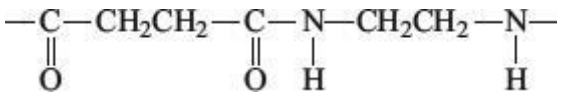
Q23.

(a) The structure below shows the repeating unit of a polymer.



By considering the functional group formed during polymerisation, name this type of polymer and the type of polymerisation involved in its formation.

Type of polymer _____

Type of polymerisation _____

(2)

(b) Draw the structure of the species present in solid aminoethanoic acid, H_2NCH_2COOH

(1)

(c) Explain why the melting point of aminoethanoic acid is much higher than that of hydroxyethanoic acid, $HOCH_2COOH$

_____

_____

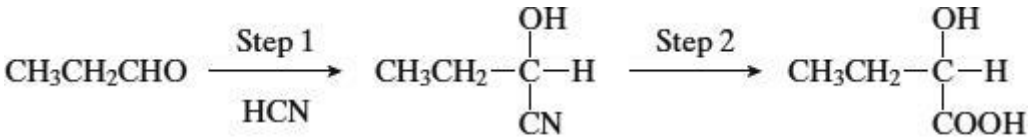
_____

(2)

(Total 5 marks)

Q24.

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.

_____

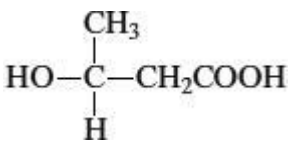
(ii) Two stereoisomers are formed by the dehydration of **Q**. Give the structures of these two isomers and name the type of stereoisomerism shown.

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.

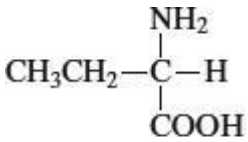
(ii) Suggest a reason why the polymer is biodegradeable.

_____

_____

(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)

Q25.

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

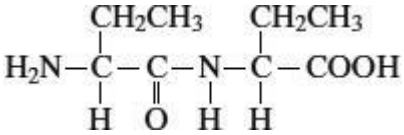
(i) Draw the repeating unit of the polymer formed from this compound.

(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.



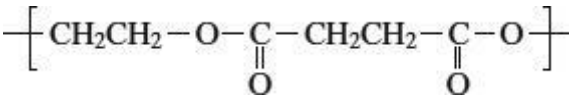
(i) Name this amino acid.

_____

(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.

_____

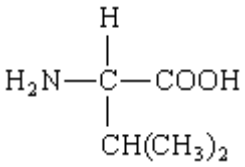
_____

(4)

(Total 8 marks)

Q26.

(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

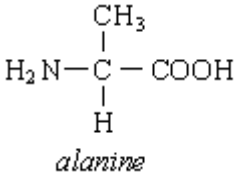
(ii) Draw the structure of an isomer of **G** which shows geometrical isomerism.

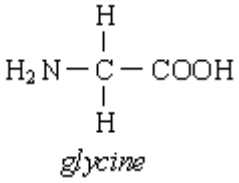
(iii) Draw the structure of an isomer of **G** which does not react with bromine water.

(4)
(Total 7 marks)

Q27.

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)

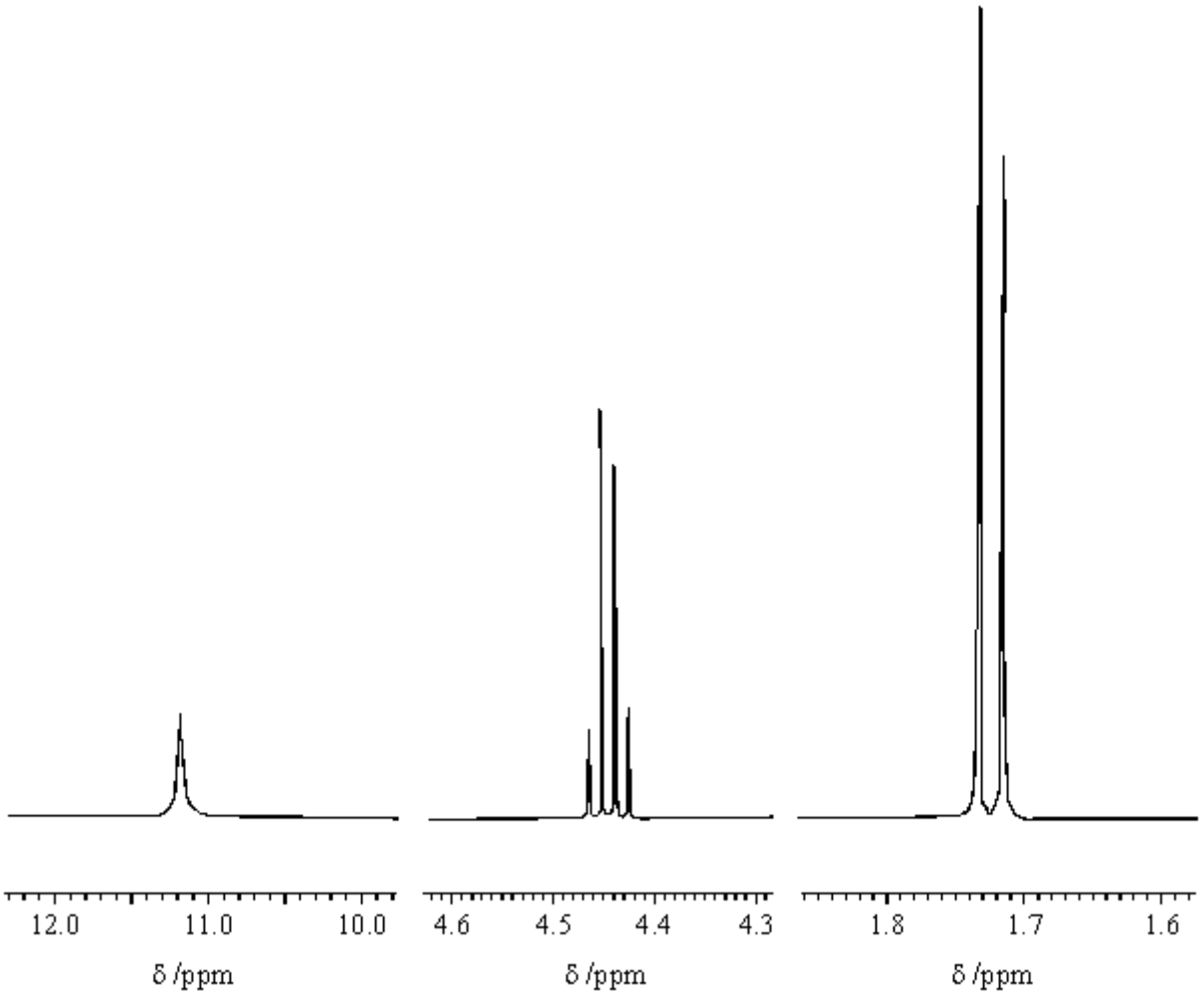
(e) Give the structural formula of the organic compound formed when *glycine* reacts with methanol in the presence of a small amount of concentrated sulphuric acid.

(1)

(Total 9 marks)

Q28.

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)

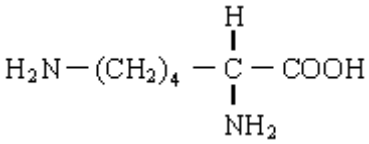
(c) Predict the splitting pattern that would be seen in the proton n.m.r. spectrum of the isomeric compound $ClCH_2CH_2COOH$

(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)

Mark Scheme

Q23.

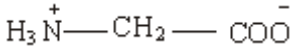
(a) *polyamide or nylon (2,4)*

(allow nylon without numbers but if numbers are present they must be correct)

1

condensation

1

(b) 

1

(c) *ionic bonding in aminoethanoic acid*

(can only score if includes that aminoethanoic is ionic)

1

stronger attractions than Hydrogen bonding in hydroxyethanoic acid

(e.g. stronger Hydrogen bonding in aminoethanoic acid scores 0)

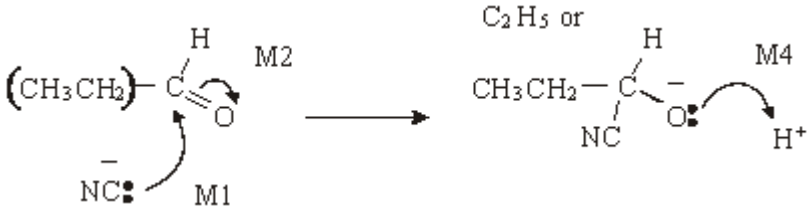
(mention of electrostatic forces between molecules scores 0)

1

[5]

Q24.

(a) *necleophilic addition;*



1

M3 structure;

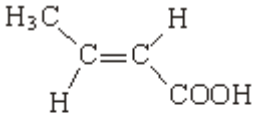
(be lenient on position of charge on CN–)
(M2 not allowed independent of M1,
but allow M1 for correct attack on C+
if M2 show as independent first.)
(+on C of C=O loses M2 but ignore δ+ if correct)
(M4 for arrow and lone pair (only allow for correct M3 or close))

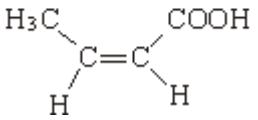
4

(b) *(i)* *2-hydroxybutanoic acid*

1

(ii)



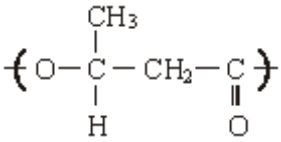


1

geometric(al) or cis-trans

1

(c) (i)



(one unit only) (ignore brackets or n) (trailing bonds are needed)

1

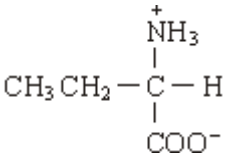
(ii) *can be hydrolysed*

OR

can be reacted with/attacked by acid/base/nucleophiles/H_2O/OH^-;

1

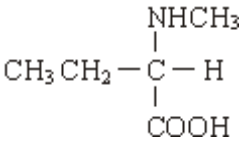
(d) (i)



(allow $-NH_3^+$)

1

(ii)



(or zwitterions product)

1

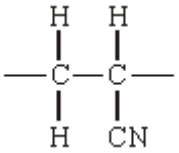
(iii) *nucleophilic substitution;*

1

[14]

Q25.

(a) (i)



(Ignore n or brackets, but trailing bonds are essential)

1

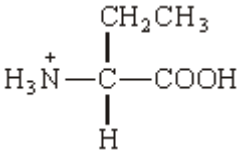
(ii) *Addition or radical*

1

(b) (i) *2-aminobutanoic (acid)*

1

(ii)

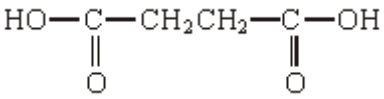


1

(c) (i) $C_3H_4O_2$

1

(ii)



1

(1,4-)butan(e)dioic (acid)

(allow succinic, but not dibutanoic nor butanedicarboxylic acid)

1

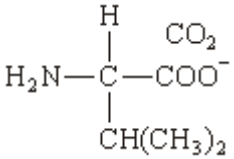
(iii) *Can be hydrolysed / can react with acid or base or water / can react with nucleophiles*

1

[8]

Q26.

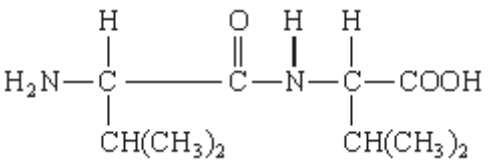
(a) (i)



(1)

ignore Na^+ unless covalently bonded

(ii)



(1)

must be dipeptide, not polymer nor anhydride
allow –CONH– or –COHN–
allow zwitterion

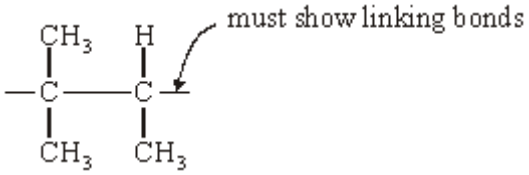
(iii) *hydrogen bonding* **(1)**

QL

Allow with dipole-dipole or v derWaals, but not dipole-dipole etc alone

3

(b) (i) *Type of polymerisation: addition(al)* **(1)**



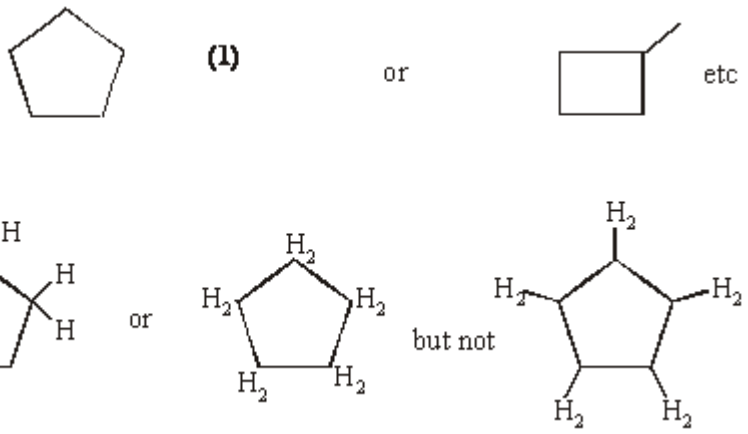
Repeating unit: **(1)**

not multiples

allow n

(ii) $CH_3CH=CHCH_2CH_3$ **(1)** C_2H_5

(iii)



4

[7]

Q27.

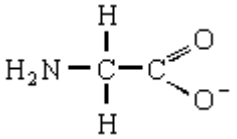
(a) *2-amino(e) propanoic acid* **(1)**

1

(b) (i) *molecules with same structure / structural formula* **(1)**
but with bonds ***(atoms or groups)*** *arranged differently in space (3D)* **(1)**

(ii) *Plane polarised light* **(1)**
Rotated (equally) in opposite directions **(1)**

4

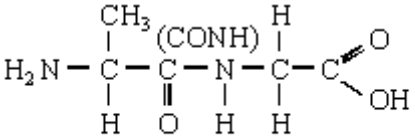
(c) 

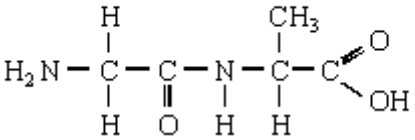
(1)

allow $H_2NCH_2COO^-$

Penalise NH_2- and OH- once per paper
but CH_3– is allowed

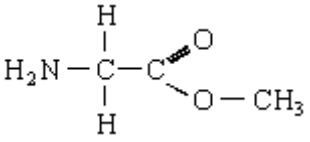
1


(1)

(d) 
(1)

Not anhydrides; not repeating units

2

(e) 
(1)

or $H_2NCH_2COOCH_3$

1

[9]

Q28.

(a) *2-chloropropanoic acid* ***(1)***

1

(b) *δ 1.72 Doublet ∴ next to CH* ***(1)***

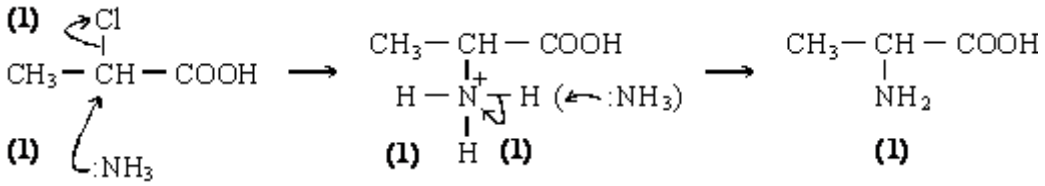
δ 4.44 Quartet ∴ next to CH_3 ***(1)***

2

(c) *Two triplets* ***(1)***

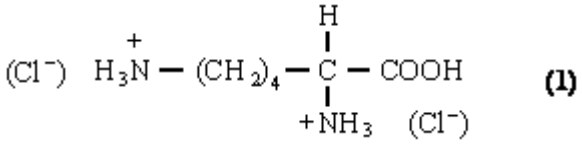
1

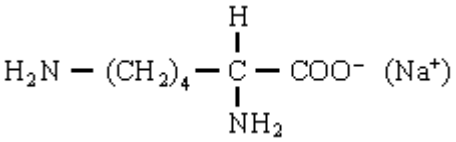
(d)



Allow S_N1

5

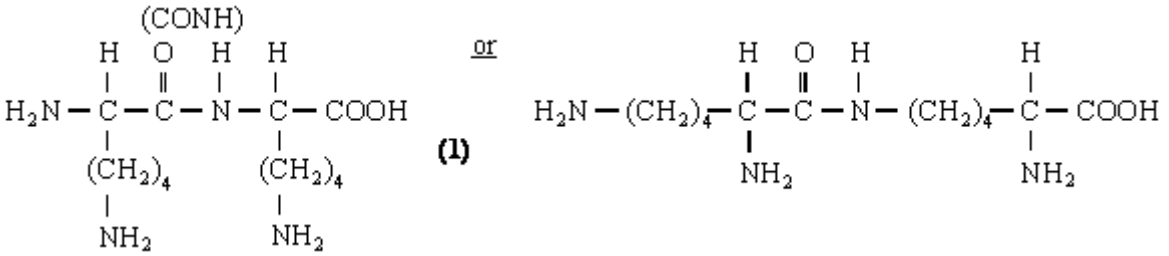
(e) (i) 
(1)



(1)

(ii)

(iii)



(1)

Or anhydride

3

[12]