Q1. The amide or peptide link is found in synthetic polyamides and also in naturally occurring proteins.

(a) (i) Draw the repeating unit of the polyamide formed by the reaction of propanedioic acid with hexane-1,6-diamine.

(2)

(ii) In terms of the intermolecular forces between the polymer chains, explain why polyamides can be made into fibres suitable for use in sewing and weaving, whereas polyalkenes usually produce fibres that are too weak for this purpose.

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(Extra space) .....

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(3)

(b) (i) Name and outline a mechanism for the reaction of CH_3CH_2COCl with CH_3NH_2

Name of mechanism.....

Mechanism

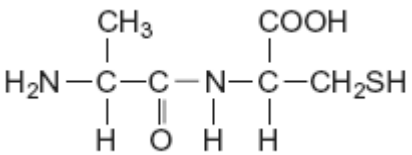
(5)

(ii) Give the name of the product containing an amide linkage that is formed in the reaction in part (b) (i).

.....

(1)

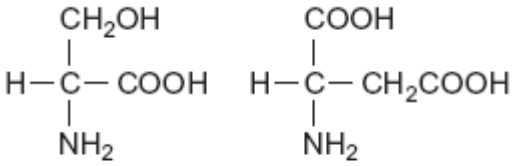
(c) The dipeptide shown below is formed from two different amino acids.



Draw the structure of the alternative dipeptide that could be formed by these two amino acids.

(1)

(d) The amino acids serine and aspartic acid are shown below.



serine aspartic acid

(i) Give the IUPAC name of serine.

.....

(1)

(ii) Draw the structure of the species formed when aspartic acid reacts with aqueous sodium hydroxide.

(1)

(iii) Draw the structure of the species formed when serine reacts with dilute hydrochloric acid.

(1)

(iv) Draw the structure of the species formed when serine reacts with an excess of bromomethane.

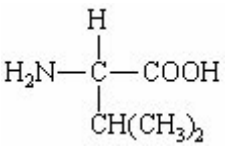
(1)

(Total 16 marks)

Q2. Fibres are made from natural and from synthetic polymers. Both types of polymer have advantages and disadvantages.

(a) Amino acids are the building blocks of naturally-occurring polymers called proteins.

Consider the following amino acid.



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

(ii) Use your understanding of amino acid chemistry to deduce the structure of the dipeptide formed from two molecules of this amino acid and illustrate your answer with a sketch showing the structure of the dipeptide.

(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) Alkenes are the building blocks of synthetic addition polymers.

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

(i) Draw the repeating unit of the polymer.

(ii) Draw the structure of an isomer of **G** which shows *E-Z* isomerism.

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

(3)

(c) Draw the repeating unit of the polymer formed by the reaction between butanedioic acid and hexane-1,6-diamine.

(2)

(d) Two plastic objects were manufactured, one from the polyalkene represented by the

repeating unit in part (b)(i) and the other from the polyamide represented by the repeating unit in part (c).

After use it was suggested that both objects be disposed of as landfill.

(i) Describe an experiment in which you could compare the biodegradability of these two objects.

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(3)

(ii) Describe an advantage or a disadvantage of a different method of disposal of such objects compared with landfill.

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(3)
(Total 14 marks)

Q3. (a) The compound $H_2C=CHCN$ is used in the formation of acrylic polymers.

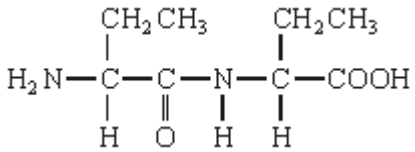
(i) Draw the repeating unit of the polymer formed from this compound.

(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.



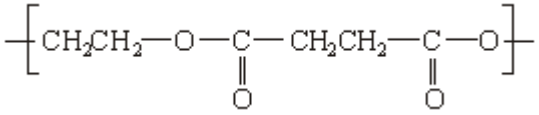
(i) Name this amino acid.

.....

(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.

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(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.

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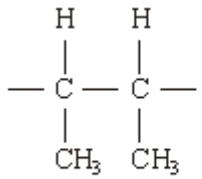
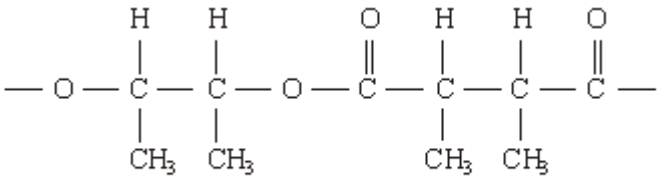
(4)
(Total 8 marks)

Q4. (a) The repeating units of two polymers, **P** and **Q**, are shown below.



P



Q

(i) Draw the structure of the monomer used to form polymer **P**. Name the type of polymerisation involved.

Structure of monomer

Type of polymerisation .....

(ii) Draw the structures of **two** compounds which react together to form polymer **Q**. Name these **two** compounds and name the type of polymerisation involved.

Structure of compound 1

Name of compound 1 .....

Structure of compound 2

Name of compound 2 .....

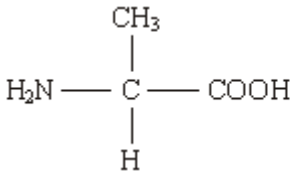
Type of polymerisation .....

(iii) Identify a compound which, in aqueous solution, will break down polymer **Q** but not polymer **P**.

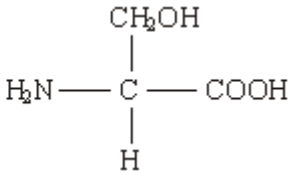
.....

(8)

(b) Draw the structures of the **two** dipeptides which can form when one of the amino acids shown below reacts with the other.



Structure 1



Structure 2

(2)

(c) Propylamine, $CH_3CH_2CH_2NH_2$, can be formed either by nucleophilic substitution or by reduction.

(i) Draw the structure of a compound which can undergo nucleophilic substitution to form propylamine.

(ii) Draw the structure of the nitrile which can be reduced to form propylamine.

(iii) State and explain which of the two routes to propylamine, by nucleophilic substitution or by reduction, gives the less pure product. Draw the structure of a compound formed as an impurity.

Route giving the less pure product .....

Explanation .....

.....

Structure of an impurity

(5)
(Total 15 marks)