Q1.

(a) The table below contains information on the digestion of two biological molecules.

Complete the below table.

Biological molecule	Enzyme	Name of bond hydrolysed	Product of digestion
Starch			Maltose
Dipeptide	Dipeptidase		

(4)

A student investigated starch digestion by mixing starch with a solution of the enzyme used to digest starch.

The student did a biochemical test for **protein** when starch digestion was completed.

(b) Describe a biochemical test to show the presence of protein.

(2)

(c) The student's test for protein was positive.

Explain why.

(2)

(d) An enzyme's turnover number (k_{cat}) is the number of substrate molecules converted into product molecules by one enzyme molecule in 1 second. It is determined using this equation.

$$k_{cat} = \frac{\text{Maximum rate of enzyme-controlled reaction / } \mu\text{mol dm}^{-3}\text{ s}^{-1}}{\text{Enzyme concentration / } \mu\text{mol dm}^{-3}}$$

A scientist investigated the action of a protease enzyme. The scientist prepared a reaction mixture with a protease concentration of 0.0118 μmol dm^{-3}. The k_{cat} for the protease is 110 substrate molecules per second.

Use this information and the formula to calculate the maximum rate of the protease-controlled reaction.

Give your answer to **3** significant figures.

Show your working.

Answer _____ μmol dm^{-3} s^{-1}

(2)

(Total 10 marks)

Q2.

(a) A non-competitive inhibitor decreases the rate of an enzyme-controlled reaction.

Explain how.

_____

_____

_____

_____

_____

_____

_____

_____

_____

(3)

(b) A scientist investigated the hydrolysis of the protein casein.

The scientist:

- mixed a solution of a protease enzyme with a solution of casein
- then measured the casein concentration in the mixture at intervals
- controlled all relevant variables appropriately.

For this investigation, identify:

the independent variable _____

_____

_____

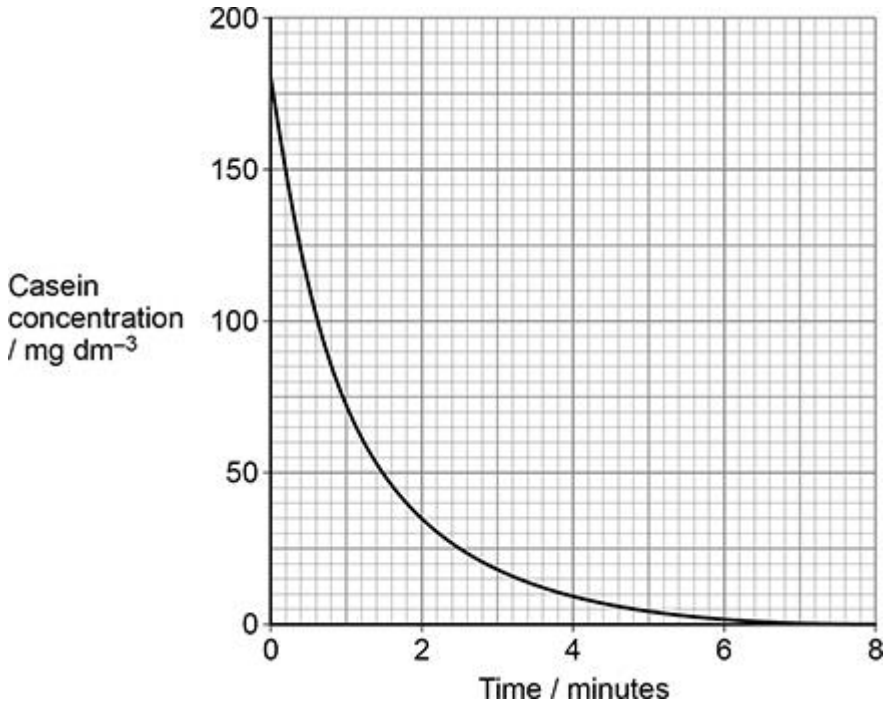
the dependent variable _____

_____

_____

(2)

(c) The graph below shows the scientist's results.



Use the graph above to determine the rate of casein hydrolysis at 2 minutes.

Show how you obtained your answer.

Answer _____ mg dm^{-3} minute^{-1}

(2)

(d) The scientist repeated the investigation but increased the temperature to the optimum temperature for this protease.

Sketch a line on the graph above showing the results you predict if the investigation is repeated at the optimum temperature for the protease.

(2)

(Total 9 marks)

Q3.

(a) A student investigated the activity of the enzyme polyphenol oxidase (PPO) in apple tissue.

When apple tissue is exposed to air, PPO catalyses a reaction between colourless phenol compounds in apple tissue and oxygen.

Figure 1 shows the reaction.

Figure 1

$$\text{phenol compounds + oxygen} \xrightarrow{\text{PPO}} \text{brown pigment}$$

The student measured the time taken for the brown pigment to appear in two apple varieties (**D** and **E**).

Method

1. Cut a 1 cm cube of apple tissue from variety **D**.
2. Put the cube on a plate and leave the plate at 30 °C
3. Measure the time for the brown pigment to appear.
4. Repeat steps 1 to 3 two more times.
5. Repeat steps 1 to 4 with apple tissue from variety **E**.

The student obtained the results shown below, but did not record the data in a results table.

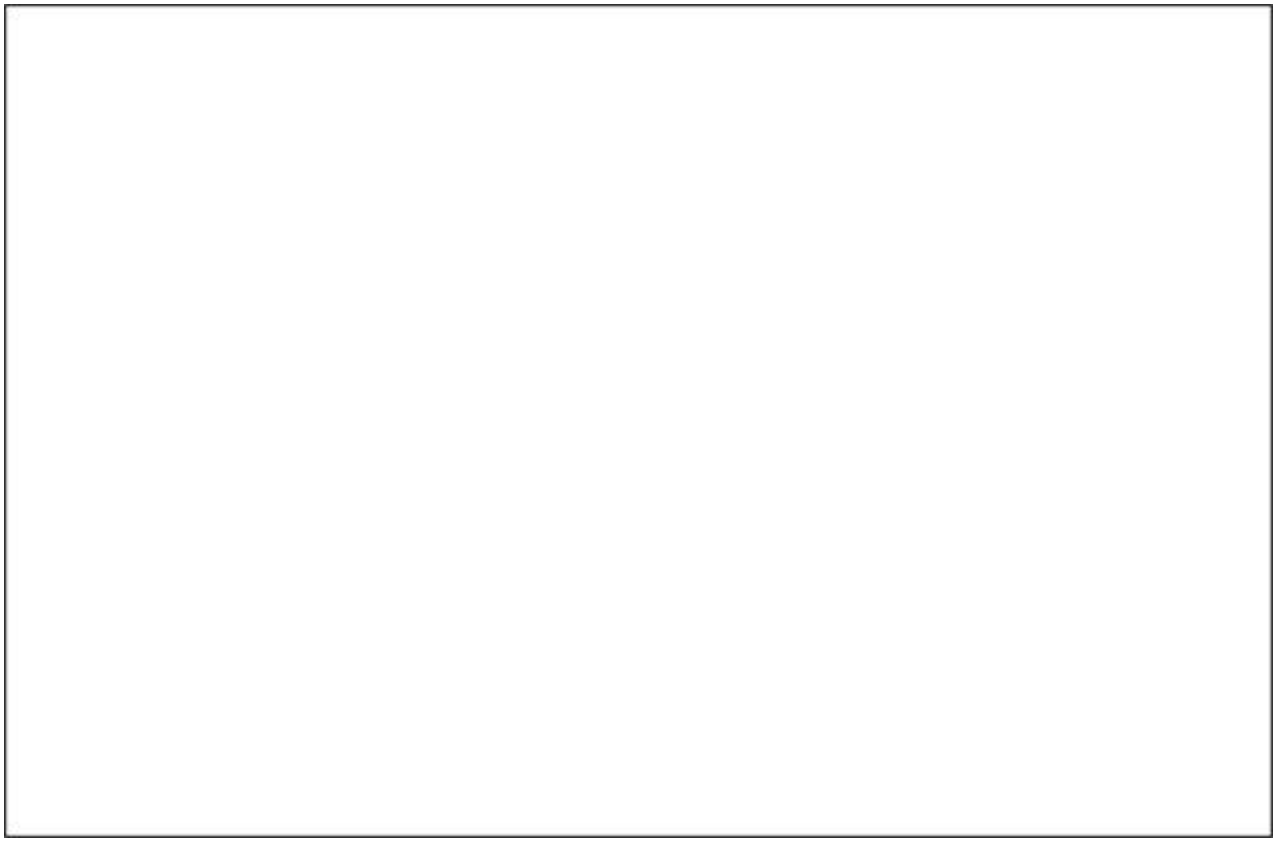
Variety **D** = 15 min 50 s, 18 min, 14 min 30 s

Variety **E** = 6 min 30 s, 8 min, 7 min

In the box labelled **Figure 2**, design a suitable results table.

- Enter the student's results into the table.
- Calculate the mean results and include these in the table.
- Use 1 decimal place for both mean results.

Figure 2



(3)

(b) Suggest and explain why the results for variety **D** are different from the results for variety **E**.

_____

_____

_____

_____

_____

_____

(2)

(c) The student repeated the investigation but made **one** change to the method used to prepare the apple tissue.

The student then observed shorter times for the brown pigment to appear in both apple varieties.

Suggest the change the student made to the method of preparing the apple tissue.

Explain why the brown pigment appeared in a shorter time.

Do **not** suggest using a different volume or mass of apple.

Change to method _____

Explanation _____

_____

_____

_____

_____

_____

(3)

(d) The student wants to change the procedure to obtain a measure of PPO activity either in terms of how much substrate is used or how much product is produced.

Which change in procedure will provide a successful measure of PPO activity for the student?

Tick (✓) **one** box.

Measure the increase in oxygen concentration in the air around the cube of apple tissue on a plate.	☐
Measure the intensity of brown colour by comparing apple tissue with a colour chart showing a range of apple tissues of known pigment concentration.	☐
Measure the intensity of colour produced from brown apple tissue in a biuret test.	☐
Measure the percentage of light transmitted through a cube of brown apple tissue using a colorimeter.	☐

(1)

(Total 9 marks)

Q4.

(a) Describe the primary structure of all proteins.

_____

_____

_____

_____

_____

_____

(2)

(b) This question is about the genetic code.

Define **universal**, **non-overlapping** and **degenerate**.

Universal _____

_____

_____

Non-overlapping _____

_____

_____

Degenerate _____

_____

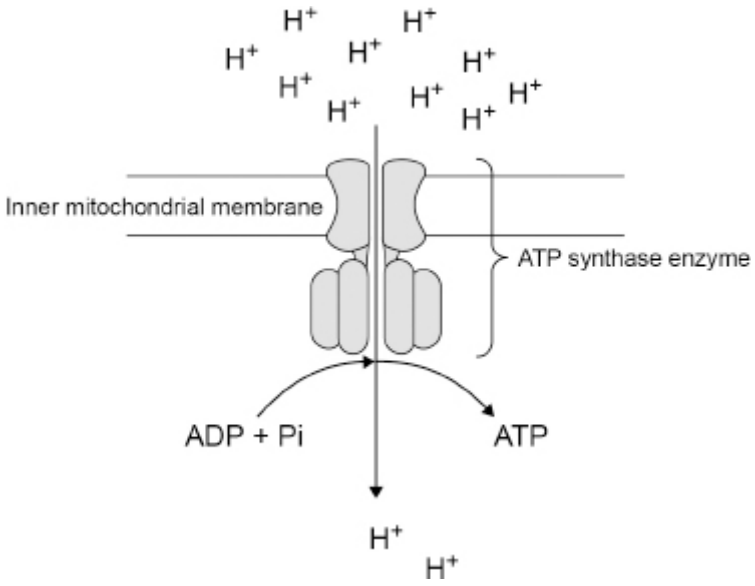
_____

(3)

(Total 5 marks)

Q5.

(a) The figure below shows an ATP synthase enzyme in the inner mitochondrial membrane.



Complete the passage with the appropriate terms.

ATP synthase comprises several polypeptides, so is said to have

a _____ structure.

It catalyses the synthesis of an ATP molecule by a _____

reaction; this involves the _____ of a water molecule.

The ATP synthase in the figure above is in a mitochondrion so would catalyse reactions during _____.

(2)

(b) As shown in the figure above, ATP synthase has two functions.

- It catalyses the synthesis of ATP.
- It allows the movement of H^+ ions.

Suggest how the shape of the ATP synthase allows it to have these two functions.

Explain your answers.

Catalyses the synthesis of ATP _____

_____

_____

_____

_____

_____

Allows the movement of H^+ ions _____

_____

_____

_____

_____

_____

(4)

(Total 6 marks)

Q6.

(a) Describe how a quaternary protein is formed from its monomers.

Do not include the process of translation in your answer.

(5)

(b) Describe the structure of DNA and the structure of a chromosome.

(6)

(c) Mutation can result in an increase in genetic variation within a species.

Describe and explain the **other** processes that result in increases in genetic variation within a species.

(4)

(Total 15 marks)

Q7.

(a) Describe how monomers join to form the primary structure of a protein.

_____

_____

_____

_____

_____

_____

_____

_____

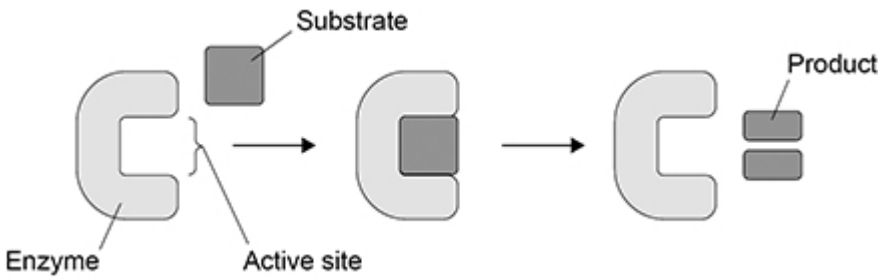
(3)

(b) Many proteins are enzymes.

In 1894, a scientist suggested the lock and key model of enzyme action.

Figure 1 shows the lock and key model.

Figure 1



Describe **one** similarity and **one** difference between the induced-fit model of enzyme action and the lock and key model of enzyme action.

Similarity _____

_____

Difference _____

_____

(2)

(c) State how enzymes help reactions to proceed quickly at lower temperatures.

Do **not** write about active sites in your answer.

_____

_____

(1)

(d) The enzyme maltase catalyses the hydrolysis of maltose to glucose.

A scientist investigated maltase activity in two different maltose solutions, **G** and **H**.

For each solution, he measured:

- the total number of glucose molecules produced by complete hydrolysis of the maltose
- the time taken for the complete hydrolysis of the maltose.

The table below shows his results.

Solution	**Total number of glucose molecules produced**	**Time taken for complete hydrolysis of maltose / s**
G	4×10^7	20
H	6×10^8	

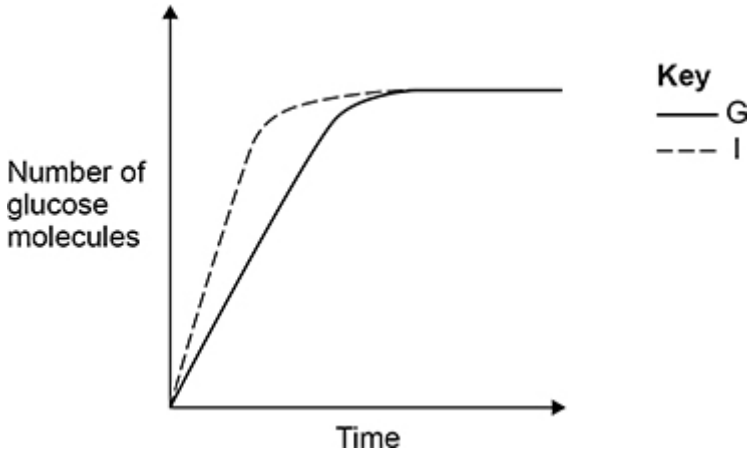
Complete the table by calculating the time taken for the complete hydrolysis of the maltose in solution **H**. Assume the rate of maltase activity is the same in solution **G** and in solution **H**.

Show your working.

(2)

(e) **Figure 2** shows the scientist's results for solution **G**. Curve **I** shows the results of a similar investigation in which he changed one independent variable.

Figure 2



Tick (✓) **one** box next to the statement that describes the independent variable that the scientist changed to give the results shown by curve **I** in **Figure 2**.

Addition of a competitive inhibitor ☐

Increased maltase concentration ☐

Increased maltose concentration ☐

Reduced temperature ☐

(1)

(Total 9 marks)

Q8.

Two enzymes, **P** and **Q**, are proteins with quaternary structure which catalyse the same reaction, but they have different amino acid sequences.

(a) Define the **quaternary structure** of a protein.

_____

_____

_____

(1)

(b) Explain how two enzymes with different amino acid sequences can catalyse the same reaction.

_____

_____

_____

_____

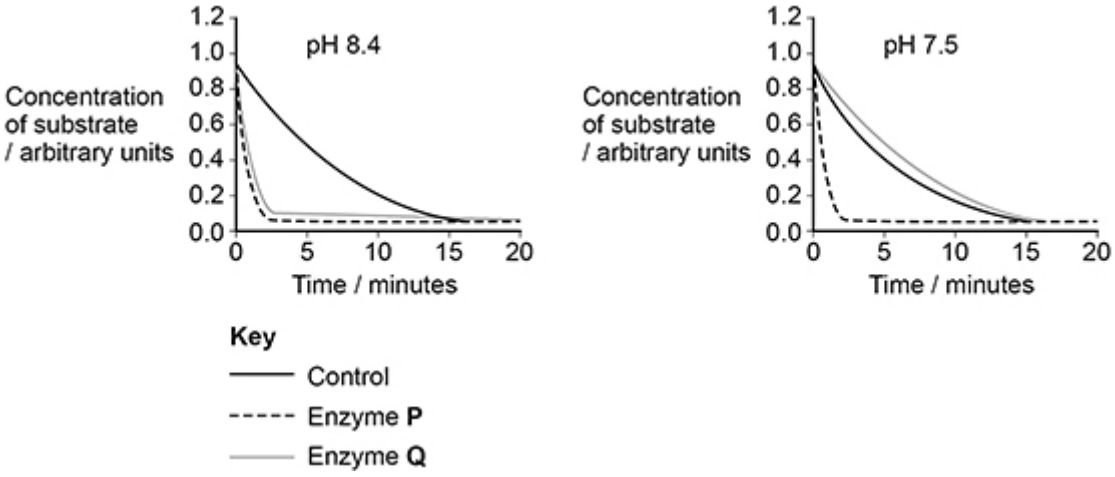
_____

_____

(2)

Scientists investigated the effect of pH 8.4 and pH 7.5 on the activity of enzymes **P** and **Q**.

The figure below shows their results.



(c) Describe what the scientists should place in the control tubes in this investigation.

(3)

(d) Give **three** conclusions you can make from the figure above.

1

2

3

(3)

(Total 9 marks)

Q9.

Amino acids are used to make proteins. **Table 1** shows the R groups of six different amino acids.

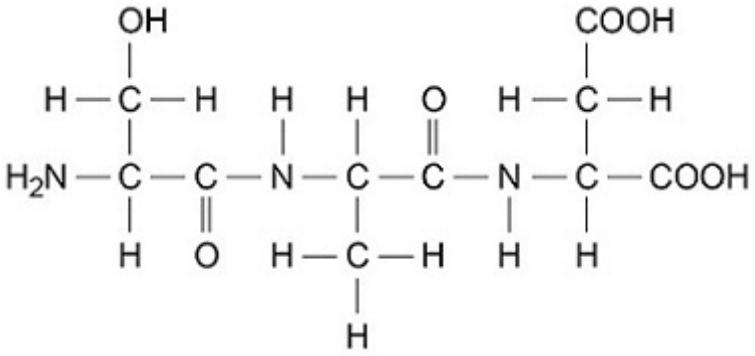
Table 1

Amino acid	R group
Alanine	CH_3
Asparagine	CH_2CONH_2
Aspartic acid	CH_2COOH

Amino acid	R group
Glutamic acid	CH_2CH_2COOH
Glycine	H
Serine	CH_2OH

(a) Use **Table 1** to identify the **three** different amino acids used to make the polypeptide shown in **Figure 1**.

Figure 1



Left amino acid _____

Middle amino acid _____

Right amino acid _____

(2)

(b) **Table 2** shows three statements and names of four biological molecules.

Put a Tick (✓) in each box where the statement is true for the biological molecule.

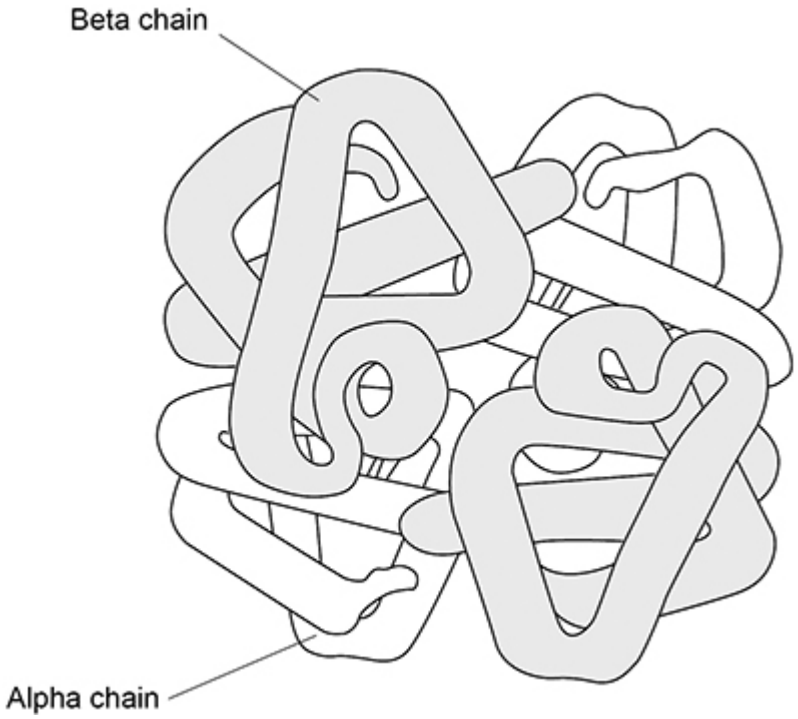
Table 2

Statement	DNA	ATP	Reverse transcriptase	Phospholipid
Contains peptide bonds				
Is formed using a condensation reaction				
Is a polymer				

(3)

Figure 2 represents the structure of adult human haemoglobin.

Figure 2



(c) The number of amino acids in the beta chains in **Figure 2** is 3.546% greater than in the alpha chains. Each alpha chain contains 141 amino acids.

Calculate how many amino acids there are in total in the haemoglobin molecule shown in **Figure 2**. Give your answer to the nearest whole number.

Answer _____ amino acids

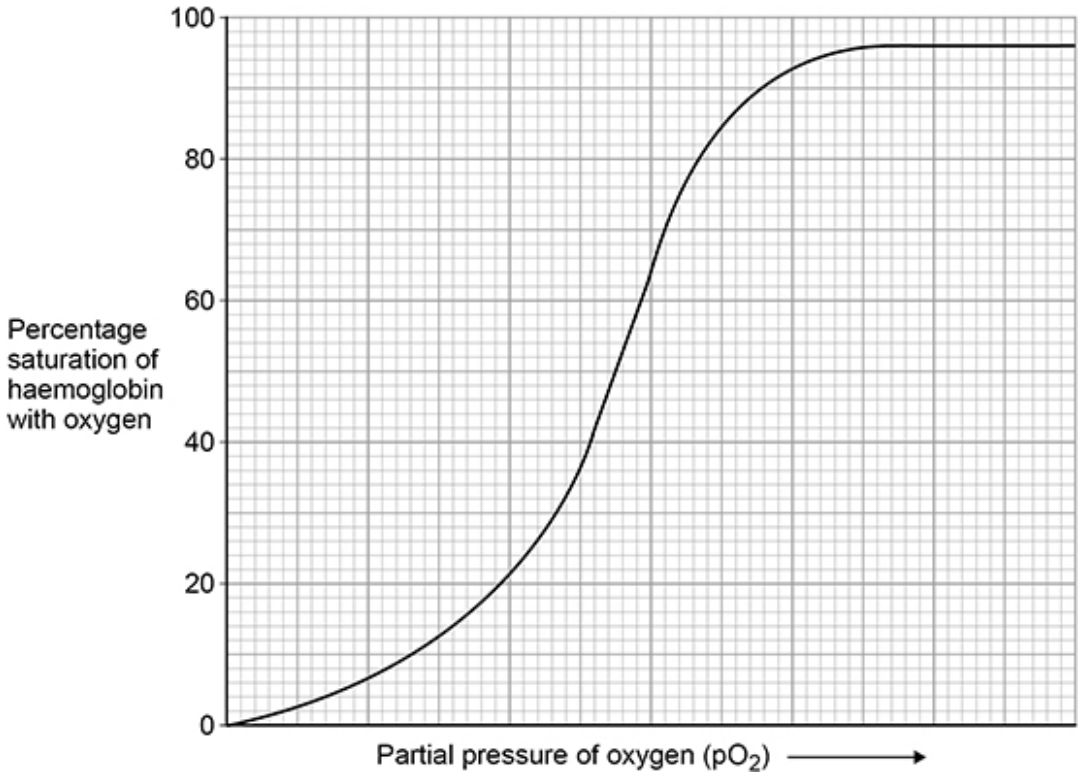
(2)

When a substance called BPG binds to haemoglobin, it reduces the affinity of haemoglobin for oxygen.

(d) **Figure 3** shows an oxyhaemoglobin dissociation curve for haemoglobin in normal conditions.

Sketch a curve on **Figure 3** to show the oxyhaemoglobin dissociation curve for haemoglobin when BPG binds to it.

Figure 3



(1)

(e) Suggest and explain when it would be an advantage to a human for BPG to bind to haemoglobin.

_____

_____

_____

_____

_____

_____

_____

(2)

(Total 10 marks)