

- 7 (a) State the relative acidities of bromoethanoic acid, BrCH_2COOH , chloroethanoic acid, ClCH_2COOH , ethanoic acid, CH_3COOH and ethanol, $\text{CH}_3\text{CH}_2\text{OH}$.

Explain your answer.

.....

most acidic least acidic

.....

.....

.....

.....

.....

.....

[4]

- (b) Fig. 7.1 shows the reaction of methylbenzene and ethanedioic acid with KMnO_4 .

Predict the major carbon-containing product for each of these reactions.

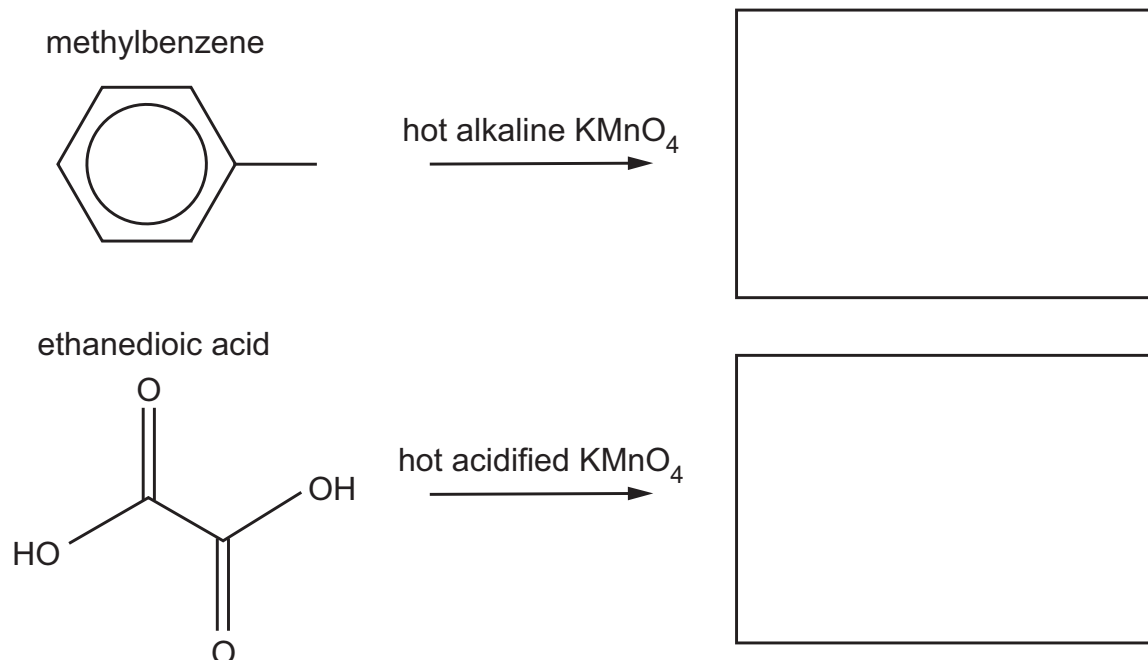
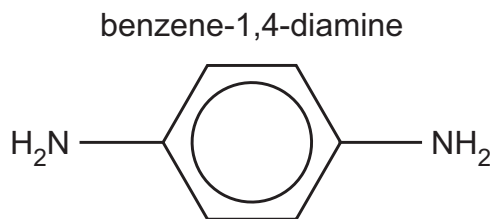


Fig. 7.1

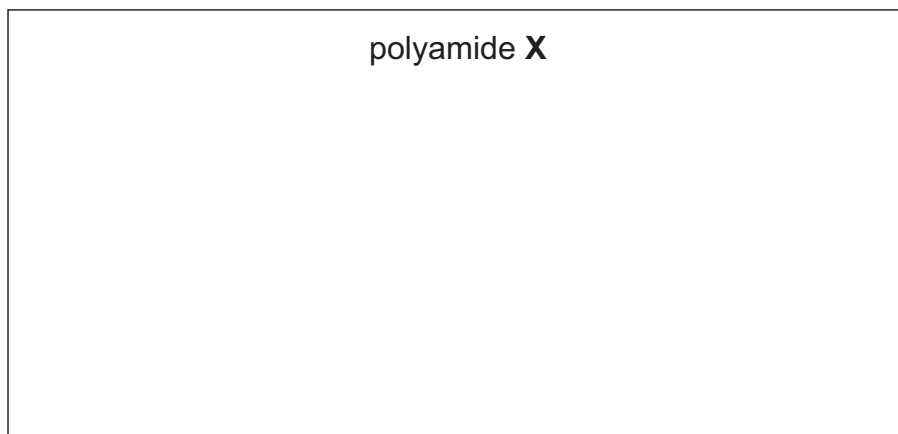
[2]

(c) Polyamide **X** can be synthesised from ethanedioic acid and benzene-1,4-diamine.



(i) Draw the repeat unit of polyamide **X** in the box.

The new functional group formed should be shown displayed.



[2]

(ii) Benzene-1,4-diamine can be formed by reduction of 1,4-dinitrobenzene.

Complete the equation for this reduction.

[H] represents one atom of hydrogen from a reducing agent.



[1]

(d) Fig. 7.2 shows the two-step synthesis of the azo compound **W**.

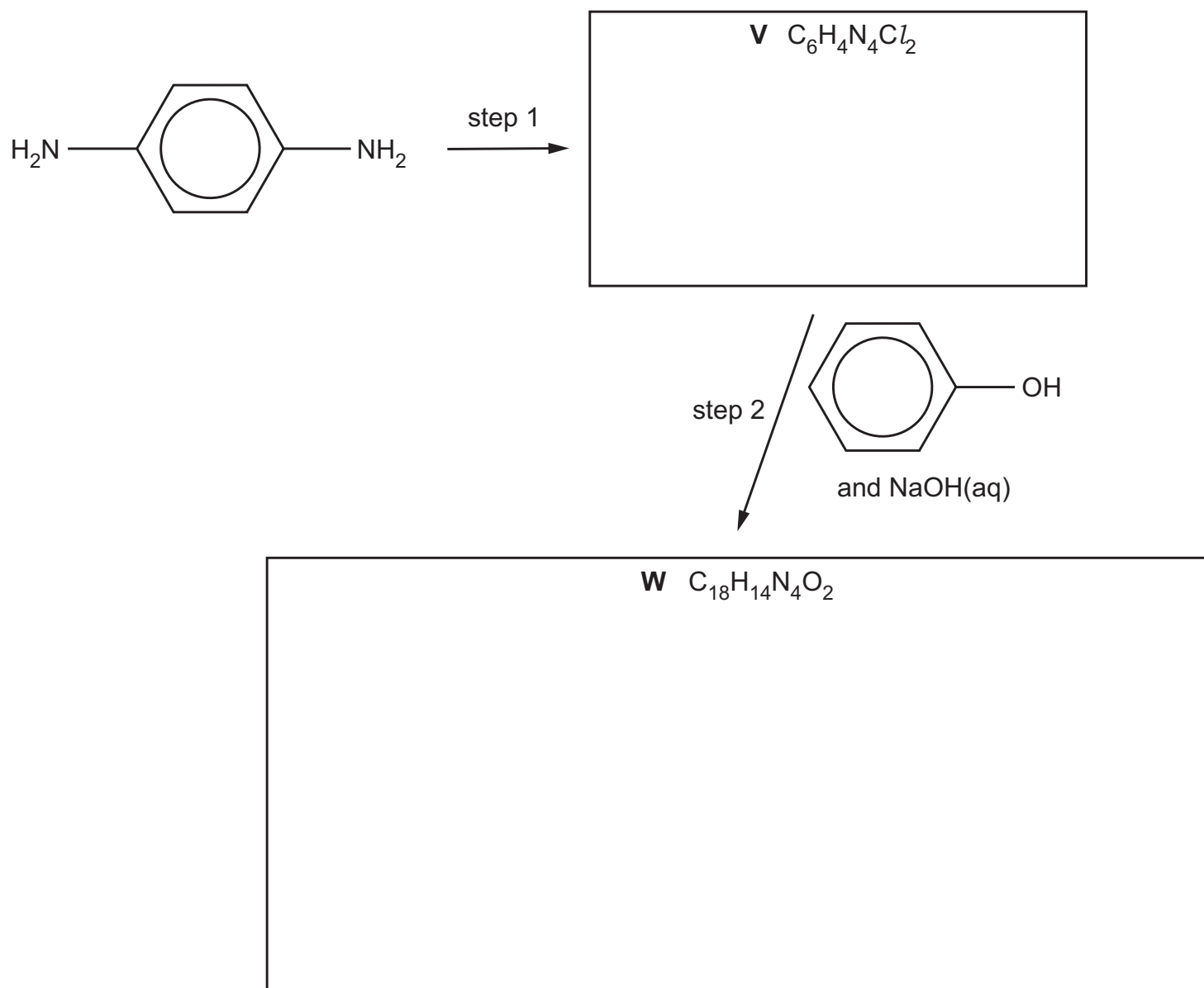


Fig. 7.2

- (i) Suggest structures for compounds **V** and **W** and draw them in the boxes in Fig. 7.2. [2]
- (ii) Give the reagents and conditions for step 1.

..... [1]

[Total: 12]

9 (a) Explain why amides are much weaker bases than amines.

.....

 [2]

(b) Fig. 9.1 shows the preparation of 2-phenylethylamine, $\text{C}_6\text{H}_5\text{CH}_2\text{CH}_2\text{NH}_2$, by three different routes.

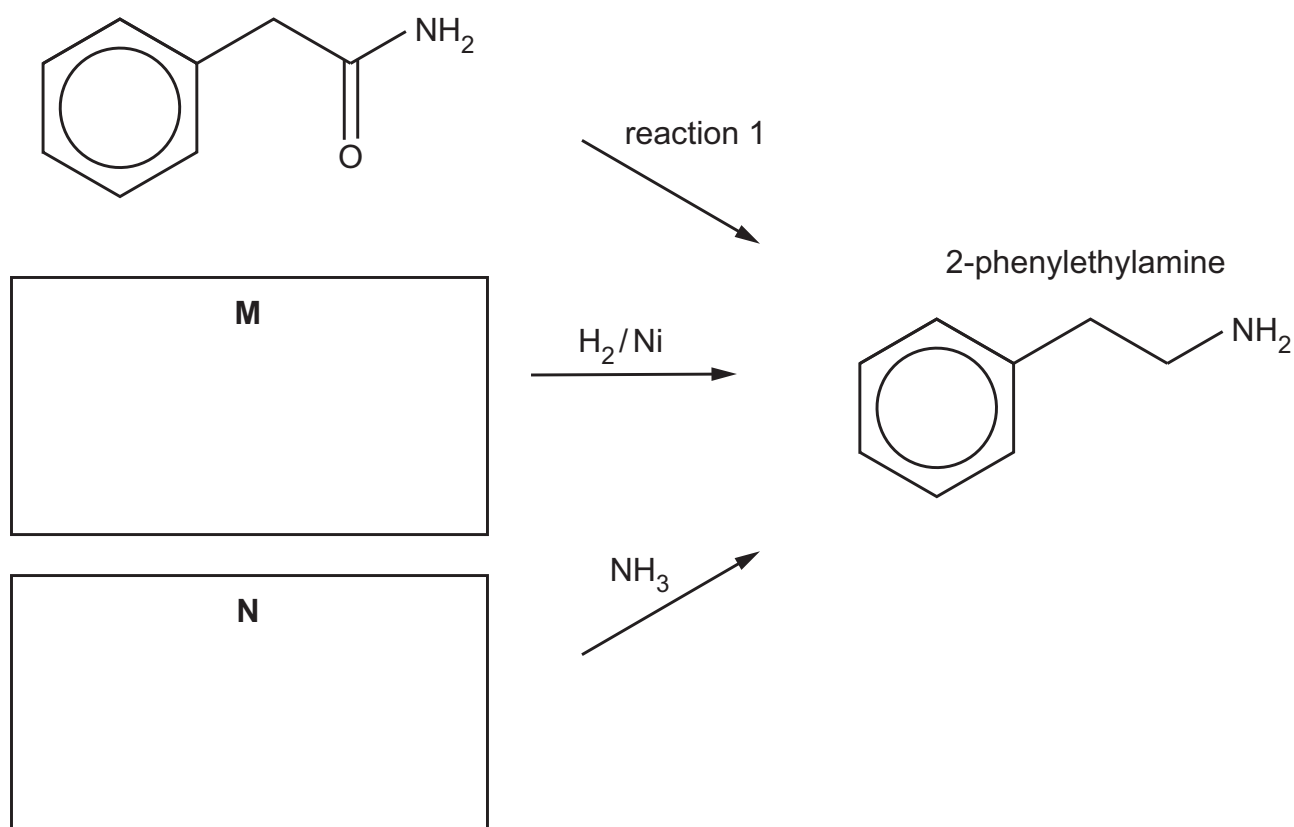


Fig. 9.1

(i) Suggest structures for compounds **M** and **N** and draw them in the boxes in Fig. 9.1. [2]

(ii) Give the reagents and conditions for reaction 1.

..... [1]

(c) Fig. 9.2 shows compound **H** which is a useful starting material in organic synthesis.

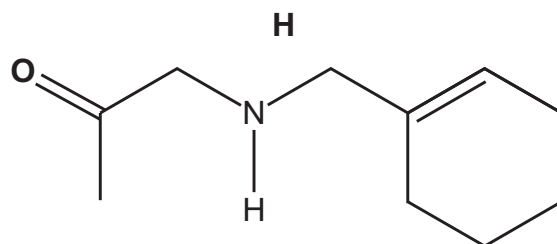


Fig. 9.2

H contains an alkene and an amine functional group.

Name the **other** functional group and give the classification of the amine group in **H**.

other functional group in **H**

classification of amine

[1]

(d) Ozonolysis involves the oxidative cleavage of a C=C bond in alkenes using ozone, O₃, as shown in Fig. 9.3.

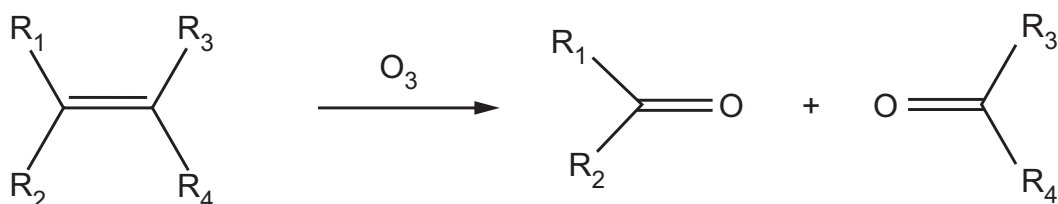


Fig. 9.3

Fig. 9.4 shows the first step in this reaction which involves the formation of an ozonide intermediate.

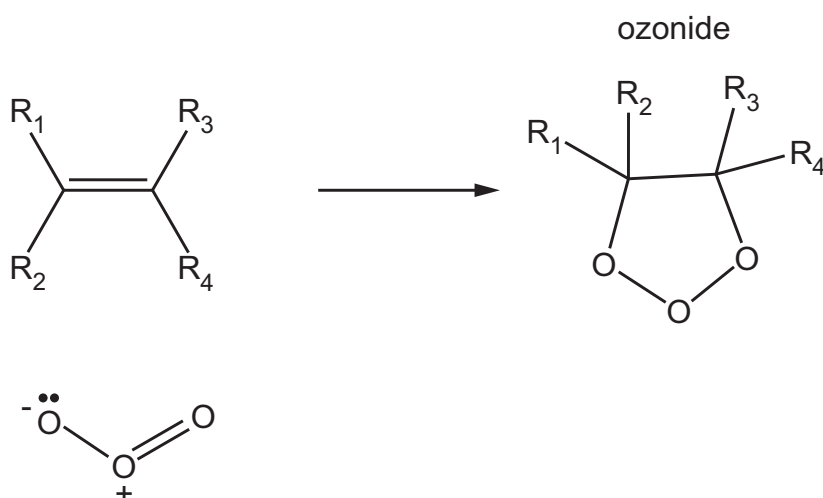
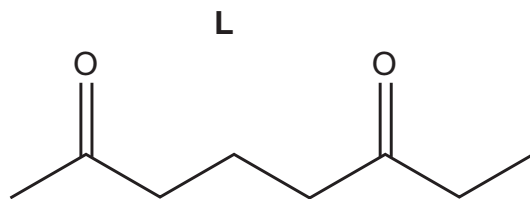


Fig. 9.4

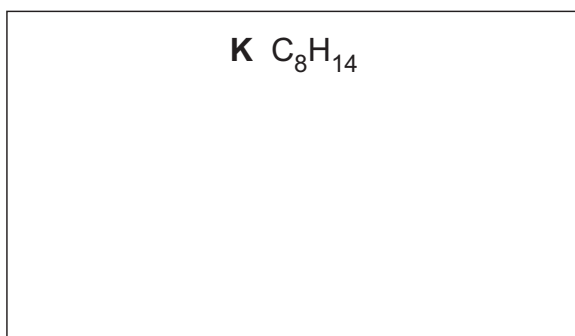
(i) On Fig. 9.4, draw **three** curly arrows to complete the mechanism of this step.

[2]

(ii) **L** is formed from alkene **K**, C_8H_{14} , by a similar reaction to that shown in Fig. 9.3.



Suggest the structure of **K**.



[1]

[Total: 9]

Important values, constants and standards

molar gas constant	$R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$
Faraday constant	$F = 9.65 \times 10^4 \text{ C mol}^{-1}$
Avogadro constant	$L = 6.02 \times 10^{23} \text{ mol}^{-1}$
electronic charge	$e = -1.60 \times 10^{-19} \text{ C}$
molar volume of gas	$V_m = 22.4 \text{ dm}^3 \text{ mol}^{-1}$ at s.t.p. (101 kPa and 273 K) $V_m = 24.0 \text{ dm}^3 \text{ mol}^{-1}$ at room conditions
ionic product of water	$K_w = 1.00 \times 10^{-14} \text{ mol}^2 \text{ dm}^{-6}$ (at 298 K (25 °C))
specific heat capacity of water	$c = 4.18 \text{ kJ kg}^{-1} \text{ K}^{-1}$ (4.18 $\text{J g}^{-1} \text{ K}^{-1}$)

- 8 Asparagine and aspartic acid are two naturally occurring amino acids. Their structures and isoelectric points are shown in Table 8.1.

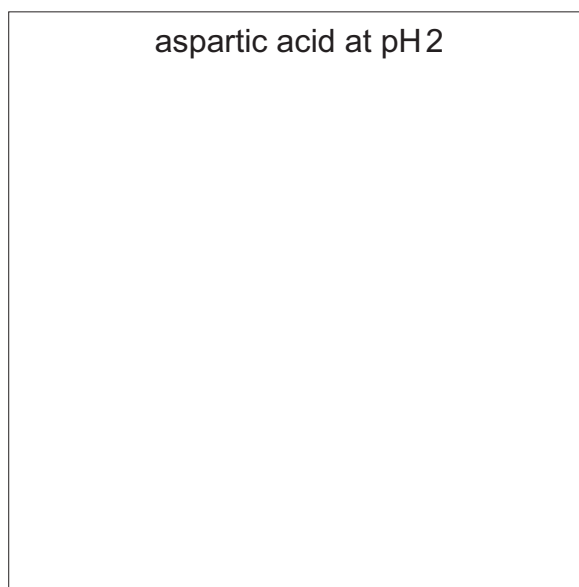
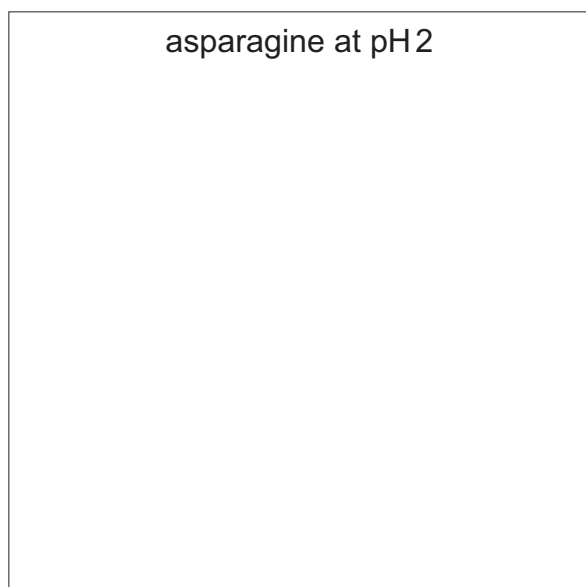
Table 8.1

amino acid	structure	isoelectric point
asparagine	$\text{HOOCCH}(\text{NH}_2)\text{CH}_2\text{CONH}_2$	5.41
aspartic acid	$\text{HOOCCH}(\text{NH}_2)\text{CH}_2\text{COOH}$	2.77

- (a) Define isoelectric point.

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

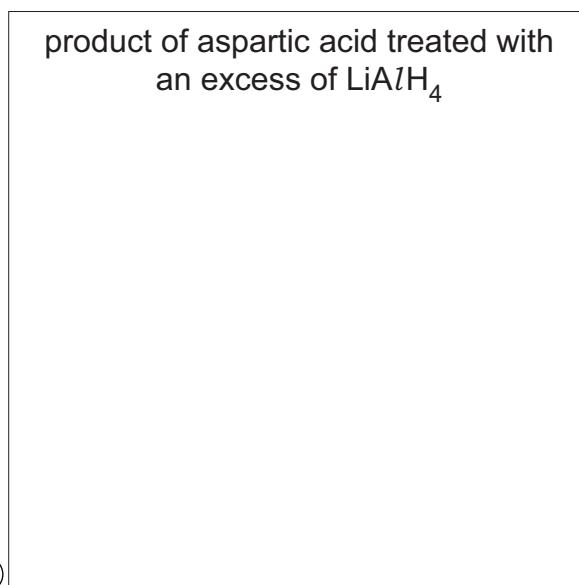
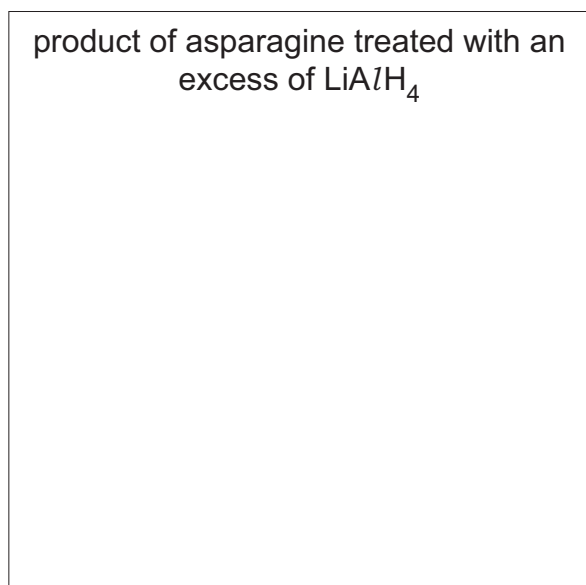
- (b) Draw the structures of asparagine and aspartic acid at pH 2.



[2]

- (c) Asparagine and aspartic acid are treated separately with an excess of LiAlH_4 .

Draw the structures of the organic products of these reactions.



- (d) Propanedioic acid, $\text{HOOCCH}_2\text{COOH}$, is treated with an excess of thionyl chloride, SOCl_2 . Propanedioyl chloride, $\text{ClOCCH}_2\text{COCl}$, is formed.

(i) Write an equation for this reaction.

..... [1]

- (ii) Propanedioyl chloride reacts with an excess of asparagine to form compound **G** with molecular formula $\text{C}_{11}\text{H}_{16}\text{N}_4\text{O}_8$.

Each molecule of compound **G** has four amide groups.

Draw the structure of compound **G**.

Compound **G**, $\text{C}_{11}\text{H}_{16}\text{N}_4\text{O}_8$

[2]

- (e) Asparagine is hydrolysed with an excess of hot NaOH(aq) .

Draw the structure of the organic product of this reaction.

[2]

- (f) A polymer can form from asparagine, $\text{HOOCCH}(\text{NH}_2)\text{CH}_2\text{CONH}_2$, as the only monomer.

Draw a length of the polymer chain containing **three** monomer residues.

Clearly label the repeat unit of the polymer on your diagram.

[3]

(g) Aspartic acid exists in two optically active forms.

- (i)** Plane polarised light is passed through pure samples of these two optically active forms in solutions of the same concentration.

Describe **two** similarities and **one** difference in their effect on the plane polarised light.

similarities

.....

difference

.....

[2]

- (ii)** Give the term used to describe a mixture of equal amounts of the two optically active forms.

..... [1]

[Total: 16]

Question 9 starts on page 20.