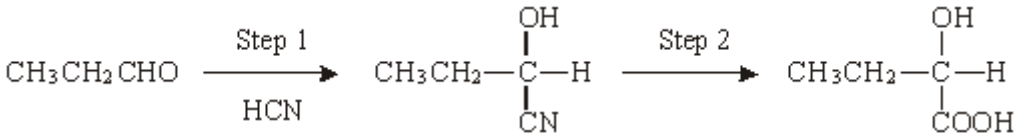
**Q1.** Consider the reaction sequence shown below.




propanal **Q**

(a) Name and outline a mechanism for the reaction in Step 1.

*Name of mechanism* .....

Mechanism

**(5)**

(b) (i) Name compound **Q** formed in Step 2.

.....

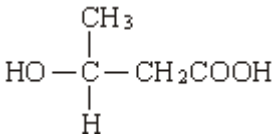
(ii) Two stereoisomers are formed by the dehydration of **Q**. Give the structures of these two isomers and name the type of stereoisomerism shown.

*Structures of isomers*

*Type of stereoisomerism* .....

**(4)**

(c) An isomer of **Q** which has the structure shown below is polymerised to form the biodegradeable polymer known as PHB.



(i) Draw the repeating unit of the polymer PHB.

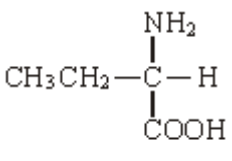
(ii) Suggest a reason why the polymer is biodegradeable.

.....

.....

**(2)**

(d) The amino acid **R** is shown below.



**R**

(i) Draw the structure of the zwitterion formed by **R**.

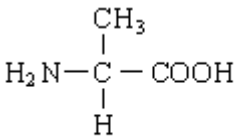
(ii) Draw the structure of the major organic product formed when an excess of **R** is reacted with bromomethane.

(iii) Name the mechanism of the reaction which results in the formation of the product given in part (ii).

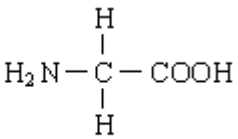
.....

**(3)**
**(Total 14 marks)**

**Q2.** The structures of the amino acids *alanine* and *glycine* are shown below.



*alanine*



*glycine*

(a) Give the systematic name for *alanine.*

.....

**(1)**

(b) *Alanine* exists as a pair of stereoisomers.

(i) Explain the meaning of the term *stereoisomers.*

.....

.....

.....

(ii) State how you could distinguish between the stereoisomers.

.....

.....

.....

**(4)**

(c) Give the structural formula of the species formed by *glycine* at pH 14.

**(1)**

(d) When two amino acids react together, a dipeptide is formed. Give the structural formulae of the **two** dipeptides which are formed when *alanine* and *glycine* react together.

*Dipeptide 1*

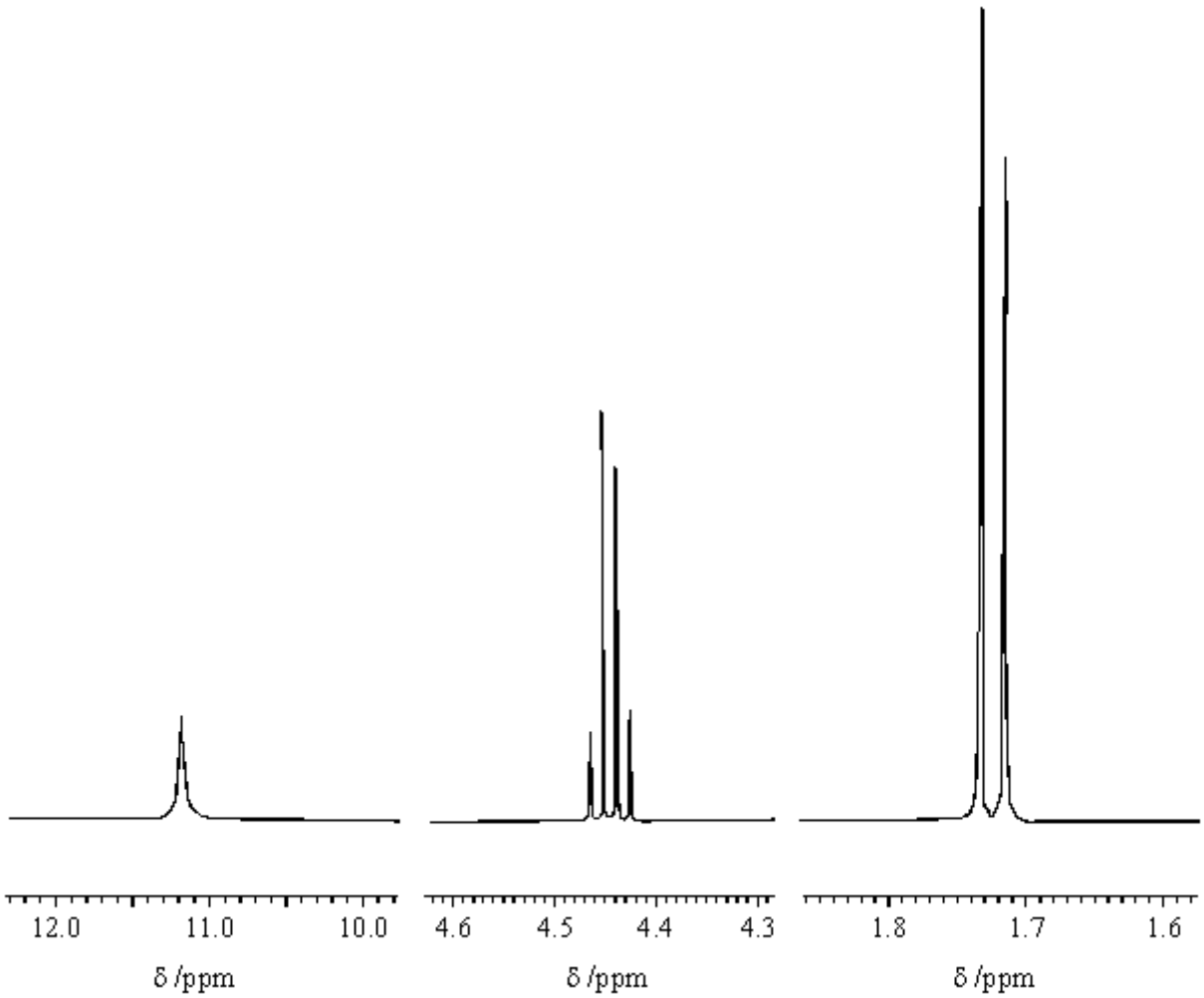
*Dipeptide 2*

**(2)**

(e) Give the structural formula of the organic compound formed when *glycine* reacts with methanol in the presence of a small amount of concentrated sulphuric acid.

**(1)**
**(Total 9 marks)**

**Q3.** Three sections of the proton n.m.r. spectrum of $CH_3CHClCOOH$ are shown below.




(a) Name the compound $CH_3CHClCOOH$

.....

**(1)**

(b) Explain the splitting patterns in the peaks at δ 1.72 and δ 4.44

.....

.....

.....

**(2)**

(c) Predict the splitting pattern that would be seen in the proton n.m.r. spectrum of the isomeric compound $ClCH_2CH_2COOH$

.....

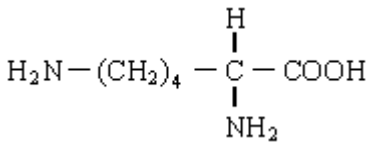
.....

**(1)**

(d) The amino acid *alanine* is formed by the reaction of $CH_3CHClCOOH$ with an excess of ammonia. The mechanism is nucleophilic substitution. Outline this mechanism, showing clearly the structure of *alanine*.

**(5)**

(e) The amino acid *lysine* has the structure



Draw structures to show the product formed in each case when lysine reacts with

(i) an excess of aqueous HCl,

(ii) an excess of aqueous NaOH,

(iii) another molecule of lysine.

**(3)**
**(Total 12 marks)**

**Q4.** (a) Synthetic polyamides are produced by the reaction of dicarboxylic acids with compounds such as $H_2N(CH_2)_6NH_2$

(i) Name the compound $H_2N(CH_2)_6NH_2$

.....

(ii) Give the repeating unit in the polyamide nylon 6,6.

.....

**(2)**

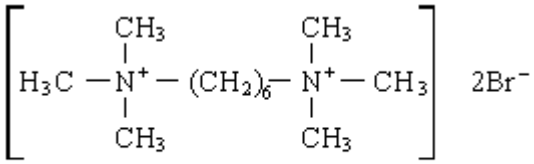
(b) Synthetic polyamides have structures similar to those found in proteins.

(i) Draw the structure of 2-aminopropanoic acid.

(ii) Draw the organic product formed by the condensation of two molecules of 2-aminopropanoic acid.

**(2)**

(c) Compounds like $H_2N(CH_2)_6NH_2$ are also used to make ionic compounds such as **X**, shown below.



Compound **X**

(i) **X** belongs to the same type of compound as $(CH_3)_4N^+Br^-$
Name this **type** of compound.

.....

(ii) State a reagent which could produce **X** from $H_2N(CH_2)_6NH_2$ and give a necessary condition to ensure that **X** is the major product.

*Reagent* .....

*Condition* .....

(iii) Name the mechanism involved in this reaction to form **X**.

.....

**(4)**
**(Total 8 marks)**

**Q5.** (a) The compound $H_2C=CHCN$ is used in the formation of acrylic polymers.

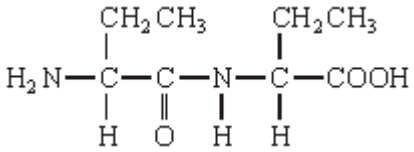
(i) Draw the repeating unit of the polymer formed from this compound.

(ii) Name the type of polymerisation involved in the formation of this polymer.

.....

**(2)**

(b) When the dipeptide shown below is heated under acidic conditions, a single amino acid is produced.



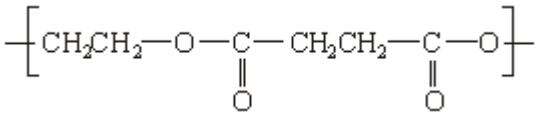
(i) Name this amino acid.

.....

(ii) Draw the structure of the amino acid species present in the acidic solution.

**(2)**

(c) The repeating unit of a polyester is shown below.



(i) Deduce the empirical formula of the repeating unit of this polyester.

.....

(ii) Draw the structure of the acid which could be used in the preparation of this polyester and give the name of this acid.

*Structure* .....

*Name* .....

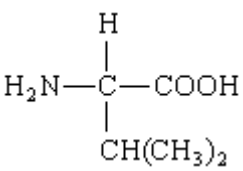
(iii) Give **one** reason why the polyester is biodegradable.

.....

.....

**(4)**
**(Total 8 marks)**

**Q6.** (a) Consider the following amino acid.



(i) Draw the structure of the amino acid species present in a solution at pH 12.

(ii) Draw the structure of the dipeptide formed from two molecules of this amino acid.

(iii) Protein chains are often arranged in the shape of a helix. Name the type of interaction that is responsible for holding the protein chain in this shape.

.....

**(3)**

(b) Consider the hydrocarbon **G**, $(CH_3)_2C=CHCH_3$, which can be polymerised.

(i) Name the type of polymerisation involved and draw the repeating unit of the polymer.

*Type of polymerisation* .....

*Repeating unit*

(ii) Draw the structure of an isomer of **G** which shows geometrical isomerism.

(iii) Draw the structure of an isomer of **G** which does not react with bromine water.

**(4)**
**(Total 7 marks)**