Q1.

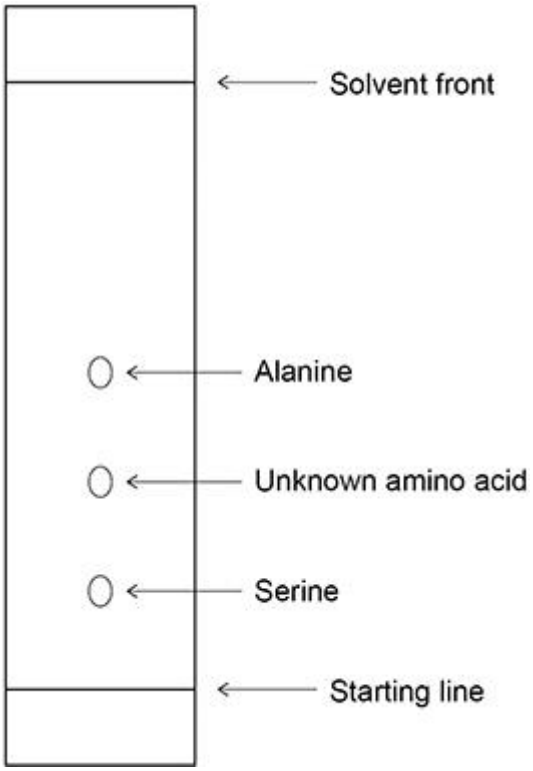
The protein fibroin can be broken down into amino acids using an enzyme.

(a) A student uses thin-layer chromatography (TLC) to identify these amino acids.

The student identifies two of the amino acids as alanine and serine.

Use the figure below to calculate the R_f value of the unknown amino acid. Show your working.

Use your R_f value and the table below to identify the unknown amino acid.



Amino acid	**R_f value**
tyrosine	0.25
glycine	0.34
valine	0.64
leucine	0.73

Rf value _____

Identity _____

(2)

(b) The amino acids cannot be seen as they move during the experiment.

State how the amino acids can be made visible at the end of the experiment.

_____

_____

(1)

(c) State why each amino acid has a different R_f value.

_____

_____

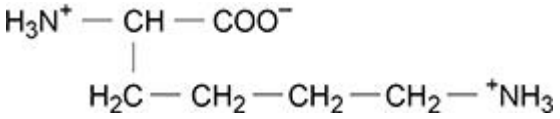
_____

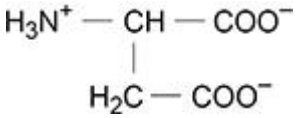
(1)

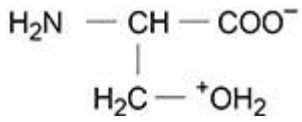
(Total 4 marks)

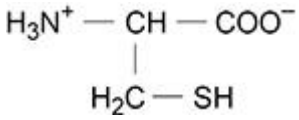
Q2.

Which is the structure of a zwitterion of an amino acid?

A 

B 

C 

D 

(Total 1 mark)

Q3.

Which row shows a pair of bases that can link two strands of DNA with three hydrogen bonds?

Use the Data Booklet to help you answer this question.

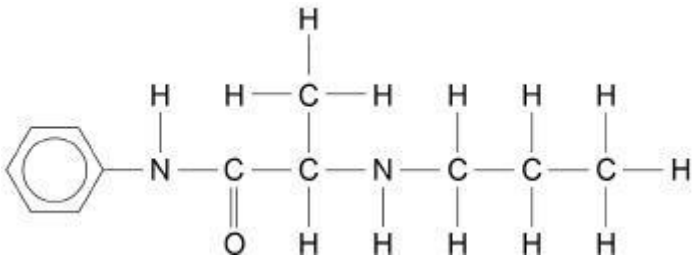
	Base 1	Base 2	
A	adenine	guanine	⬭
B	cytosine	thymine	⬭
C	cytosine	guanine	⬭
D	adenine	thymine	⬭

(Total 1 mark)

Q4.

Prilocaine is used as an anaesthetic in dentistry.
Figure 1 shows the structure of prilocaine.

Figure 1



(a) Draw a circle around any chiral centre(s) in **Figure 1**.

(1)

(b) Identify the functional group(s) in the prilocaine molecule.

Tick (✓) the box(es) corresponding to the functional group(s).

Amide	Amine	Ester	Ketone

(1)

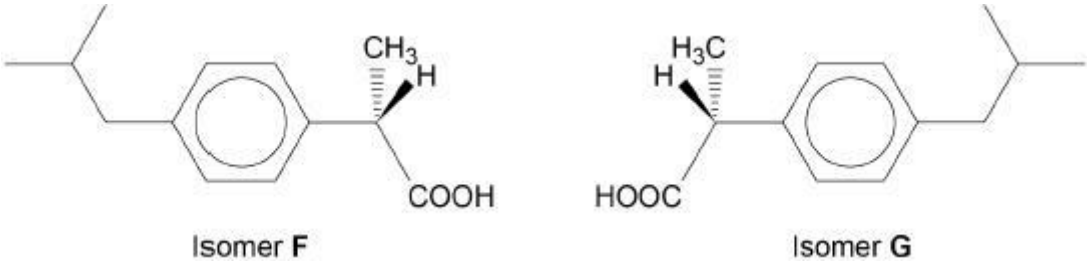
(c) Prilocaine is completely hydrolysed in the human body to give a mixture of products.

Draw the structures of the two organic products formed in the complete hydrolysis of prilocaine in acidic conditions.

(3)

(d) **Figure 2** shows optical isomers **F** and **G**.

Figure 2



Isomer **F** Isomer **G**

Isomer **F** is the active compound in the medicine ibuprofen.

In the manufacture of ibuprofen both isomers **F** and **G** are formed. An enzyme is then used to bind to isomer **G** and catalyse its hydrolysis.

After the products of hydrolysis of **G** are removed, a pure sample of isomer **F** is collected.

Explain how a structural feature of this enzyme enables it to catalyse the hydrolysis of isomer **G** but not the hydrolysis of isomer **F**.

_____

_____

_____

_____

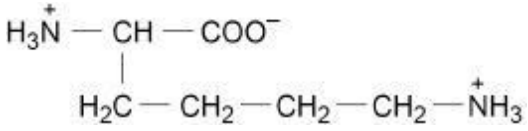
(2)

(Total 7 marks)

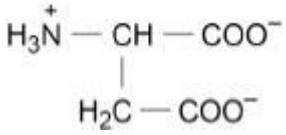
Q5.

Which structure shows the zwitterion of an amino acid?

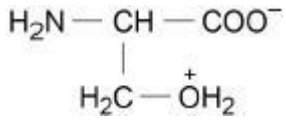
A



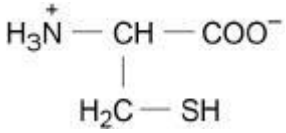
B



C



D

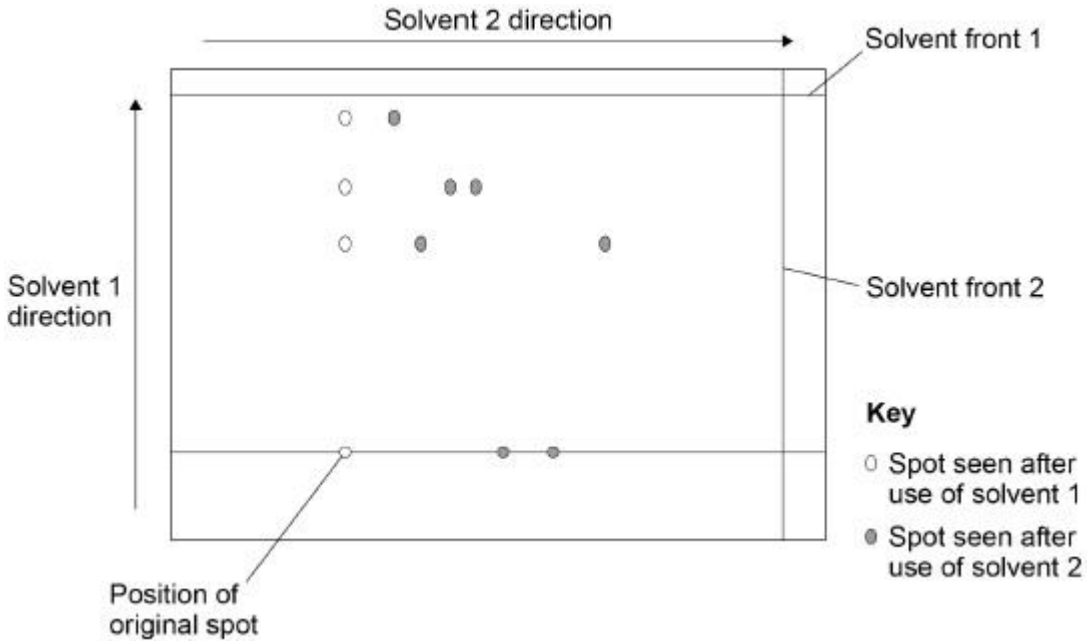


(Total 1 mark)

Q6.

This question is about thin-layer chromatography (TLC).

- A protein was hydrolysed to form a mixture of amino acids.
- A spot of this mixture was added to a TLC plate and the plate placed vertically in a small volume of solvent 1.
- When the solvent front reached nearly to the top of the plate, the plate was removed and allowed to dry.
- The plate was turned anticlockwise through 90° and placed vertically in a small volume of solvent 2.
- When the solvent front reached nearly to the top of the plate, the plate was again removed and allowed to dry.
- The diagram shows the final TLC plate.



(a) Suggest a suitable reagent for the hydrolysis of a protein.

_____

_____

(1)

(b) Suggest how the positions of the amino acids on the TLC plate were located.

_____

_____

(1)

(c) Deduce the minimum number of amino acids present in the original mixture.

_____

_____

(1)

(d) Suggest why it was necessary to use two different solvents.

_____

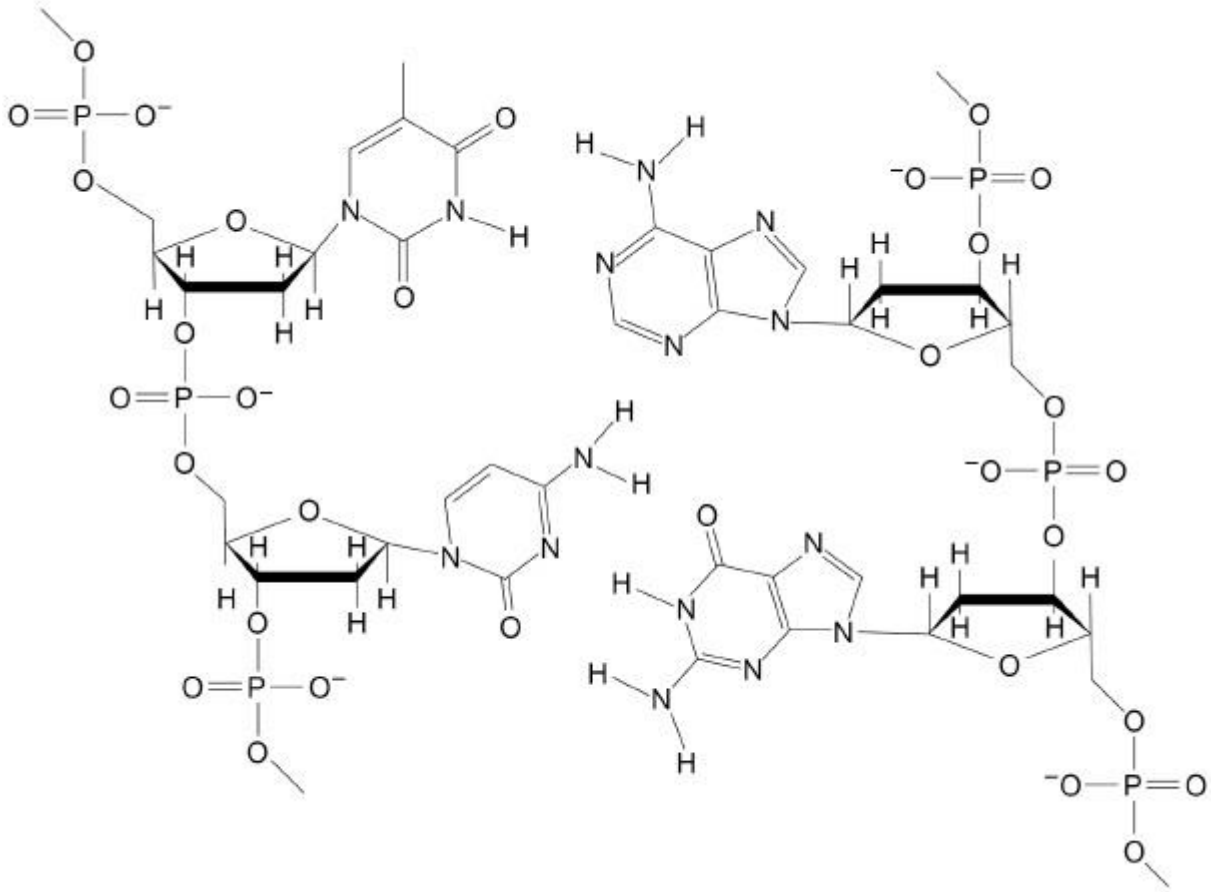
_____

(1)

(Total 4 marks)

Q7.

The diagram shows two complementary strands in part of a DNA double helix structure.



(a) Draw all the hydrogen bonds between the complementary strandsshown in the diagram.

Use dashed lines to show the hydrogen bonds.
You do **not** need to show lone pairs of electrons or partial charges.

(2)

(b) Draw a ring around each of the component parts that make up the cytosine nucleotide in the section of DNA shown in the diagram above.

(2)

(c) State the meaning of the term complementary when it is used to refer to DNA strands.

_____

_____

_____

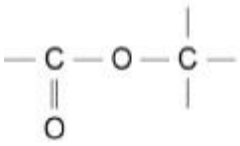
(1)

(Total 5 marks)

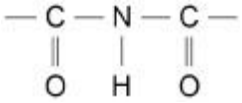
Q8.

Which structure shows part of a peptide link in a protein?

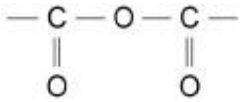
A



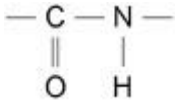
B



C



D



(Total 1 mark)

Q9.

Two strands of DNA are linked together by hydrogen bonding between bases on each strand.
Which row shows the number of hydrogen bonds between the pair of bases?
Use the Data Booklet to help you answer this question.

	Base 1	Base 2	Number of hydrogen bonds
A	adenine	guanine	2
B	cytosine	thymine	2
C	guanine	cytosine	3
D	adenine	thymine	3

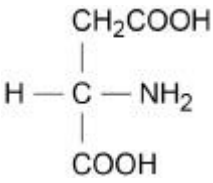
(Total 1 mark)

Q10.

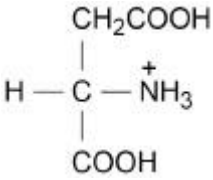
Use the Data Booklet to help you answer this question

Which is the main aspartic acid species present in an aqueous solution at pH = 14?

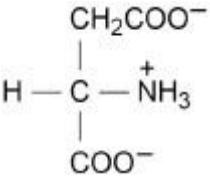
A



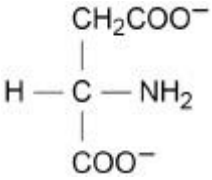
B



C



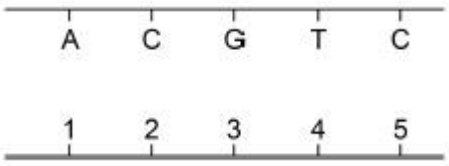
D



(Total 1 mark)

Q11.

Use the Data Booklet to help you answer this question about DNA.
The figure below shows a fragment of a DNA double helix.
The letters A, C, G and T represent the four bases in one strand.
The numbers 1, 2, 3, 4 and 5 represent the bases in the complementary strand.



(a) Complete Table 4 to show the correct sequence of bases in the complementary strand represented by the numbers 1 to 5

1	2	3	4	5

(1)

(b) Deduce the total number of hydrogen bonds formed between the five bases in each strand.

Tick (✓) **one** box.

10	12	13	15

(1)

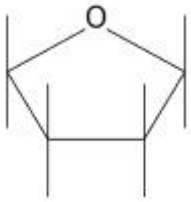
(c) Base A is part of a nucleotide in the DNA strand shown in the figure above.

A nucleotide contains a 2-deoxyribose molecule.

An incomplete 2-deoxyribose molecule is shown.

Complete the structure to show the nucleotide that contains base A.

You should represent base A by the letter A.

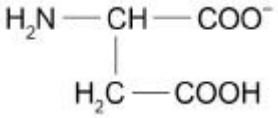


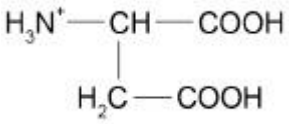
(2)

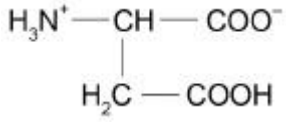
(Total 4 marks)

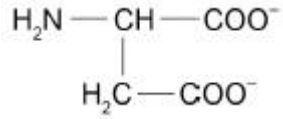
Q12.

Which structure is formed by aspartic acid in solution at pH 12?

A  ⬭

B  ⬭

C  ⬭

D  ⬭

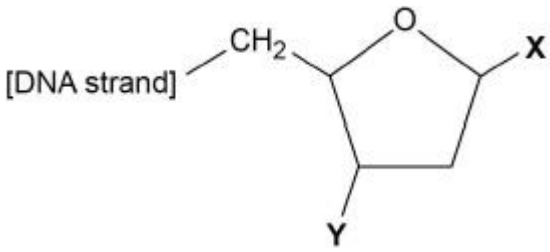
(Total 1 mark)

Q13.

Use the Data Booklet to help you answer these questions.

DNA exists as two strands of nucleotides in the form of a double helix with hydrogen bonding between the two strands.

(a) A deoxyribose molecule in a strand of DNA is shown.



Name the types of group attached to 2-deoxyribose at positions X and Y.

X

_____

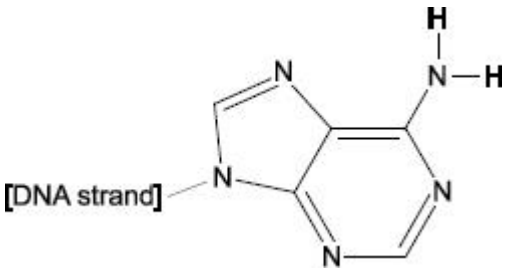
Y

_____

(2)

(b) In the DNA double helix, adenine is linked by hydrogen bonds to a molecule in the other strand of DNA.

Complete the diagram below to show the other molecule and the hydrogen bonds between it and adenine.



(2)

(Total 4 marks)

Q14.

Use the information in the Data Booklet to help you answer these questions.

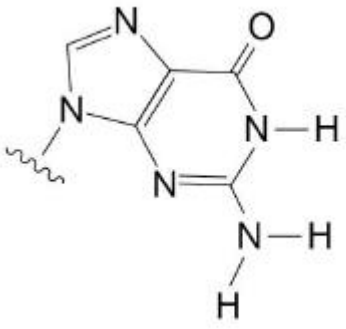
A single strand of DNA is made from many nucleotides linked together.

(a) Draw the structure of the nucleotide that contains guanine, showing clearly the bonding between the components.

(3)

(b) Two complementary strands of DNA form a double helix in which one strand is attracted to another by interactions between pairs of bases.

Complete the base pair diagram showing the interactions.



(2)

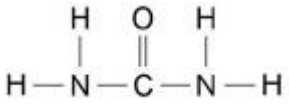
(c) State how the interactions in the adenine-thymine base pair differ from those you identified in part **(b)**.

_____

_____

(1)

(d) Urea has the displayed formula



Suggest why urea is effective at separating the complementary strands in DNA.

_____

_____

_____

_____

_____

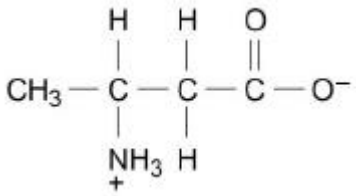
(2)

(Total 8 marks)

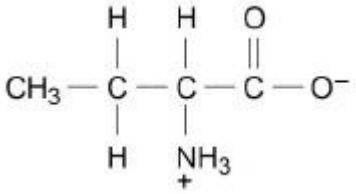
Q15.

Which structure shows 2-aminobutanoic acid as a zwitterion?

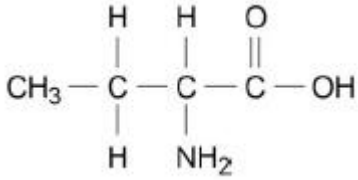
A



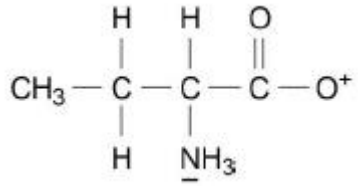
B



C



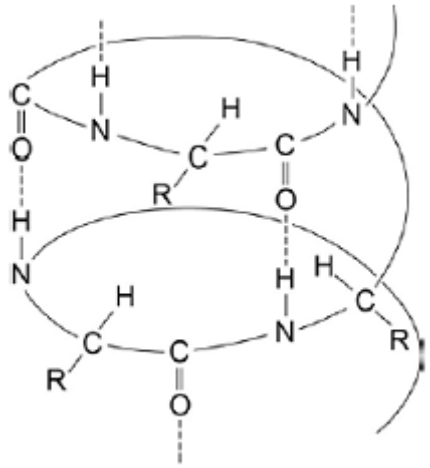
D



(Total 1 mark)

Q16.

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.

_____

_____

_____

_____

_____

_____

_____

_____

_____

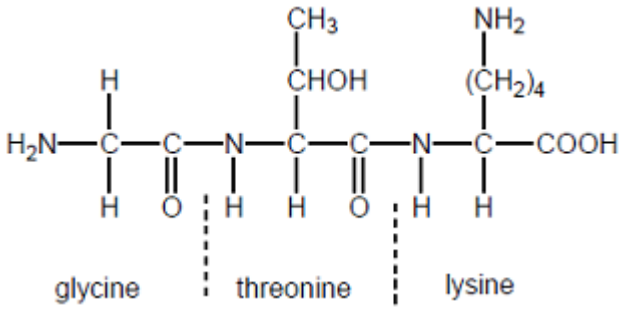
_____

(4)

(Total 5 marks)

Q17.

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)

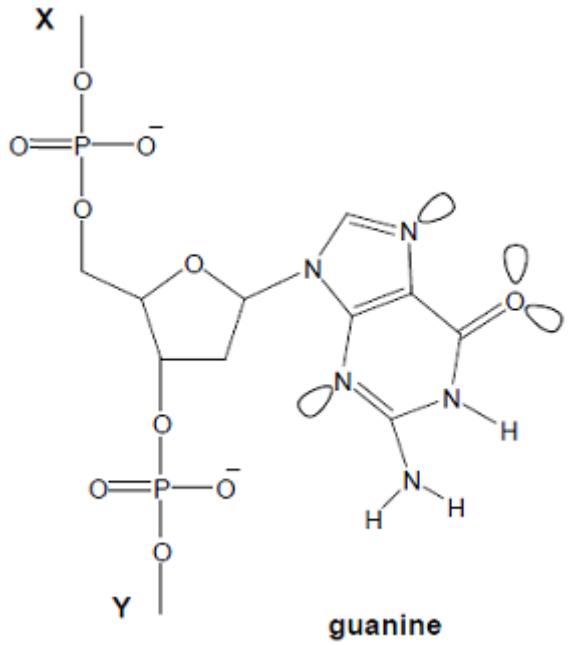
(Total 5 marks)

Q18.

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**.

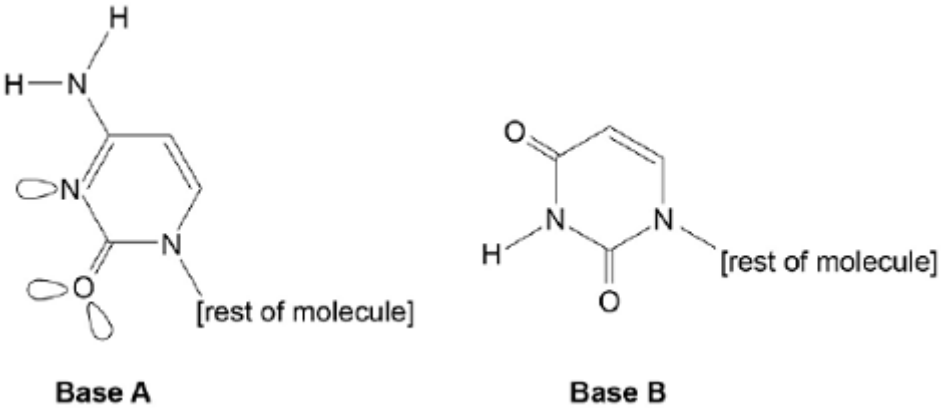
_____

(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)

Q19.

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.

_____

_____

_____

_____

_____

_____

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(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.

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(4)

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

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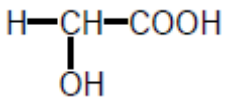
(2)

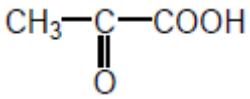
(Total 10 marks)

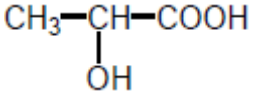
Q20.

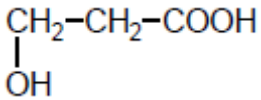
A drug is designed to simulate one of the following molecules that adsorbs onto the active site of an enzyme.

Which molecule requires the design of an optically active drug?

A  ⬭

B  ⬭

C  ⬭

D  ⬭

(Total 1 mark)