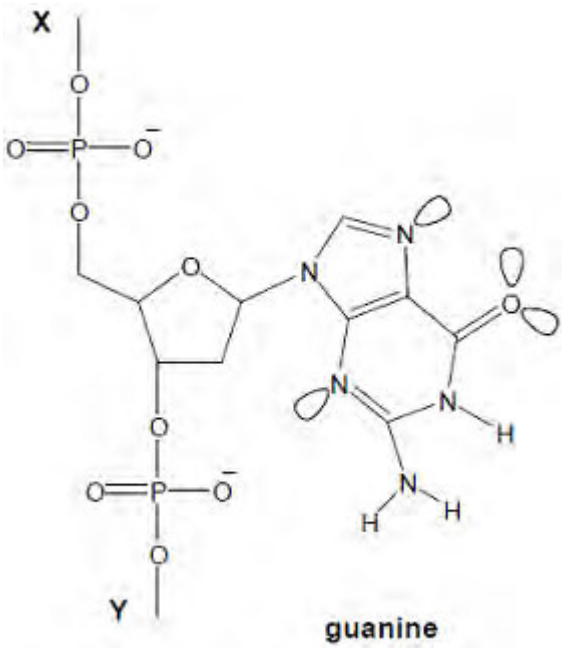
Q1. The anticancer drug cisplatin operates by reacting with the guanine in DNA.

Figure 1 shows a small part of a single strand of DNA. Some lone pairs are shown.

Figure 1



(a) The DNA chain continues with bonds at **X** and **Y**.

State the name of the sugar molecule that is attached to the bond at **X**.

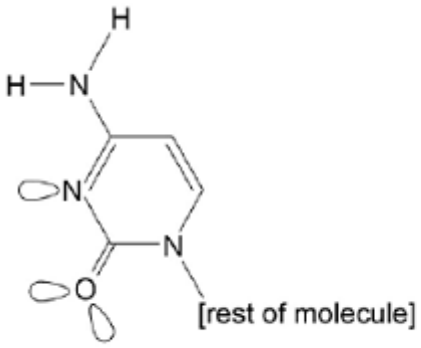
.....

(1)

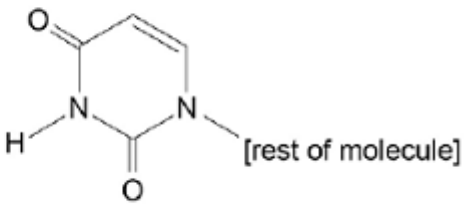
(b) Messenger RNA is synthesised in cells in order to transfer information from DNA. The bases in one strand of DNA pair up with the bases used to synthesise RNA.

Figure 2 shows two bases used in RNA.

Figure 2



Base A



Base B

Suggest which of the bases **A** and **B** forms a pair with guanine in **Figure 1** when messenger RNA is synthesised.
Explain how the base that you have chosen forms a base pair with guanine.

.....

.....

.....

.....

.....

.....

.....

.....

(4)

(c) Cisplatin works because one of the atoms on guanine can form a co-ordinate bond with platinum, replacing one of the ammonia or chloride ligands. Another atom on another guanine can also form a co-ordinate bond with the same platinum by replacing another ligand.

On **Figure 1**, draw a ring round an atom in guanine that is likely to bond to platinum.

(1)

(d) An adverse effect of cisplatin is that it also prevents normal healthy cells from replicating.

Suggest **one** way in which cisplatin can be administered so that this side effect is minimised.

.....

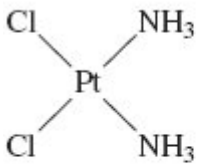
.....

.....

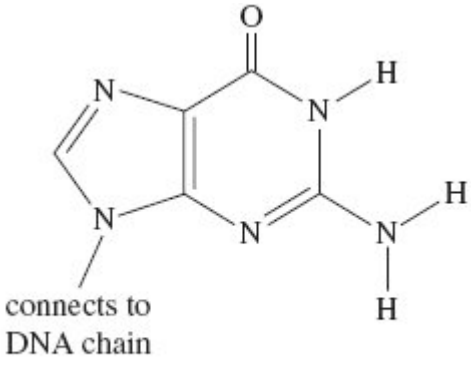
(1)

(Total 7 marks)

Q2. The complex cisplatin acts as an anticancer drug by changing the properties of DNA when it reacts with guanine, a component of DNA.



cisplatin



guanine

When cisplatin is absorbed into the human body, it undergoes a ligand substitution reaction and one chloride ligand is replaced by a water molecule forming a complex ion **Q**.

(a) Write an equation for this substitution reaction to form the complex ion **Q**.

.....

(2)

(b) The complex ion **Q** can bond to guanine in two different ways.

(i) The first way involves a hydrogen atom, from one of the ammonia ligands on **Q**, bonding to an atom in a guanine molecule. State the type of bond formed to guanine and identify an atom in guanine that could form a bond to this hydrogen atom.

Type of bond .....

Atom in guanine .....

(2)

(ii) The second way involves a ligand substitution reaction in which an atom in a guanine molecule bonds to platinum by displacing the water molecule from **Q**. State the type of bond formed between guanine and platinum when a water molecule is displaced and identify an atom in guanine that could bond to

platinum in this way.

Type of bond .....

Atom in guanine .....

(2)

(c) State and explain **one** risk associated with the use of cisplatin as an anticancer drug.

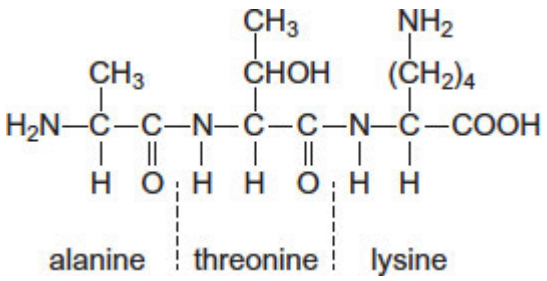
Risk .....

Explanation .....

(2)

(Total 8 marks)

Q1.(a) The tripeptide shown is formed from the amino acids alanine, threonine and lysine.



(i) Draw a separate circle around **each** of the asymmetric carbon atoms in the tripeptide.

(1)

(ii) Draw the zwitterion of alanine.

(1)

(iii) Give the IUPAC name of threonine.

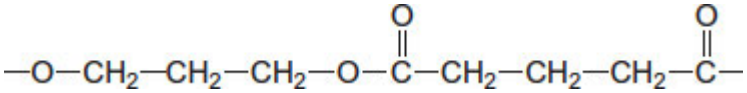
.....

(1)

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

(1)

(b) The repeating unit shown represents a polyester.



(i) Name this type of polymer.

.....

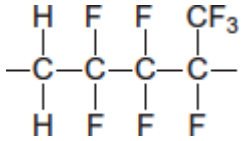
(1)

(ii) Give the IUPAC name for the alcohol used to prepare this polyester.

.....

(1)

(c) The repeating unit shown represents a polyalkene co-polymer. This co-polymer is made from two different alkene monomers.



(i) Name the type of polymerisation occurring in the formation of this co-polymer.

.....

(1)

(ii) Draw the structure of each alkene monomer.

Alkene monomer 1 Alkene monomer 2

(2)

(d) One of the three compounds shown in parts (a), (b) and (c) cannot be broken down by hydrolysis.

Write the letter **(a)**, **(b)** or **(c)** to identify this compound and explain why hydrolysis of this compound does **not** occur.

Compound .....

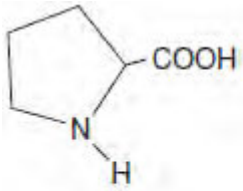
Explanation .....

.....

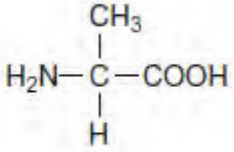
.....

(2)
(Total 11 marks)

Q2.(a) The structures and common names of two amino acids are shown.



proline



alanine

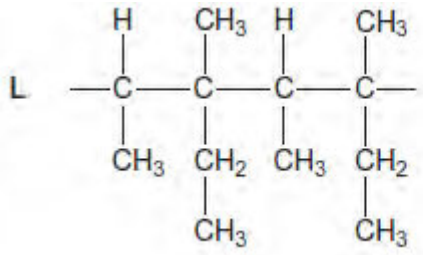
(i) Draw the structure of the zwitterion of proline.

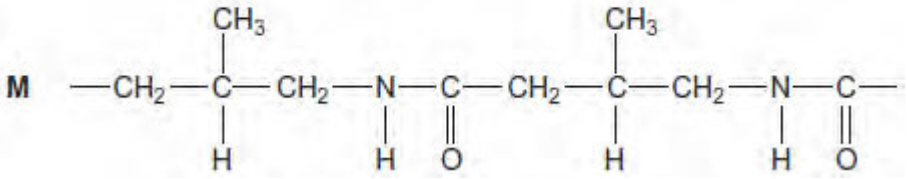
(1)

(ii) Draw the structure of the tripeptide formed when a proline molecule bonds to two alanine molecules, one on each side.

(2)

(b) Sections of two polymers, **L** and **M**, are shown.

L 

M 

(i) Give the IUPAC name of a monomer that forms polymer **L**.

.....

(1)

(ii) Give the IUPAC name of the monomer that forms polymer **M**.

.....

(1)

(iii) Draw the section of a polymer made from a dicarboxylic acid and a diamine that is isomeric with the section of polymer **M** shown.

(1)

(vi) Explain why polymer **L** is non-biodegradable.

.....

.....

.....

(1)
(Total 7 marks)

Q3. (a) Name compound **Y**, $HOCH_2CH_2COOH$

.....

(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.

.....

(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.

.....

(1)

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

(1)

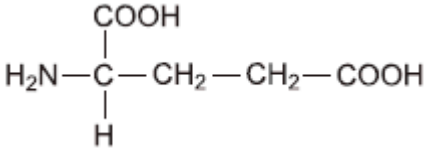
(iii) The organic product from part (ii) can also be polymerised.
Draw the repeating unit of the polymer formed from this organic product.

(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.

.....

.....

.....

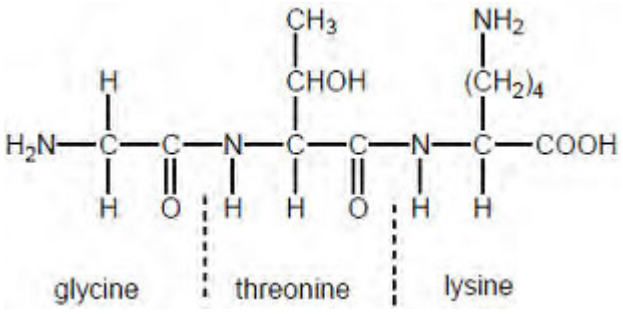
.....

.....

.....

(3)
(Total 13 marks)

Q4. The tripeptide shown in the following figure is formed from the amino acids glycine, threonine and lysine.



(a) Draw a separate circle around **each** of the asymmetric carbon atoms in the tripeptide in the figure.

(1)

(b) Draw the zwitterion of glycine.

(1)

(c) Draw the structure of the species formed when glycine reacts with an excess of bromomethane.

(1)

(d) Deduce the IUPAC name of threonine.

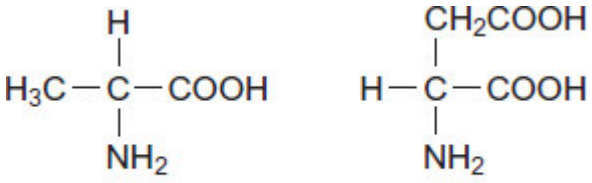
.....

(1)

(e) Draw the structure of the species formed by lysine at low pH.

(1)
(Total 5 marks)

Q5. Alanine and aspartic acid are naturally occurring amino acids.



alanine aspartic acid

(a) Draw the structure of the zwitterion formed by alanine.

(1)

(b) Draw the structure of the compound formed when alanine reacts with methanol in the presence of a small amount of concentrated sulfuric acid.

(1)

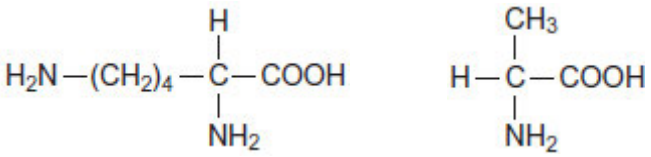
(c) Draw the structure of the species formed by aspartic acid at high pH.

(1)

(d) Draw the structure of a dipeptide formed by two aspartic acid molecules.

(1)
(Total 4 marks)

Q6. Lysine and alanine are two amino acids.



lysine

alanine

(a) Give the IUPAC name of lysine.

.....

(1)

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

(i) an excess of aqueous HCl

(1)

(ii) an excess of aqueous NaOH

(1)

(iii) methanol in the presence of a small amount of concentrated H_2SO_4

(1)

(c) The mass spectrum of alanine gives a major peak at $m / z = 44$

Write an equation for the fragmentation of the molecular ion of alanine to give an ion that produces this peak.
In your answer, draw the displayed formula for this fragment ion.

(2)

(d) Draw a dipeptide formed from one molecule of lysine and one molecule of alanine.

(1)

(e) The dipeptide in part (d) is hydrolysed in acid conditions and the mixture produced is analysed by column chromatography. The column is packed with a resin which acts as a polar stationary phase.

Suggest why lysine leaves the column after alanine.

.....

.....

.....

.....

(2)
(Total 9 marks)

Q7. A peptide is hydrolysed to form a solution containing a mixture of amino acids. This mixture is then analysed by silica gel thin-layer chromatography (TLC) using a toxic solvent. The individual amino acids are identified from their R_f values.

Part of the practical procedure is given below.

1. **Wearing plastic gloves to hold a TLC plate**, draw a pencil line 1.5 cm from the bottom of the plate.
2. Use a capillary tube to apply a very small drop of the solution of amino acids to the mid-point of the pencil line.
3. Allow the spot to dry completely.
4. In the developing tank, add the developing solvent to **a depth of not more than 1 cm**.
5. Place your TLC plate in the developing tank.
6. Allow the developing solvent to rise up the plate **to the top**.
7. Remove the plate and quickly mark the position of the solvent front with a pencil.
8. Allow the plate to dry **in a fume cupboard**.

(a) Parts of the procedure are in bold text.

For each of these parts, consider whether it is essential and justify your answer.

.....

.....

.....

.....

.....

.....

.....

.....

(4)

(b) Outline the steps needed to locate the positions of the amino acids on the TLC plate and to determine their R_f values.

.....

.....

.....

.....

.....

.....

.....

.....

(4)

(c) Explain why different amino acids have different R_f values.

.....

.....

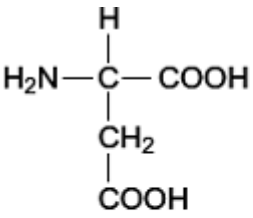
.....

.....

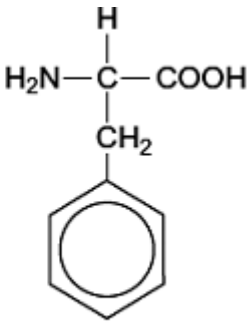
.....

(2)
(Total 10 marks)

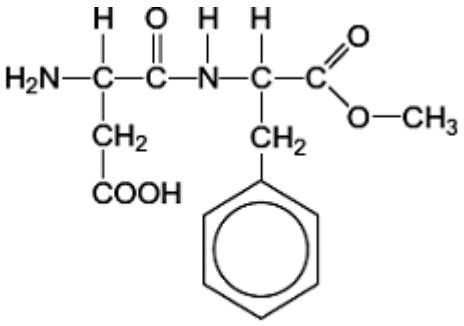
Q1. The amino acids aspartic acid and phenylalanine react together to form a dipeptide. This dipeptide can be converted into a methyl ester called aspartame.



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.

.....

.....

(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*.

.....

.....

.....

.....

(2)

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

.....

.....

.....

.....

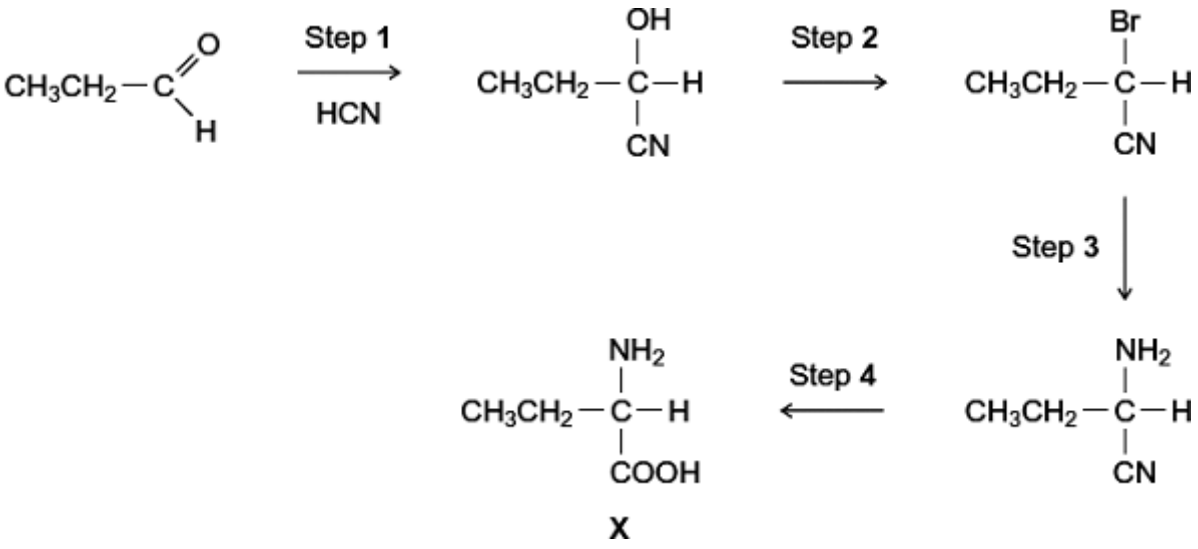
(Extra space) .....

.....

(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 $CH_3CH_2CH(OH)COOH$.

.....

.....

.....

.....

.....

(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)

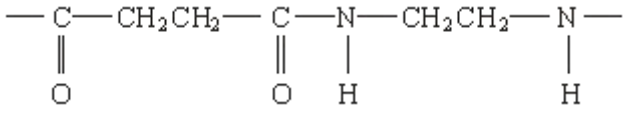
(iii) Draw a structural isomer of **X** that has an unbranched carbon chain and can be polymerised to form a polyamide.

(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, $HOCH_2COOH$

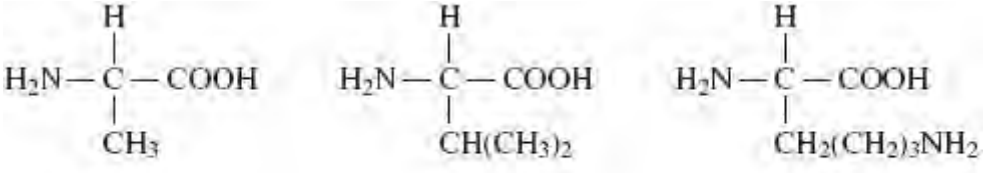
.....

.....

.....

(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.

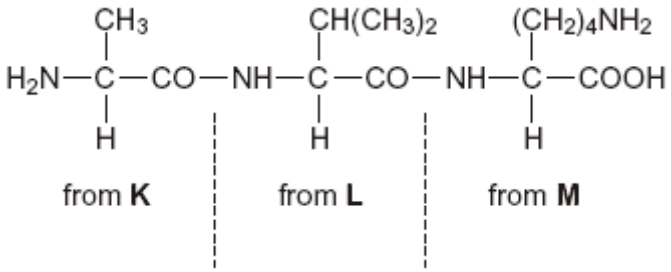
(2)

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

.....

(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.

.....

(1)

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

.....

(1)

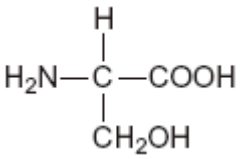
(iii) Draw the structure of the zwitterion of amino acid **L**.

(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**, $HOCH_2CH_2COOH$

.....

(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.

.....

(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.

.....

(1)

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

(1)

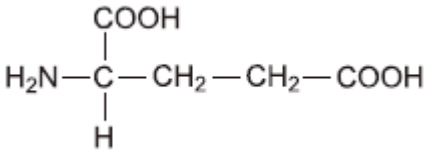
(iii) The organic product from part (ii) can also be polymerised.
Draw the repeating unit of the polymer formed from this organic product.

(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.

.....

.....

.....

.....

.....

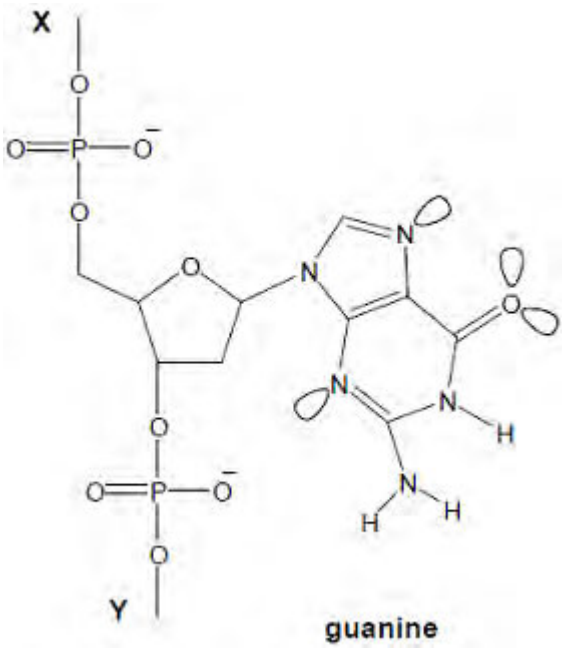
.....

(3)
(Total 13 marks)

Q1. The anticancer drug cisplatin operates by reacting with the guanine in DNA.

Figure 1 shows a small part of a single strand of DNA. Some lone pairs are shown.

Figure 1



(a) The DNA chain continues with bonds at **X** and **Y**.

State the name of the sugar molecule that is attached to the bond at **X**.

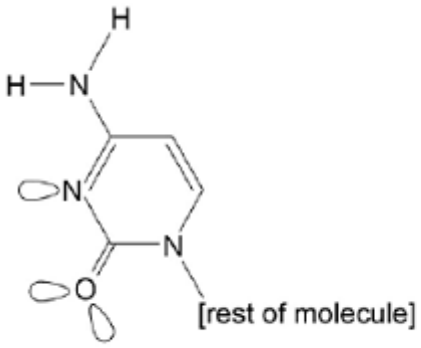
.....

(1)

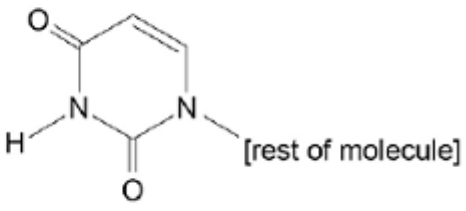
(b) Messenger RNA is synthesised in cells in order to transfer information from DNA. The bases in one strand of DNA pair up with the bases used to synthesise RNA.

Figure 2 shows two bases used in RNA.

Figure 2



Base A



Base B

Suggest which of the bases **A** and **B** forms a pair with guanine in **Figure 1** when messenger RNA is synthesised.
Explain how the base that you have chosen forms a base pair with guanine.

.....

.....

.....

.....

.....

.....

.....

.....

(4)

(c) Cisplatin works because one of the atoms on guanine can form a co-ordinate bond with platinum, replacing one of the ammonia or chloride ligands. Another atom on another guanine can also form a co-ordinate bond with the same platinum by replacing another ligand.

On **Figure 1**, draw a ring round an atom in guanine that is likely to bond to platinum.

(1)

(d) An adverse effect of cisplatin is that it also prevents normal healthy cells from replicating.

Suggest **one** way in which cisplatin can be administered so that this side effect is minimised.

.....

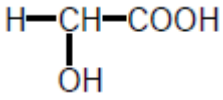
.....

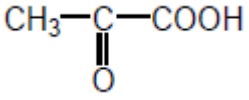
.....

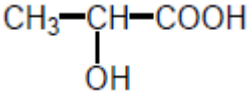
(1)
(Total 7 marks)

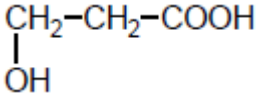
Q1. A drug is designed to simulate one of the following molecules that adsorbs onto the active site of an enzyme.

Which molecule requires the design of an optically active drug?

A  ⬭

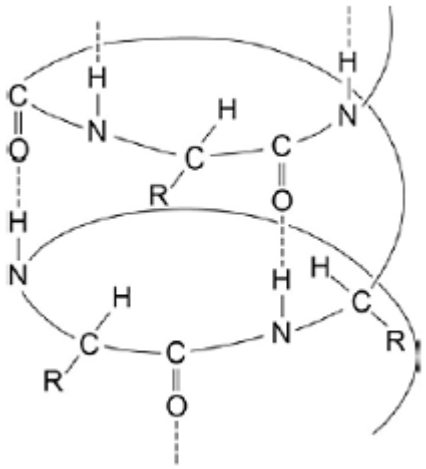
B  ⬭

C  ⬭

D  ⬭

(Total 1 mark)

Q1. The following figure shows a simplified representation of the arrangement of some amino acids in a portion of a protein structure in the form of an α-helix.



(a) Name the type of protein structure in the figure.

.....

(1)

(b) Explain the origin of the interaction represented by the dotted lines in the figure above.

.....

.....

.....

.....

.....

.....

.....

.....

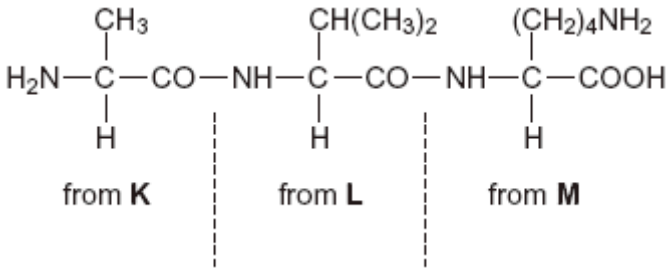
.....

.....

(4)

(Total 5 marks)

Q2. (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.

.....

(1)

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

.....

(1)

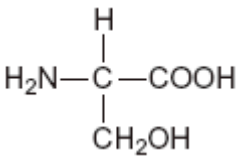
(iii) Draw the structure of the zwitterion of amino acid **L**.

(1)

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

(1)

(b) Consider the amino acid serine.



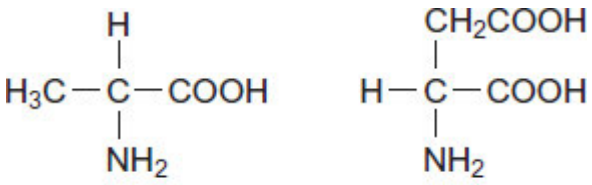
(i) Draw the structure of the product formed when serine reacts with an excess of CH_3Br

(1)

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

(1)
(Total 6 marks)

Q3. Alanine and aspartic acid are naturally occurring amino acids.



alanine

aspartic acid

(a) Draw the structure of the zwitterion formed by alanine.

(1)

(b) Draw the structure of the compound formed when alanine reacts with methanol in the presence of a small amount of concentrated sulfuric acid.

(1)

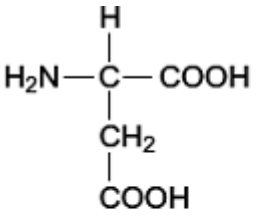
(c) Draw the structure of the species formed by aspartic acid at high pH.

(1)

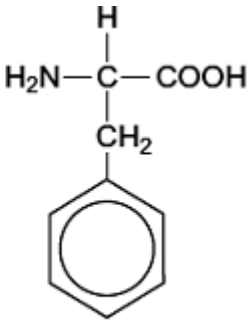
(d) Draw the structure of a dipeptide formed by two aspartic acid molecules.

(1)
(Total 4 marks)

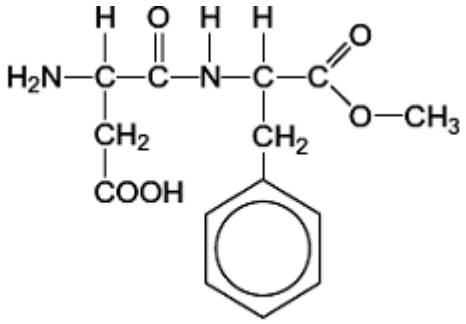
Q4. The amino acids aspartic acid and phenylalanine react together to form a dipeptide. This dipeptide can be converted into a methyl ester called aspartame.



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.

.....

.....

(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*.

.....

.....

.....

.....

(2)

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

.....

.....

.....

.....

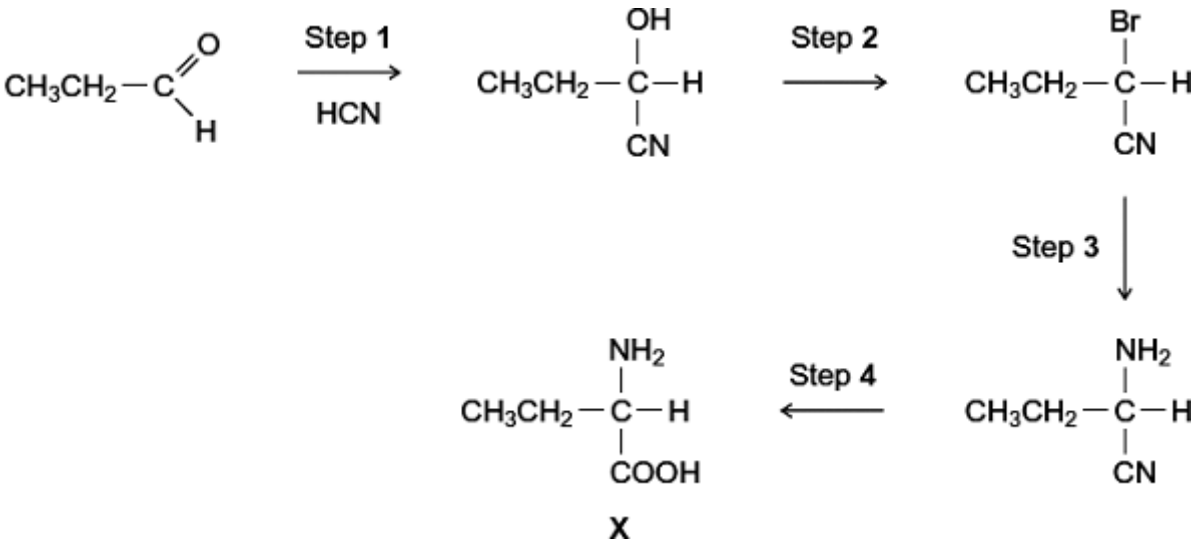
(Extra space) .....

.....

(2)

(Total 8 marks)

Q5.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 $CH_3CH_2CH(OH)COOH$.

.....

.....

.....

.....

.....

(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)

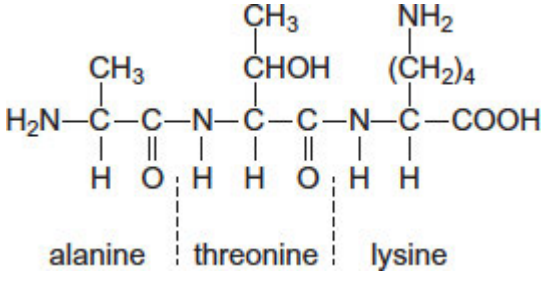
(iii) Draw a structural isomer of **X** that has an unbranched carbon chain and can be polymerised to form a polyamide.

(1)

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

(1)
(Total 16 marks)

Q6.(a) The tripeptide shown is formed from the amino acids alanine, threonine and lysine.



(i) Draw a separate circle around **each** of the asymmetric carbon atoms in the tripeptide.

(1)

(ii) Draw the zwitterion of alanine.

(1)

(iii) Give the IUPAC name of threonine.

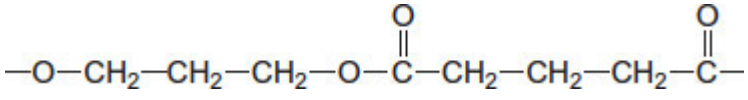
.....

(1)

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

(1)

(b) The repeating unit shown represents a polyester.



(i) Name this type of polymer.

.....

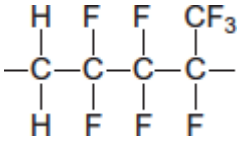
(1)

(ii) Give the IUPAC name for the alcohol used to prepare this polyester.

.....

(1)

(c) The repeating unit shown represents a polyalkene co-polymer. This co-polymer is made from two different alkene monomers.



(i) Name the type of polymerisation occurring in the formation of this co-polymer.

.....

(1)

(ii) Draw the structure of each alkene monomer.

Alkene monomer 1 Alkene monomer 2

(2)

(d) One of the three compounds shown in parts (a), (b) and (c) cannot be broken down by hydrolysis.

Write the letter **(a)**, **(b)** or **(c)** to identify this compound and explain why hydrolysis of this compound does **not** occur.

Compound .....

Explanation .....

.....

.....

(2)

(Total 11 marks)

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.

.....

.....

.....

.....

.....

.....

(Extra space) .....

.....

.....

(3)

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

Name of mechanism.....

Mechanism

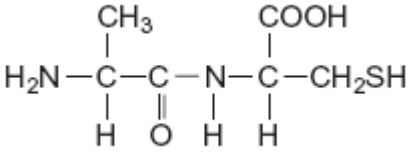
(5)

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

.....

(1)

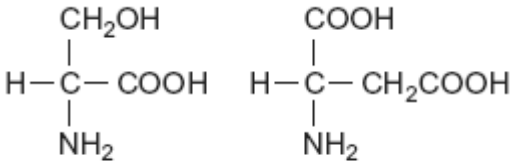
(c) The dipeptide shown below is formed from two different amino acids.



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.

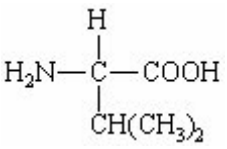
(1)

(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.

.....

.....

.....

.....

.....

.....

.....

(3)

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

.....

.....

.....

.....

.....

.....

(3)
(Total 14 marks)

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

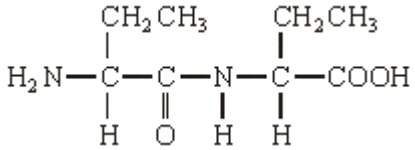
(i) Draw the repeating unit of the polymer formed from this compound.

(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.



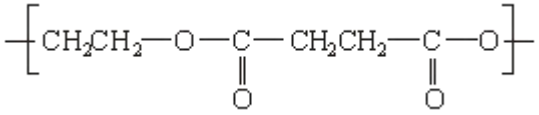
(i) Name this amino acid.

.....

(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.

.....

(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 .....

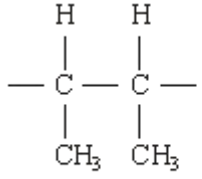
(iii) Give **one** reason why the polyester is biodegradable.

.....

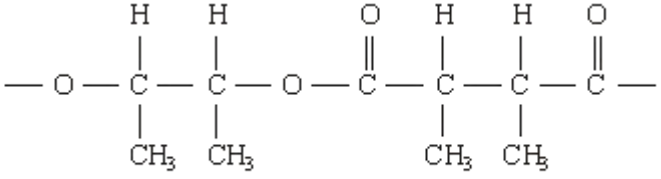
.....

(4)
(Total 8 marks)

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 .....

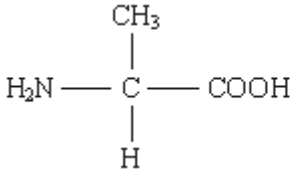
Type of polymerisation .....

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

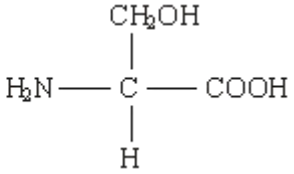
.....

(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)