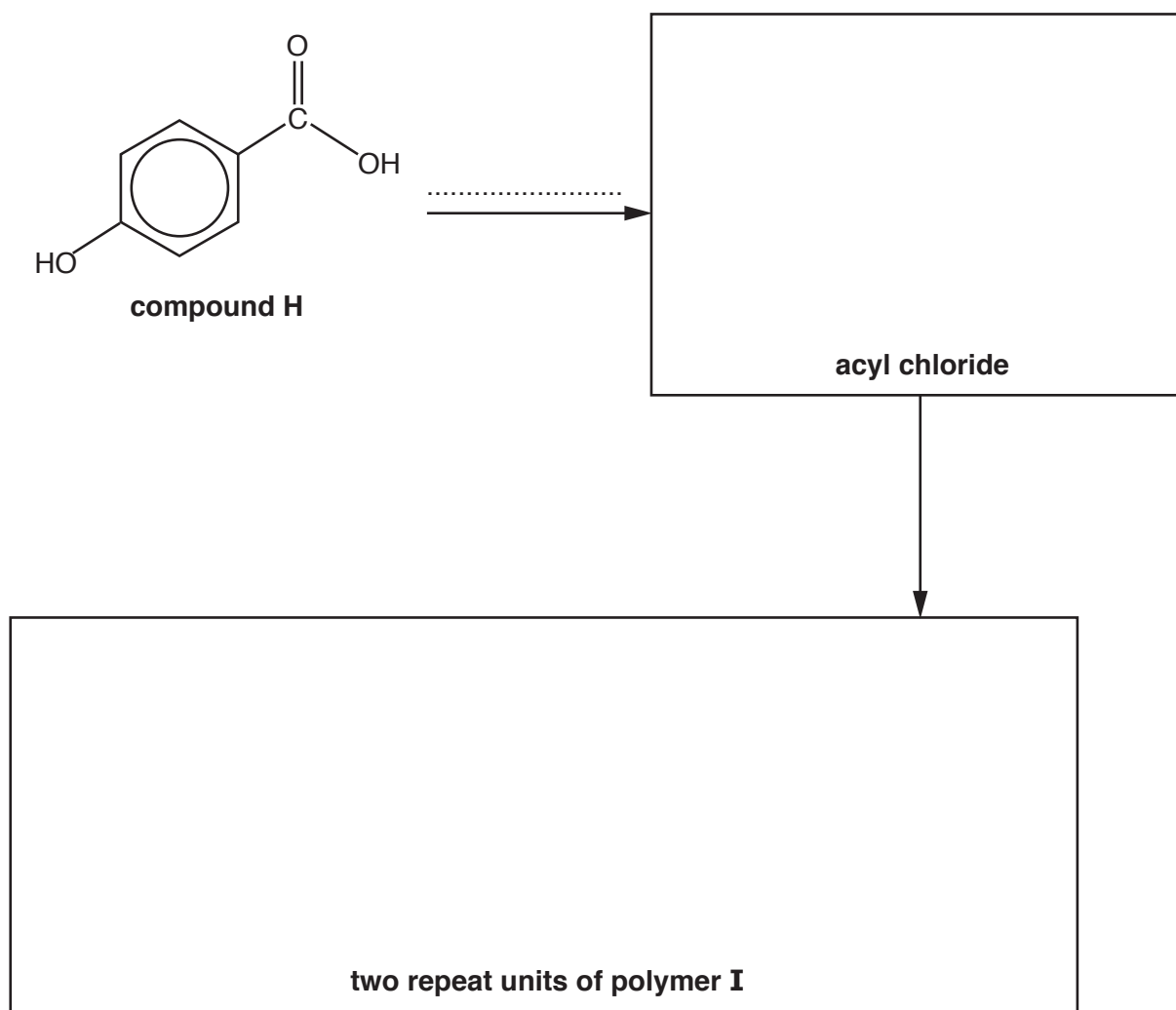


A student hydrolyses the protein with hot $\text{NaOH}(\text{aq})$.

Draw the structures of the organic products formed from this section of the protein.

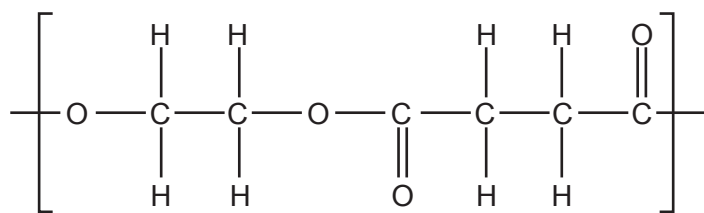
- 10 Compound **H** is used in the synthesis of polymer **I**, as shown in the flowchart below.

Complete the flowchart by drawing the structure of the acyl chloride and **two** repeat units of polymer **I**, and stating the **formula** of the reagent(s) required for the first stage on the dotted line.

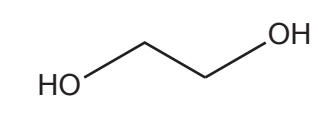
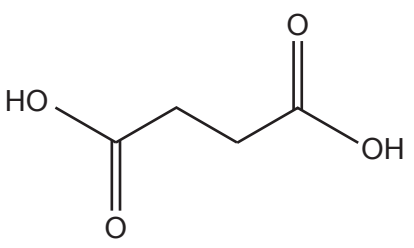
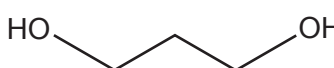
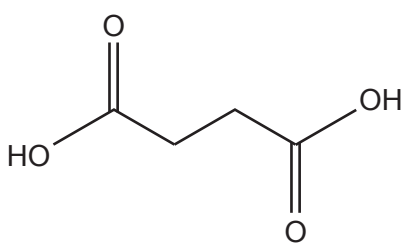
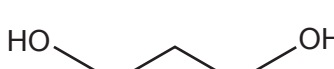
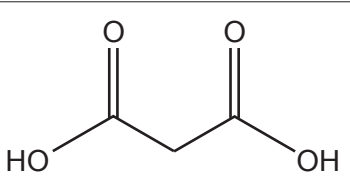
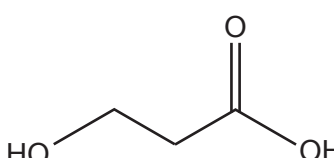
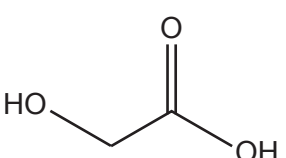


[4]

- 11 The repeat unit of a polymer is shown below.



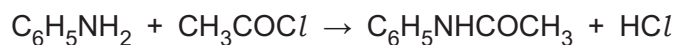
Which monomers could form this polymer?

A		
B		
C		
D		

Your answer

[1]

- 12 A student reacts 4.50 g of $\text{C}_6\text{H}_5\text{NH}_2$ with excess CH_3COCl in the reaction below.



$$M_r = 93.0$$

$$M_r = 135.0$$

The reaction produces 3.25 g of $\text{C}_6\text{H}_5\text{NHCOCH}_3$.

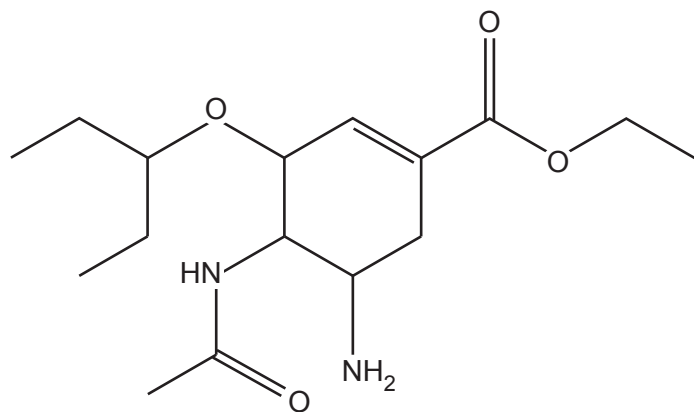
What is the percentage yield of $\text{C}_6\text{H}_5\text{NHCOCH}_3$?

- A** 49.8
- B** 68.9
- C** 72.2
- D** 95.4

Your answer

[1]

- 13 The structure of a compound used to treat influenza is shown below.



Which functional group(s) is/are in a molecule of the compound?

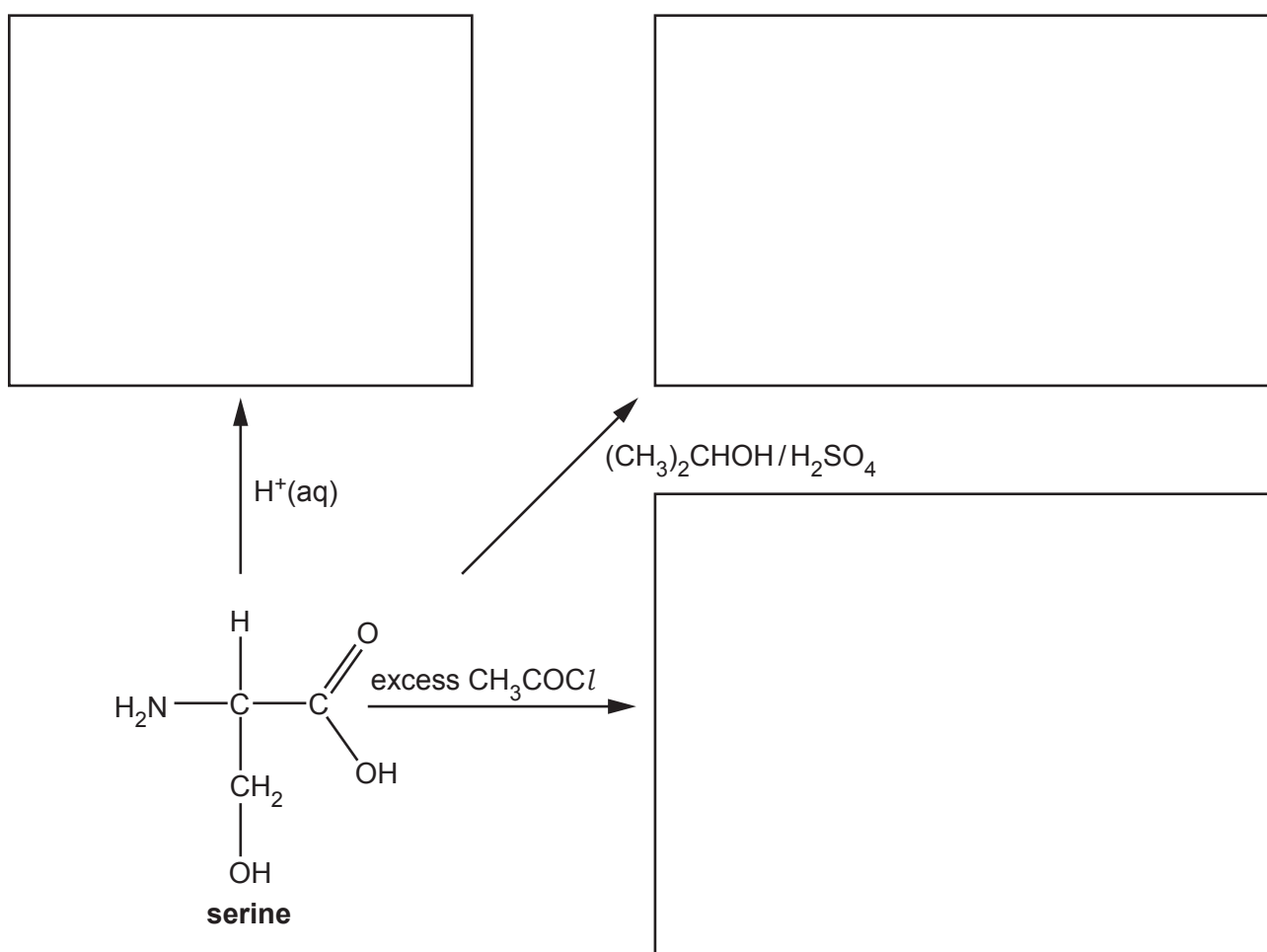
14 This question is about α -amino acids, $\text{RCH}(\text{NH}_2)\text{COOH}$.

Table 17.1 shows the R groups in four amino acids.

Amino acid	R group
alanine (ala)	CH_3-
serine (ser)	HOCH_2-
leucine (leu)	$(\text{CH}_3)_2\text{CHCH}_2-$
glycine (gly)	$\text{H}-$

Table 17.1

(i) In the boxes, draw the organic products for the reactions of serine shown below.



[4]

(ii) A student is provided with one of the four amino acids in **Table 17.1**.

A student carries out a titration with a standard solution of hydrochloric acid to identify the amino acid. The student's method is outlined below.

- The student dissolves 5.766 g of the amino acid in water and makes the solution up to 250.0 cm³ in a volumetric flask.
- The student titrates this solution with 25.0 cm³ of 0.150 mol dm⁻³ hydrochloric acid.
- 21.30 cm³ of the amino acid solution were required for complete neutralisation of the hydrochloric acid.

Determine which amino acid the student used.

[4]

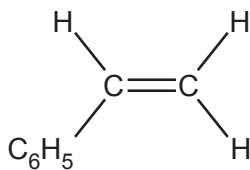
- 15 A polyester is formed from 200 molecules of 4-hydroxybenzoic acid.

What is the relative molecular mass, M_r , of the polyester?

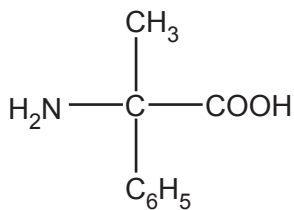
$M_r = \dots\dots\dots \text{ g mol}^{-1}$ **[2]**

- 16 Benzene can be used as the starting material for the synthesis of compounds **D** and **E**, shown below.

In the diagrams C_6H_5 is a phenyl group.



compound D



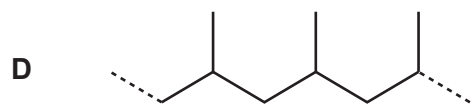
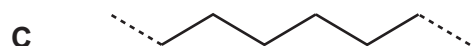
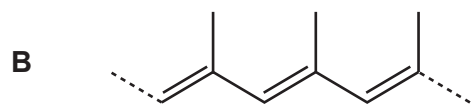
compound E

Compounds **D** and **E** can be converted into polymers.

- (i) Draw **two** repeat units of these polymers.

Two repeat units of polymer formed from **D**

17 Which structure shows a section of poly(propene)?



Your answer

[1]

18 $\text{HOOC}(\text{CH}_2)_2\text{COOH}$ and $\text{HO}(\text{CH}_2)_4\text{OH}$ react together to form polymer **E**.

(i) Draw **one** repeat unit of polymer **E**.

The functional groups should be clearly displayed.

[2]

(ii) Governments are encouraging the development of biodegradable polymers to reduce dependency on persistent plastic waste derived from fossil fuels.

Polymer **E** is a biodegradable polymer.

Suggest why polymer **E** is able to biodegrade.

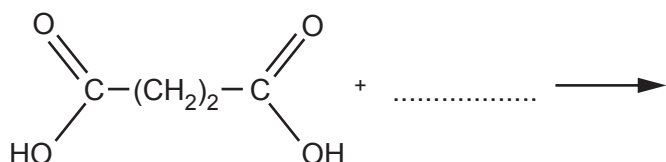
.....

..... [1]

(iii) A large yield of polymer **E** can be obtained by reacting a diacyl dichloride with $\text{HO}(\text{CH}_2)_4\text{OH}$.

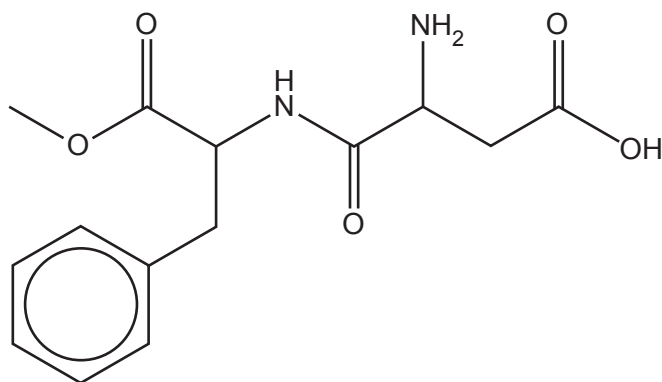
The diacyl dichloride is prepared from $\text{HOOC}(\text{CH}_2)_2\text{COOH}$.

Complete the equation for the formation of a diacyl dichloride from $\text{HOOC}(\text{CH}_2)_2\text{COOH}$.



[3]

- 19 Aspartame, shown below, is an artificial sweetener commonly used as a sugar substitute.



aspartame

- (i) Aspartame contains several functional groups.

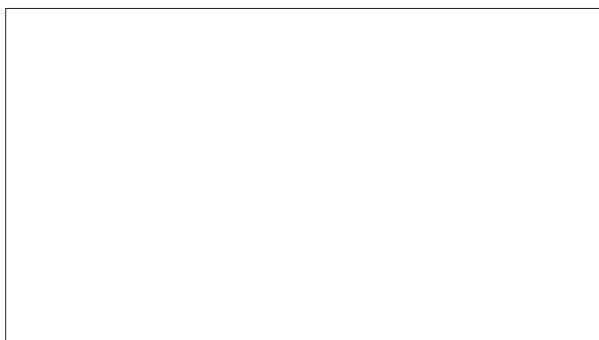
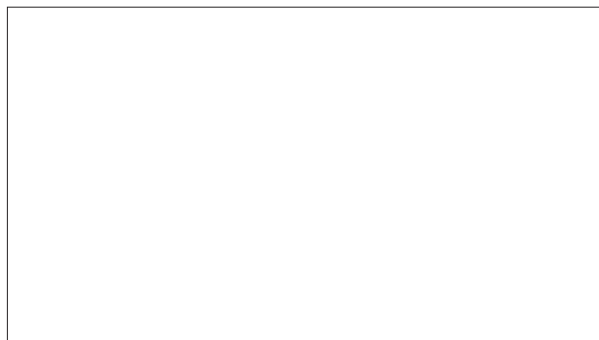
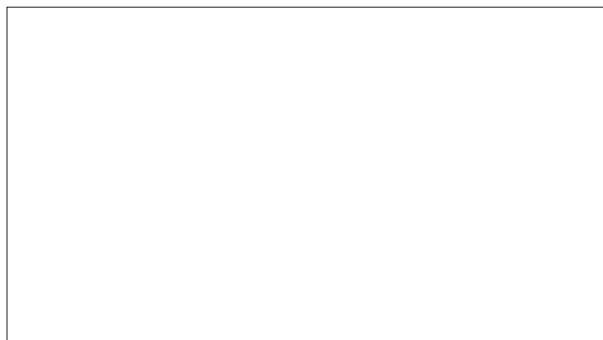
Apart from the benzene ring, name the functional groups in aspartame.

.....

 [3]

- (ii) A sample of aspartame is hydrolysed with aqueous acid.

Draw the structures of the **three** organic products of the complete **acid hydrolysis** of aspartame.



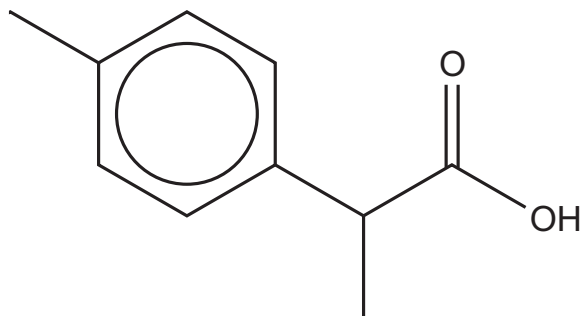
[4]

- 20 A polymer can be made from the monomers:
- 1,4-diaminobutane
 - benzene-1,4-diacyl dichloride.

Draw the structures of these monomers and **one** repeat unit of the polymer.

1,4-diaminobutane	benzene-1,4-diacyl dichloride
one repeat unit of polymer	

[4]



ibuprofen

- 21 Tablets based on ibuprofen and lysine are now available from pharmacies.

These tablets are claimed to act faster than ibuprofen by being absorbed into the body more quickly than ibuprofen alone.

One type of these tablets contains a salt of ibuprofen and the amino acid lysine ($R = -(CH_2)_4NH_2$) in a 1:1 molar proportion.

- (i) Suggest the structure of each ion in this lysine salt of ibuprofen, including the position of any charges.

– ion	+ ion

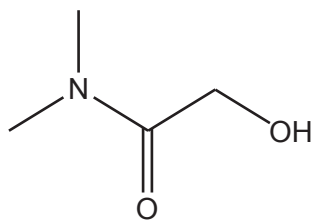
[2]

- (ii) Suggest why tablets based on a salt of ibuprofen should act faster in the body than ibuprofen.

.....

 [1]

- 22 The skeletal formula of an organic compound is shown below.



Which functional groups are present?

- A** amide and alcohol
- B** amide and carboxylic acid
- C** amine and carboxylic acid
- D** amine, ketone and alcohol

Your answer

☐

[1]

23 This part is about polymers derived from carboxylic acid monomers.

(i) Poly(pent-3-enoic acid) is an addition polymer.

Draw the structure of pent-3-enoic acid and **two** repeat units of this polymer.

Pent-3-enoic acid	
Two repeat units of poly(pent-3-enoic acid)	

[2]

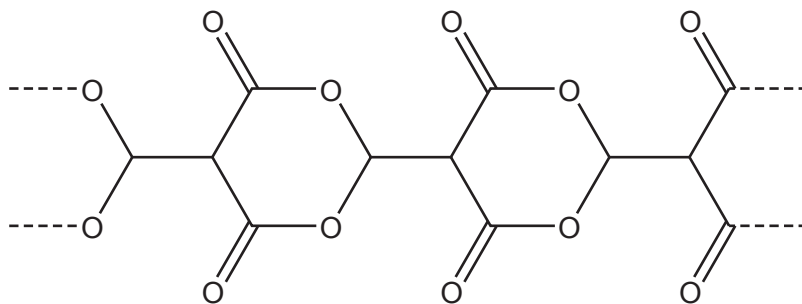
(ii) Butanedicarboxylic acid and 1,4-dihydroxy-2-methylbenzene react to form a condensation polymer.

Draw **one** repeat unit of this condensation polymer.

--

[2]

- (iii) Three repeat units of a condensation polymer are shown below.

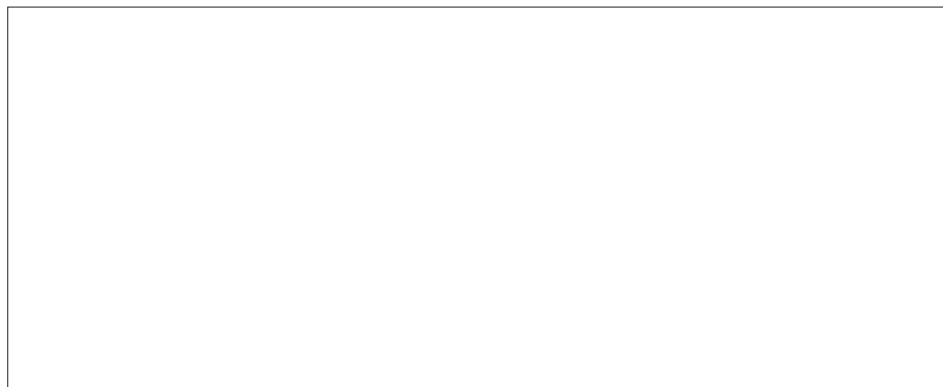


Draw the structure of the monomer required to form this polymer.

[1]

- (d) A polymer is formed from 400 molecules of 2-aminopropanoic acid.

- (i) Draw **one** repeat unit of this polymer.

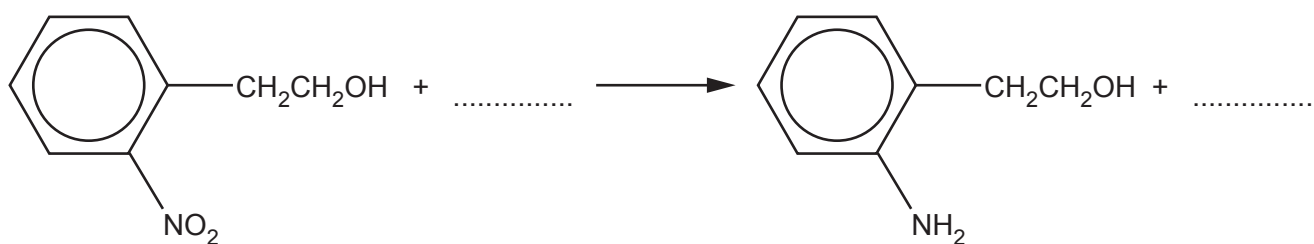


[1]

- (ii) What is the relative molecular mass, M_r , of the polymer?

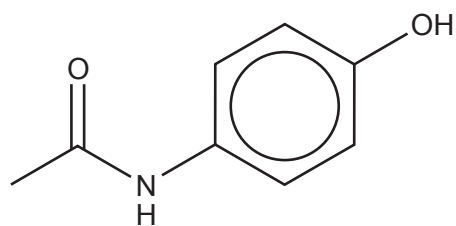
$M_r = \dots\dots\dots$ [2]

24 Fill in the equation for the reduction stage of this synthesis.



[1]

- 25 The structure of the painkiller paracetamol is shown below.



Paracetamol

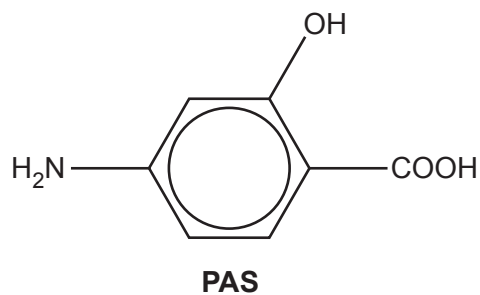
Which functional groups are present in paracetamol?

- A** alcohol, amide
- B** alcohol, arene, ketone, amine
- C** phenol, amide
- D** phenol, ketone, amine

Your answer

[1]

- 26 PAS, shown below, is an antibiotic used to treat several diseases including tuberculosis (TB).



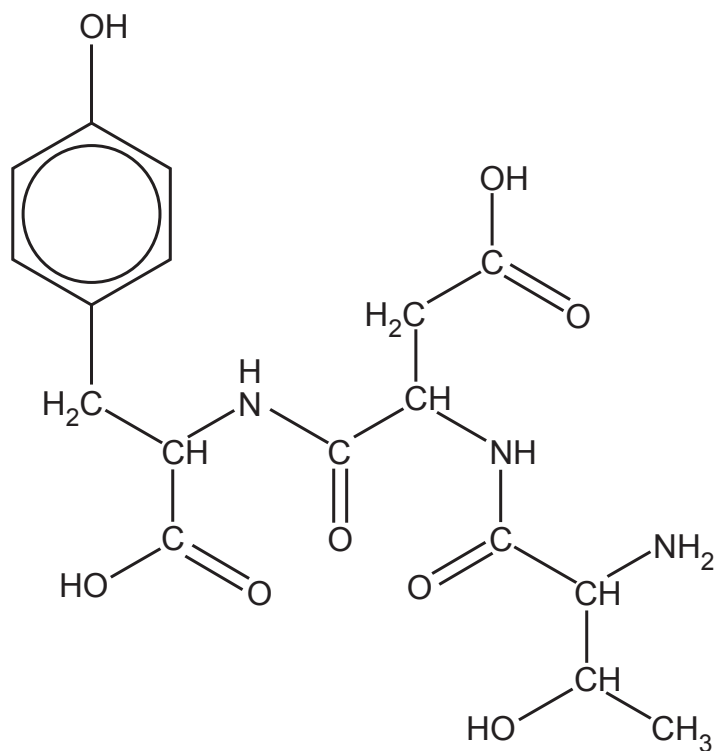
A student predicts that PAS could polymerise to form a polymer containing **both** ester and amide linkages.

Draw a section of this polymer.

The section should contain **one** amide and **one** ester linkage, which should be displayed.

[3]

Three α -amino acids can react together to form compound **E**



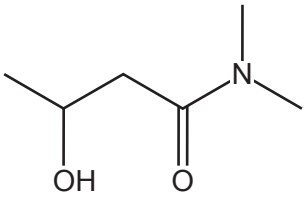
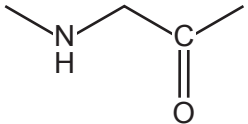
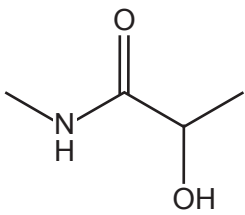
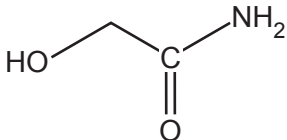
Compound E

27 A student hydrolyses compound **E** with dilute hydrochloric acid, $\text{HCl}(\text{aq})$.

Draw the structures of the organic products formed by this hydrolysis.

[4]

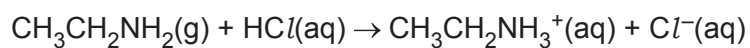
28 Which compound is a secondary amide?

A	
B	
C	
D	

Your answer

[1]

- 29 1.35 g of ethylamine gas, $\text{CH}_3\text{CH}_2\text{NH}_2$ ($M_r = 45.0$), is reacted with 20 cm^3 of 2.0 mol dm^{-3} hydrochloric acid forming a solution of ethylammonium chloride.



What is the concentration of ethylammonium chloride in mol dm^{-3} ?

- A** 0.03
- B** 0.67
- C** 1.50
- D** 2.00

Your answer

[1]

- 30 1,6-Diaminohexane, $\text{H}_2\text{N}(\text{CH}_2)_6\text{NH}_2$, reacts with hexanedioyl dichloride, $\text{ClOC}(\text{CH}_2)_4\text{COCl}$ to form a polyamide and one other product.

What is the other product formed in this reaction?

- A** HCl
- B** H_2O
- C** CO
- D** NH_3

Your answer

[1]

31 α -Amino acids have the general formula $\text{RCH}(\text{NH}_2)\text{COOH}$.

The R group in an α -amino acid contains C and H only.

This R group has a molar mass of 91 g mol^{-1} .

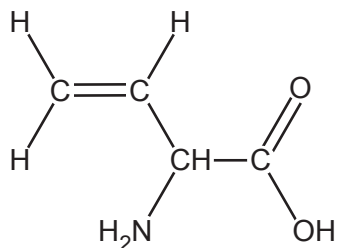
(a) A polymer is formed from 500 molecules of this α -amino acid.

Determine the molar mass of this polymer.

Give your answer to the nearest whole number.

molar mass of polymer = ... g mol^{-1} [3]

(b) The amino acid below can form addition and condensation polymers.



Draw **2** repeat units of these polymers.
Display the sections linking the monomers together.

addition polymer (2 repeat units)

condensation polymer (2 repeat units)

[3]

32 What are the **organic** products of the **acid** hydrolysis of $\text{CH}_3\text{CH}_2\text{CONHCH}_3$?

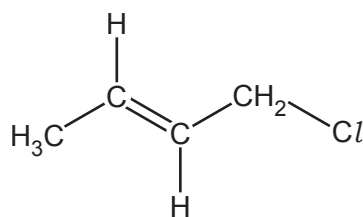


Your answer

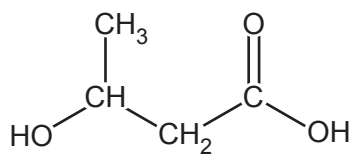
[1]

33 This question is about polymers.

The structures of 1-chlorobut-2-ene and 3-hydroxybutanoic acid are shown.



1-Chlorobut-2-ene



3-Hydroxybutanoic acid

(a) 1-Chlorobut-2-ene and 3-hydroxybutanoic acid can both form polymers.

Draw **two** repeat units of each of the polymers formed.

State the type of polymerisation reaction that takes place for each compound.

Two repeat units of polymer of 1-chlorobut-2-ene

Type of polymerisation

Two repeat units of polymer of 3-hydroxybutanoic acid

Type of polymerisation

[4]

(b) The disposal of polymers containing chlorine is a major challenge.

(i) Suggest why a polymer made from monomers containing chlorine, such as 1-chlorobut-2-ene, is difficult to dispose of by incineration.

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

(ii) The polymer formed from 3-hydroxybutanoic acid can be hydrolysed. This makes the polymer biodegradable.

Suggest what feature in the structure of this polymer allows this hydrolysis.

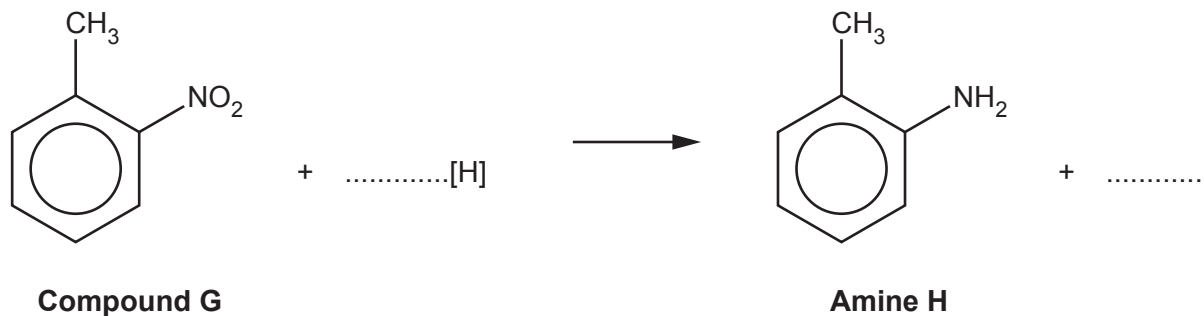
.....
..... **[1]**

- 34 In the production of a pesticide, compound **G** is reduced to amine **H**.

Suggest suitable reagents and complete the equation for this reduction.

Reagents

Equation:



[2]