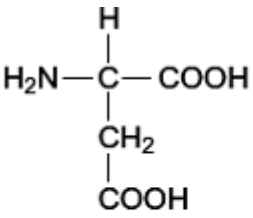
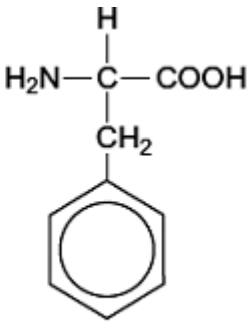
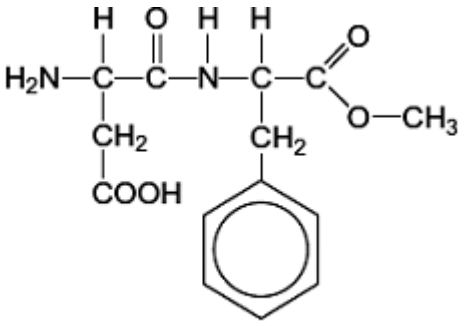
Q1. The amino acids aspartic acid and phenylalanine react together to form a dipeptide. This dipeptide can be converted into a methyl ester called aspartame.



aspartic acid



phenylalanine



aspartame

Aspartame has a sweet taste and is used in soft drinks and in sugar-free foods for people with diabetes.

Hydrolysis of aspartame forms methanol initially. After a longer time the peptide link breaks to form the free amino acids. Neither of these amino acids tastes sweet.

(a) Apart from the release of methanol, suggest why aspartame is **not** used to sweeten foods that are to be cooked.

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(Extra space) .....

.....

(1)

(b) Give the IUPAC name of aspartic acid.

.....

(1)

(c) Draw the organic species formed by aspartic acid at high pH.

(1)

(d) Draw the zwitterion of phenylalanine.

(1)

(e) Phenylalanine exists as a pair of stereoisomers.

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

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(2)

(ii) Explain how a pair of stereoisomers can be distinguished.

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(Extra space) .....

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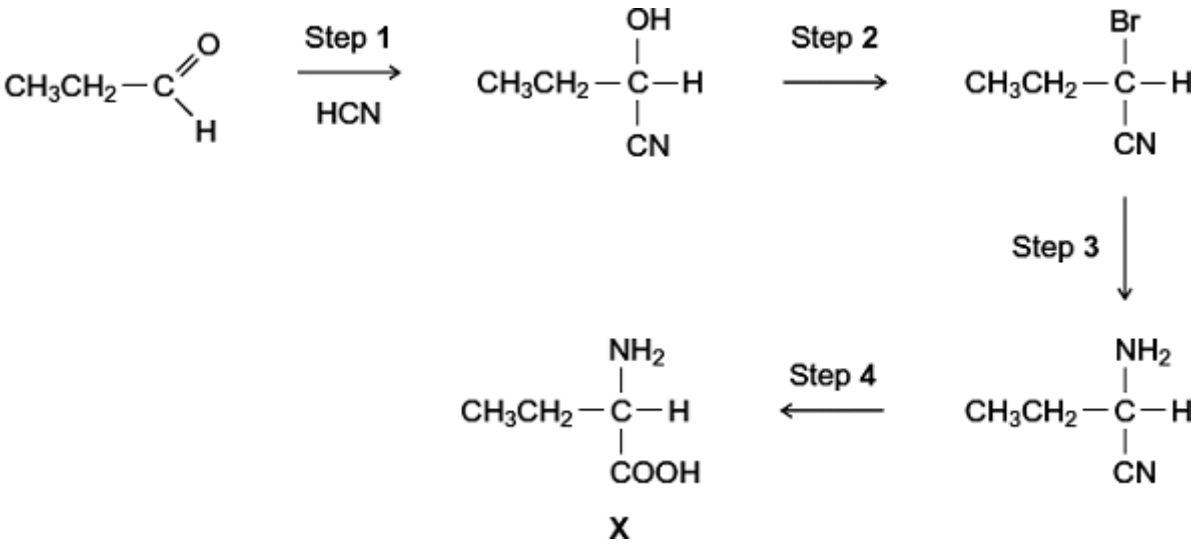
(2)

(Total 8 marks)

Q2.A possible synthesis of the amino acid **X** is shown below.



(a) Name and outline a mechanism for Step **1**.

Name of mechanism .....

Mechanism

(5)

(b) Give the IUPAC name of the product of Step **2**.

.....

(1)

(c) For Step **3**, give the reagent, give a necessary condition and name the mechanism.

Reagent .....

Condition .....

Name of mechanism .....

(3)

(d) At room temperature, the amino acid **X** exists as a solid.

(i) Draw the structure of the species present in the solid amino acid.

(1)

(ii) With reference to your answer to part (d)(i), explain why the melting point of the amino acid **X** is higher than the melting point of $CH_3CH_2CH(OH)COOH$.

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.....

(Extra space) .....

.....

(2)

(e) There are many structural isomers of **X**, $CH_3CH_2CH(NH_2)COOH$.

(i) Draw a structural isomer of **X** that is an ethyl ester.

(1)

(ii) Draw a structural isomer of **X** that is an amide and also a tertiary alcohol.

(1)

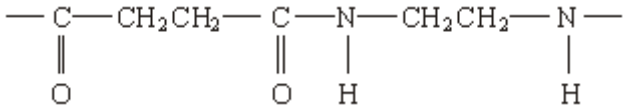
(iii) Draw a structural isomer of **X** that has an unbranched carbon chain and can be polymerised to form a polyamide.

(1)

(f) Draw the structure of the tertiary amine formed when **X** reacts with bromomethane.

(1)
(Total 16 marks)

Q3. (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, $HOCH_2COOH$

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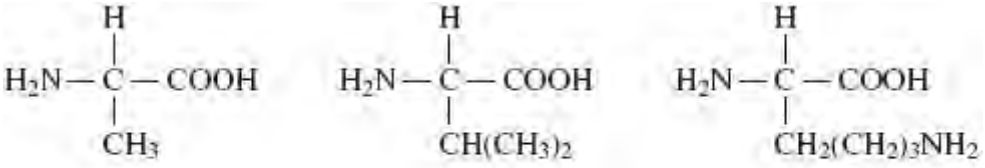
(2)
(Total 5 marks)

Q4. The three amino acids shown below were obtained by hydrolysis of a protein.



alanine valine lysine

(a) (i) Draw the zwitterion of alanine.

(1)

(ii) Draw the species formed when valine is dissolved in an alkaline solution.

(1)

(iii) Draw the species formed by lysine at low pH.

(1)

(b) Draw the two dipeptides formed by the reaction of alanine with valine.

(2)

(c) Name a suitable method by which the mixture of amino acids formed by hydrolysis of the protein can be separated.

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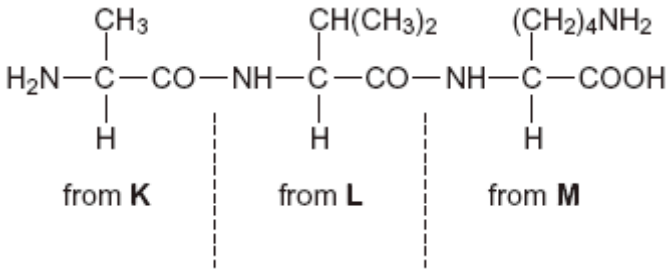
(1)
(Total 6 marks)

Q5. (a) Consider the tripeptide shown below that is formed from three amino acids, **K**, **L** and **M**.



(i) Name the process by which the tripeptide is split into three amino acids.

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(1)

(ii) Give the IUPAC name for the amino acid **K**.

.....

(1)

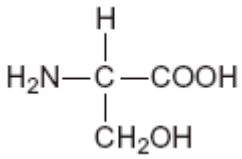
(iii) Draw the structure of the zwitterion of amino acid **L**.

(1)

(iv) Draw the structure of the species formed by amino acid **M** at low pH.

(1)

(b) Consider the amino acid serine.



(i) Draw the structure of the product formed when serine reacts with an excess of CH_3Br

(1)

(ii) Draw the structure of the dipeptide formed by two molecules of serine.

(1)
(Total 6 marks)

Q6. (a) Name compound **Y**, $HOCH_2CH_2COOH$

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(1)

(b) Under suitable conditions, molecules of **Y** can react with each other to form a polymer.

(i) Draw a section of the polymer showing **two** repeating units.

(1)

(ii) Name the type of polymerisation involved.

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(1)

(c) When **Y** is heated, an elimination reaction occurs in which one molecule of **Y** loses one molecule of water. The organic product formed by this reaction has an absorption at 1637 cm^{-1} in its infrared spectrum.

(i) Identify the bond that causes the absorption at 1637 cm^{-1} in its infrared spectrum.

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(1)

(ii) Write the displayed formula for the organic product of this elimination reaction.

(1)

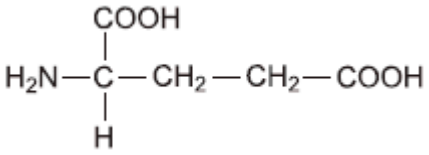
(iii) The organic product from part (ii) can also be polymerised.
Draw the repeating unit of the polymer formed from this organic product.

(1)

(d) At room temperature, 2-aminobutanoic acid exists as a solid.
Draw the structure of the species present in the solid form.

(1)

(e) The amino acid, glutamic acid, is shown below.



Draw the structure of the organic species formed when glutamic acid reacts with each of the following.

(i) an excess of sodium hydroxide

(1)

(ii) an excess of methanol in the presence of concentrated sulfuric acid

(1)

(iii) ethanoyl chloride

(1)

(f) A tripeptide was heated with hydrochloric acid and a mixture of amino acids was formed. This mixture was separated by column chromatography.
Outline briefly why chromatography is able to separate a mixture of compounds.
Practical details are **not** required.

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(3)
(Total 13 marks)