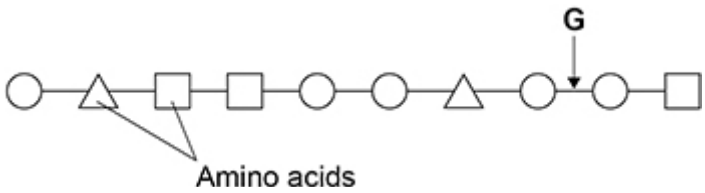
Q1.

The diagram shows the primary structure of part of a polypeptide. Each shape represents an amino acid. Identical amino acids have the same shape.



(b) Name the type of peptidase which will hydrolyse the bond labelled **G** in the diagram above.

_____

(1)

(c) Give the number of different **R** groups in the polypeptide shown in the diagram above.

_____

(1)

A scientist used an enzyme to digest a polypeptide containing 101 amino acids. The digestion produced a range of smaller polypeptides.

The scientist determined the number of amino acids in each of the polypeptides produced. He also counted the number of polypeptides of each length.

The table below shows some of the scientist's results.

Number of amino acids in polypeptide	Number of polypeptides of each length
5	2
6	
15	3
20	

(d) Use the information in the table above to calculate the number of polypeptides:

6 amino acids in length _____

20 amino acids in length _____

(2)

Q2.

(a) Describe the induced-fit model of enzyme action **and** how an enzyme acts as a catalyst.

_____

_____

_____

_____

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_____

(3)

(b) Scientists investigated the action of the enzyme ATP synthase. They made reaction mixtures each containing:

- ATP synthase
- buffer (to control pH)
- substrates.

One of the substrates required in these reaction mixtures is inorganic phosphate (Pi).

Tick (✓) **one** box to show which other substrate the scientists must add to the reaction mixtures to produce ATP.

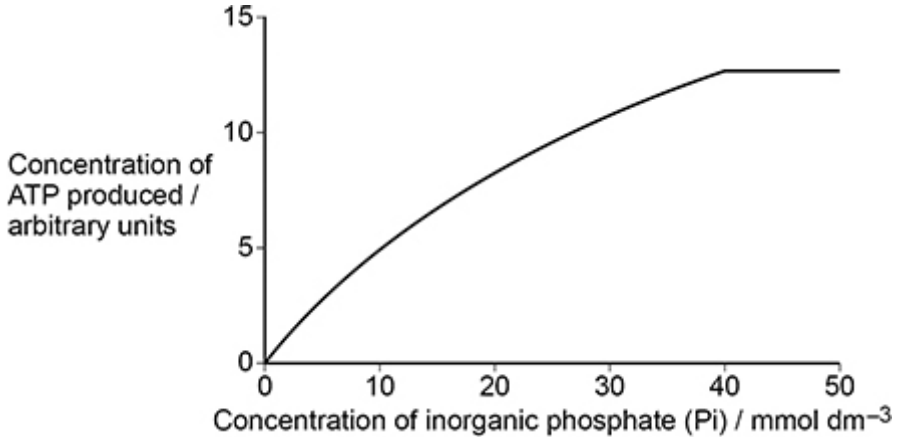
Adenine	☐
Adenosine diphosphate	☐
Glucose	☐
Ribose	☐

(1)

(c) The scientists investigated the effect of concentration of inorganic phosphate (Pi) on ATP synthase activity.

After 2 minutes, they stopped each reaction and then measured the concentration of ATP.

The figure below shows the scientists' results.



Suggest and explain a procedure the scientists could have used to stop each reaction.

(2)

(d) Explain the change in ATP concentration with increasing inorganic phosphate concentration.

(2)

(Total 8 marks)

Q3.

(a) A student investigated starch hydrolysis using the enzyme amylase.

During the procedure, the student:

- treated the starch to make it soluble
- prepared 10 cm^3 of different concentrations (mg dm^{-3}) of starch solution
- added an identical concentration of amylase to each starch solution
- measured the time in minutes to completely hydrolyse starch.

He repeated the procedure and calculated the mean time to completely hydrolyse starch in each concentration of starch solution.

Draw a table the student could use to record all of his results.

You only need to show completed column headings.

(2)

(b) Describe the results you would expect the student to obtain.

_____

_____

_____

_____

(1)

(c) A competitive inhibitor decreases the rate of an enzyme-controlled reaction.
Explain how.

_____

_____

_____

_____

(3)

(d) When bread becomes stale, the structure of some of the starch is changed. This changed starch is called retrograded starch.

Scientists have suggested retrograded starch is a competitive inhibitor of amylase in the small intestine.

Assuming the scientists are correct, suggest how eating stale bread could help to reduce weight gain.

(3)

(Total 9 marks)

Q4.

(b) Describe how the structure of a protein depends on the amino acids it contains.

_____

_____

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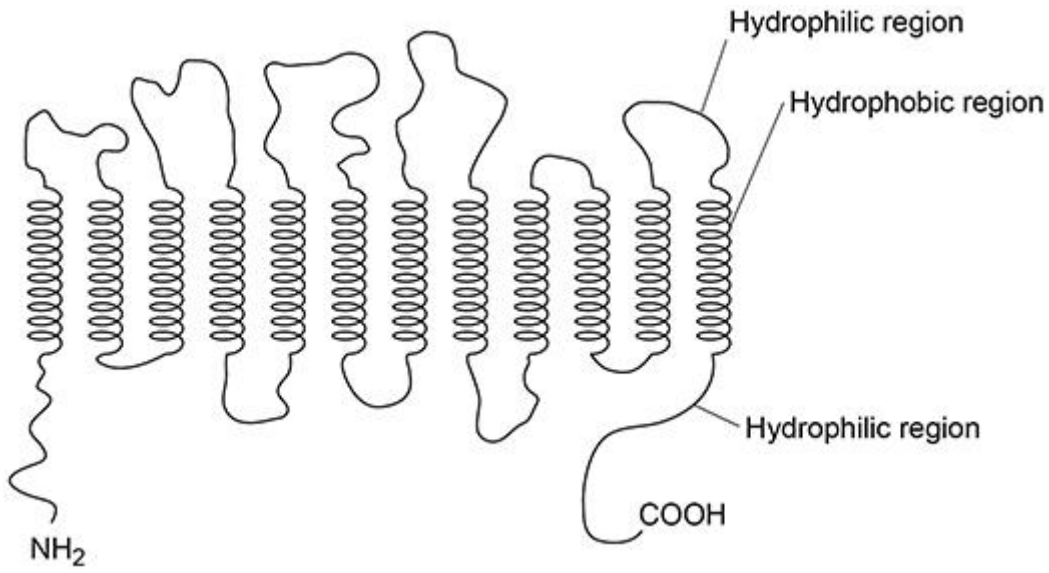
_____

(5)

Q5.

Figure 2 is a diagram of one SGLT1 carrier protein.

Figure 2



(e) **Figure 2** shows the SGLT1 polypeptide with NH_2 at one end and COOH at the other end.

Describe how amino acids join to form a polypeptide so there is always NH_2 at one end and COOH at the other end.

You may use a diagram in your answer.

Space for diagram:

(2)

Q6.

(a) Explain how the active site of an enzyme causes a high rate of reaction.

(3)

The action of the enzyme catalase is shown below.

$$\text{hydrogen peroxide} \xrightarrow{\text{catalase}} \text{water} + \text{oxygen}$$

A student investigated the effect of hydrogen peroxide concentration on the rate of this reaction. He used catalase from potato tissue.

The student:

- put five potato chips in a flask
- added 20 cm^3 of 0.5 mol dm^{-3} hydrogen peroxide solution to the flask
- measured the time in seconds for production of 10 cm^3 of oxygen gas
- repeated this procedure with four different concentrations of hydrogen peroxide solution.

His results are shown in the table.

Hydrogen peroxide concentration / mol dm^{-3}	**Time for production of 10 cm^3 of oxygen gas / seconds**	**Rate of reaction / arbitrary units**
0.5	18	
1.0	10	
1.5	7	
2.0	6	
2.5	6	

(b) Other than those stated, give **one** factor the student would have controlled in his investigation.

_____

_____

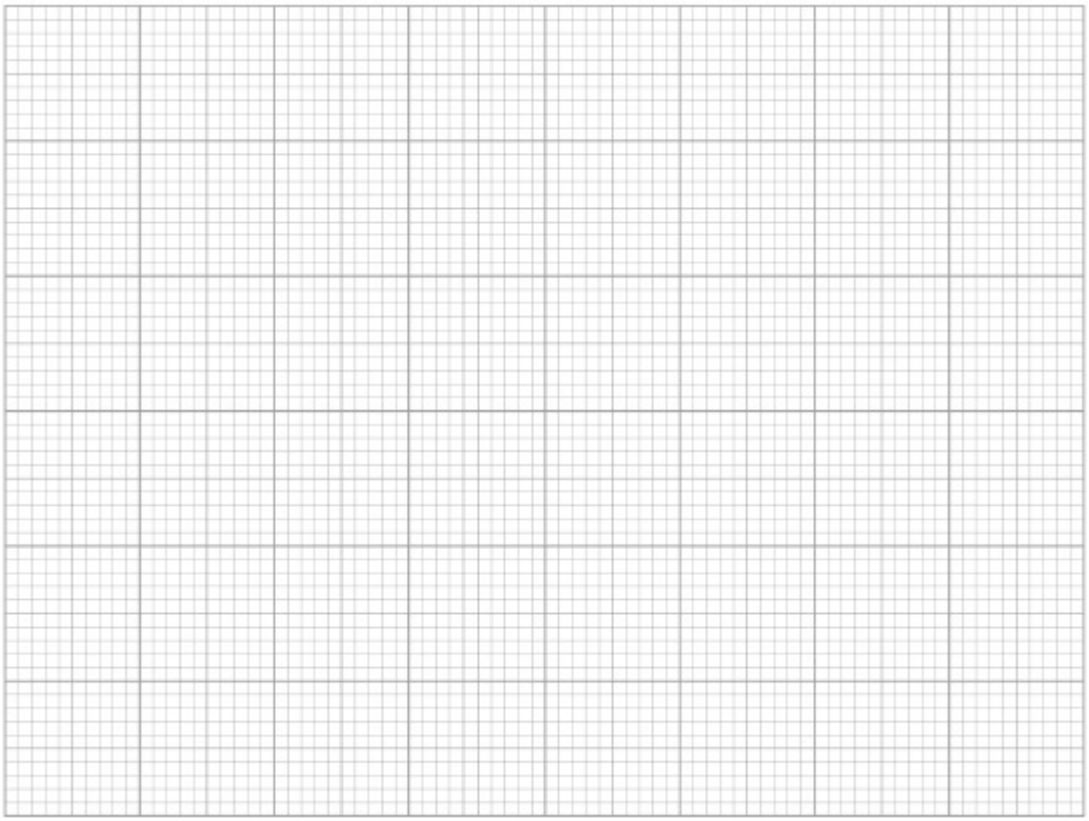
(1)

(c) The student gave the maximum rate of reaction a value of 1.0 arbitrary units.

Complete the table above by calculating the rate of reaction in arbitrary units at each hydrogen peroxide concentration. Record the rates using an appropriate number of significant figures.

(2)

(d) Plot a suitable graph of your processed data shown in the table.



(3)

(e) Suggest a change the student could make to his procedure so that 10 cm^3 of oxygen would be produced in less than 6 seconds.

_____

_____

_____

_____

(1)

(Total 10 marks)

Q7.

(a) Describe a biochemical test to confirm the presence of protein in a solution.

_____

_____

_____

_____

_____

_____

(2)

(b) A dipeptide consists of two amino acids joined by a peptide bond. Dipeptides may differ in the type of amino acids they contain.

Describe **two other** ways in which all dipeptides are similar and one way in which they might differ.

Similarities

1 _____

_____

_____

2 _____

_____

_____

Difference _____

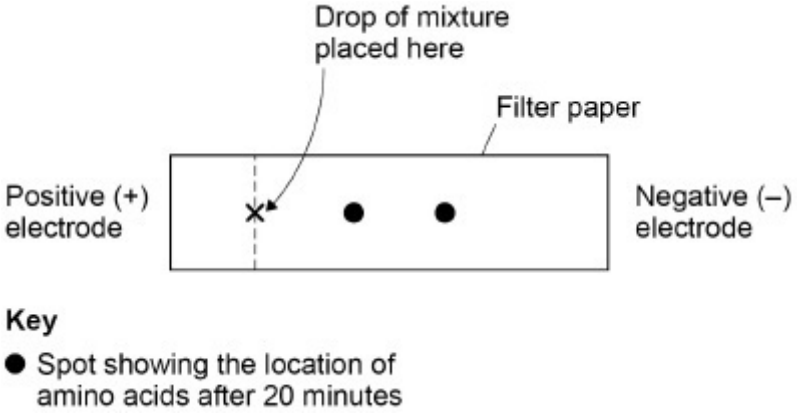
_____

(3)

A solution contained a mixture of **three** different amino acids. A scientist passed an electric current through the solution to separate the amino acids.

She placed a drop of the mixture at one end of a piece of filter paper, attached an electrode to each end of the paper and switched on the current. She switched off the current after 20 minutes and stained the paper to show spots of the amino acids at new positions.

Her results are shown in the diagram.



(c) Explain what the positions of the spots in the diagram show about these amino acids.

(3)

(Total 8 marks)

Q8.

(a) Describe how a **non-competitive** inhibitor can reduce the rate of an enzyme-controlled reaction.

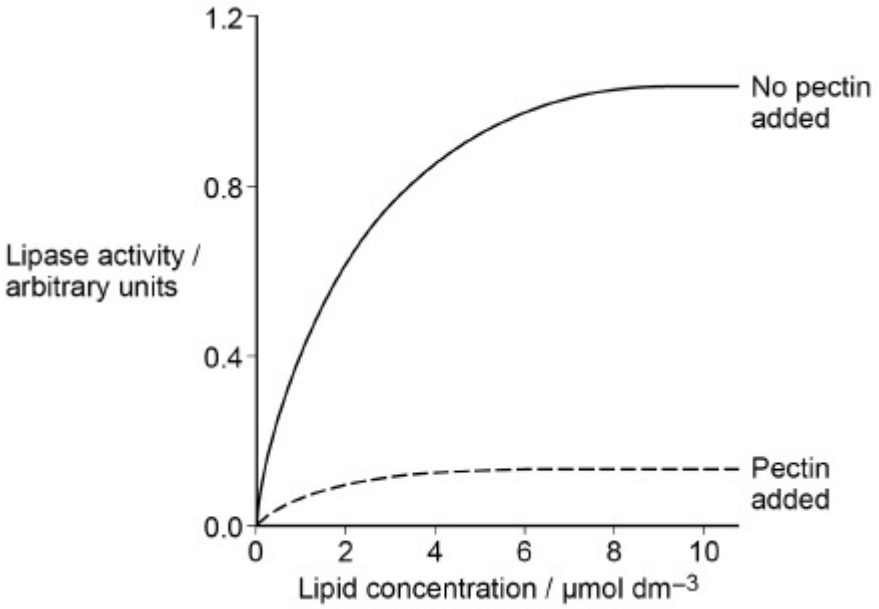
(3)

Pectin is a substance found in some fruit and vegetables.

A scientist investigated the effect of pectin on the hydrolysis of lipids by a lipase enzyme.

His results are shown in **Figure 1**.

Figure 1



(b) The scientist concluded that pectin is a non-competitive inhibitor of the lipase enzyme.

Use **Figure 1** to explain why the scientist concluded that pectin is a **non-competitive** inhibitor.

_____

_____

_____

_____

_____

(1)

Q9.

(a) Describe how a peptide bond is formed between two amino acids to form a dipeptide.

_____

_____

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_____

(2)

(b) The secondary structure of a polypeptide is produced by bonds between amino acids.

Describe how.

(2)

(c) Two proteins have the same number and type of amino acids but different tertiary structures.

Explain why.

_____

_____

(2)

(Total 6 marks)

Q10.

(a) Formation of an enzyme-substrate complex increases the rate of reaction.

Explain how.

_____

_____

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(2)

(b) A scientist measured the rate of removal of amino acids from a polypeptide with and without an enzyme present. With the enzyme present, 578 amino acids were released per second. Without the enzyme, 3.0×10^{-9} amino acids were released per second.

Calculate by how many times the rate of reaction is greater with the enzyme present.
Give your answer in standard form.

Answer = _____ times faster

(2)

Another scientist investigated an enzyme that catalyses the following reaction.

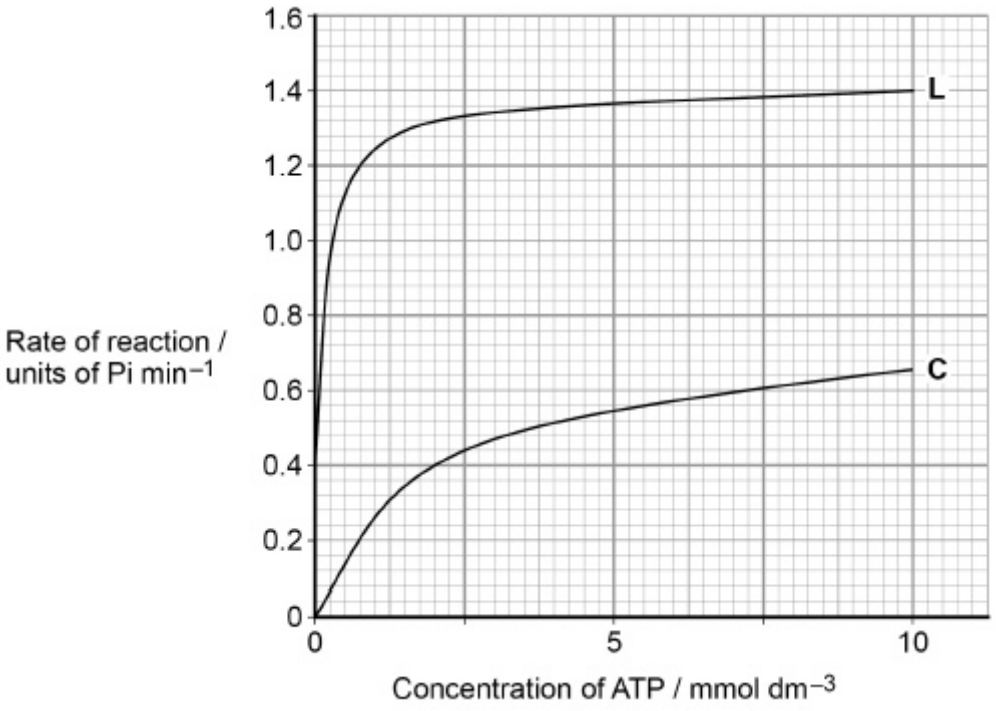
$$ATP \longrightarrow ADP + Pi$$

The scientists set up two experiments, **C** and **L**.

Experiment **C** used
- the enzyme
- different concentrations of ATP.

Experiment **L** used
- the enzyme
- different concentrations of ATP
- a sugar called lyxose.

The scientists measured the rate of reaction in each experiment. Their results are shown in the graph.



(c) Calculate the rate of reaction of the enzyme activity with no lyxose at 2.5 mmol dm^{-3} of ATP as a percentage of the maximum rate shown with lyxose.

Answer = _____ %

(2)

(d) Lyxose binds to the enzyme.

Suggest a reason for the difference in the results shown in the graph with and without lyxose.

_____

_____

_____

_____

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(3)

(Total 9 marks)

Q11.

(a) Draw the general structure of an amino acid.

(1)

Table 1 shows mRNA codons and the amino acids coded for by each codon. It also shows some properties of the R group of each amino acid.

Table 1

1st base	2nd base				3rd base
	U	C	A	G	
U	Phe	Ser	Tyr	Cys	U
					C
	Leu		Stop	Stop	A
				Trp	G
C	Leu	Pro	His	Arg	U
					C
			Gin		A
					G
A	Ile	Thr	Asn	Ser	U
					C
			Lys	Arg	A
	Met				G
G	Val	Ala	Asp	Gly	U
					C
			Glu		A
					G

Key to the properties of the R group of each amino acid

No overall change Positively charged Negatively charged

(b) The genetic code is described as degenerate.

What is meant by this? Use an example from **Table 1** to illustrate your answer.

_____

_____

(2)

A scientist investigated changes in the amino acid sequence of a human enzyme resulting from mutations. All these amino acid changes result from single base substitution mutations.
This enzyme is a polypeptide 465 amino acids long.

Table 2 shows the result of three of the base substitutions.

Table 2

Amino acid number	Correct amino acid	Amino acid inserted as a result of mutation
203	Val	Ala
279	Glu	Lys
300	Glu	Lys

(c) What is the minimum number of bases in the gene coding for this polypeptide?

Answer = _____

(1)

(d) Use information from **Table 1** to tick (✓) one box that shows a single base substitution mutation in DNA that would result in a change from Val to Ala at amino acid number 203

CAA ⟶ CGA ☐

GUU ⟶ GCA ☐

GUU ⟶ GUC ☐

CAC ⟶ CGG ☐

(1)

(e) A change from Glu to Lys at amino acid 300 had no effect on the rate of reaction catalysed by the enzyme. The same change at amino acid 279 significantly reduced the rate of reaction catalysed by the enzyme.

Use all the information and your knowledge of protein structure to suggest reasons for the differences between the effects of these two changes.

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_____

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(3)

(Total 8 marks)

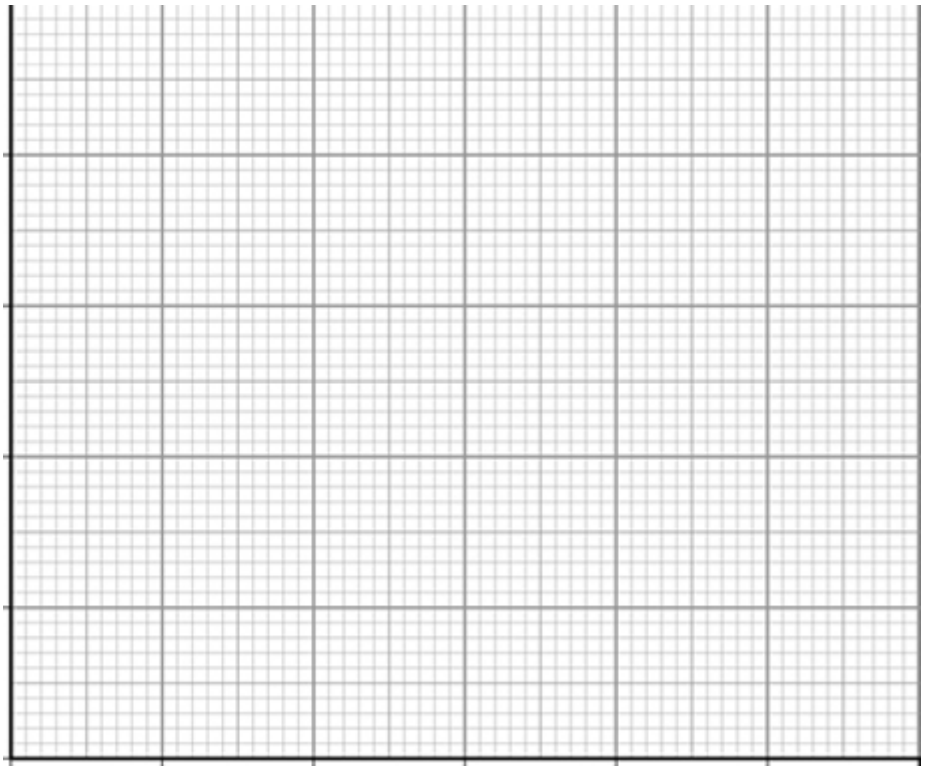
Q12.

A biochemist isolated a protease from a bacterium. He investigated the effect of temperature on the rate of hydrolysis of a protein by this protease. He measured the mass of protein hydrolysed in **5 minutes** at each temperature.

The results are shown in the table below.

Temperature / °C	Mass of protein hydrolysed / g	Rate of hydrolysis / $\frac{\quad}{\quad}$
5	0.48	
10	1.11	
15	1.23	
20	1.05	
30	0.78	
45	0.12	

(a) Process the data in the table. Plot the processed data on the graph paper.



(4)

(b) A student concluded from a graph of the data in the table that the bacterium lives at 15 °C.

Does the data support the student's conclusion? Give reasons for your answer.

_____

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(c) Suggest **two** variables the biochemist controlled when investigating the effect of temperature on the rate of breakdown of a protein by the protease.

1. _____

2. _____

(1)

(Total 9 marks)