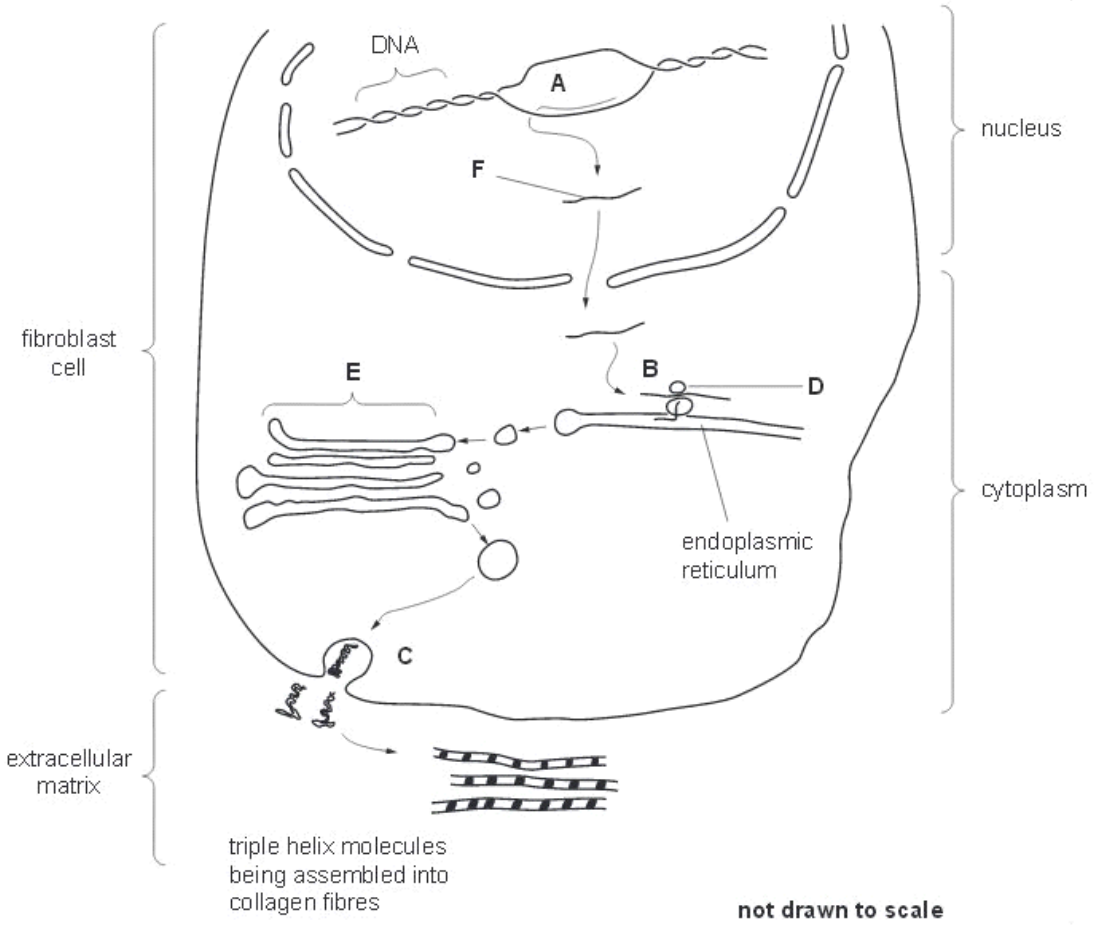
Q1.

4 Collagen is found in the extracellular matrix of muscles, tendons, ligaments and bones. Fibroblast cells in these tissues make collagen by synthesising polypeptides that form molecules with a triple helix shape. These are secreted from fibroblasts into the extracellular matrix where enzymes assemble them into collagen fibres.

Fig. 4.1 is a diagram summarising these events.



(a) (i) Name the processes occurring at **A**, **B** and **C**.

A .....

B .....

C ..... [3]

(ii) Name structures **D** and **E**.

D .....

E ..... [2]

(iii) Name molecule **F**.

F ..... [1]

Collagen is continuously broken down in the extracellular matrix by the enzyme collagenase, which catalyses the hydrolysis of the peptide bond between the amino acids glycine and isoleucine.

(b) Suggest how collagenase is only able to act on the peptide bond between glycine and isoleucine and not on peptide bonds between any other amino acids.

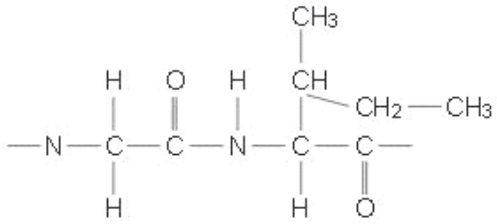
.....

.....

.....

..... [2]

(c) Draw a diagram below to show how the peptide bond between glycine and isoleucine is broken by hydrolysis including the product or products.



[3]

[Total: 11]

Q2.

The activity of urease can be measured by following the increase in pH as ammonia is produced in the reaction. A student was provided with urease extracted from bacteria and solutions of urea and two chemical inhibitors, thiourea and lead nitrate. The student prepared six reaction mixtures (**1** to **6**) as shown in Table 5.1 in order to investigate the effect of the two chemical inhibitors on the activity of urease.

Table 5.1

reaction mixture	urea	water	thiourea	lead nitrate	urease	boiled urease
1	✔	✔	✘	✘	✔	✘
2	✔	✘	✔	✘	✔	✘
3	✔	✘	✘	✔	✔	✘
4	✔	✔	✘	✘	✘	✘
5	✘	✔	✔	✘	✔	✘
6	✔	✔	✘	✘	✘	✔

Key ✔ = present in reaction mixture ✘ = absent from reaction mixture

The student recorded an increase in pH in reaction mixtures **1** and **2**. The reaction was faster in **1** than in **2**. The pH in the other reaction mixtures did not change.

(b) The student made some conclusions about the results from the test-tubes. Match the statements to the reaction mixtures, **1** to **6**. You may use the numbers once, more than once or not at all.

(i) 'No reaction took place because urease was denatured.' ☐ [1]

(ii) 'There was no reaction because there was no substrate for urease.' ☐ [1]

(iii) 'The reaction did not occur because there was an inhibitor present.' ☐ [1]

Thiourea has a molecular structure that is very similar to that of urea. The student designed an experiment to find out whether thiourea is a competitive inhibitor. The student set up several reaction mixtures like **1** using increasing concentrations of urea. The student determined the initial rate of the reaction for urease at each concentration of urea. The results are shown in Fig. 5.1.

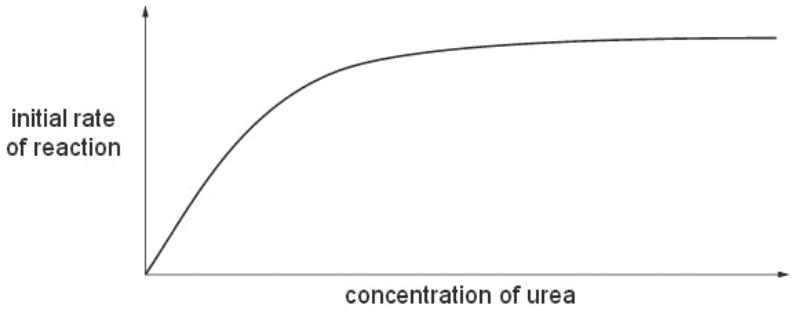


Fig. 5.1

The student then repeated the experiment using the same concentrations of urea. However, the student added the same volume and concentration of a thiourea solution to each test-tube in place of the water.

(c) Sketch a curve on Fig. 5.1 to show the results that the student would expect if thiourea acts as a competitive inhibitor of urease. [2]

(d) Explain why it is important to determine the **initial** rate of reaction when investigating the effect of a competitive inhibitor on an enzyme.

.....

.....

.....

.....[2]

[Total: 10]

Q3.

2 **(a)** Describe how enzymes take part in chemical reactions.

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.....[4]

Starch phosphorylase is an enzyme found in plant cells. In potato tuber cells, the enzyme takes part in the breakdown of starch when the tuber begins to grow.

$$\text{starch} + \text{phosphate ions} \xrightarrow{\text{starch phosphorylase}} \text{glucose 1-phosphate}$$

A student investigated the effect of pH on this reaction using two buffer solutions.

The student prepared four test-tubes, **A** to **D**, as shown in Table 2.1 and described below.

The student made an extract of potato tissue that contained the enzyme. Some of this extract was boiled.

A solution of potassium dihydrogen phosphate was added to some tubes as a source of phosphate ions.

The test-tubes were left for ten minutes in a water bath at 30 °C and then samples were tested with iodine solution.

Table 2.1

test-tube	contents					results with iodine solution after ten minutes
	volume of starch solution / cm^3	volume of glucose 1-phosphate solution / cm^3	volume of potassium dihydrogen phosphate solution / cm^3	pH of buffer solution	enzyme extract	
A	2		0.5	6.5	unboiled	negative
B	2		0.5	2.0	unboiled	positive
C	2		0.5	6.5	boiled	positive
D		2		6.5	boiled	negative

(b) (i) State what the student would conclude from a positive result with iodine solution.

.....[1]

(ii) Explain why the student boiled some of the extract in this investigation.

.....

.....

.....

.....[2]

(c) Explain the results shown in Table 2.1.

.....

.....

.....

.....

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.....

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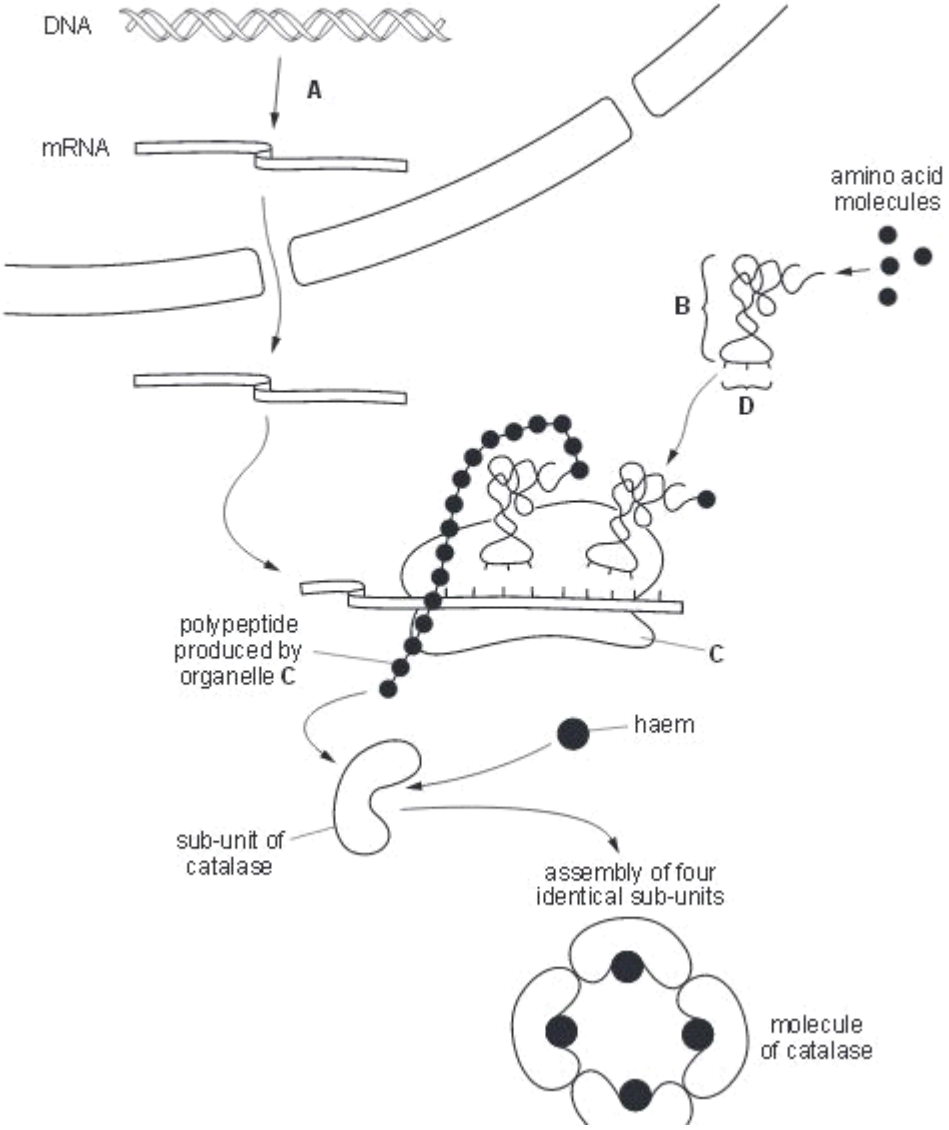
.....[4]

[Total: 11]

Q4.

4 Catalase is an enzyme with a molecular structure composed of four identical sub-units.

Fig. 4.1 is a diagram that shows how catalase is produced in cells.



(a) With reference to Fig. 4.1,

For Examiner Use

(i) name

process **A** .....

molecule **B** .....

structure **C** .....

sequence of bases **D** .....[4]

(ii) state two ways in which the structure of catalase is similar to the structure of haemoglobin and one way in which it differs

structural similarities

1. .....

2. .....[2]

structural difference

.....[1]

(iii) State why it is possible for a catalase molecule to bind to four substrate molecules at the same time.

.....[1]

(b) The enzyme amylase catalyses the following reaction:

starch + water $\longrightarrow$ maltose

The progress of this reaction may be followed by measuring either the starch concentration or the maltose concentration at intervals of time.

State which chemicals you would use to detect the disappearance of the substrate and the appearance of the product, in order to follow the progress of the reaction.

disappearance of substrate .....

.....

appearance of product .....

.....[2]

[Total: 10]

Q5.

(c) The reaction shown in Fig. 1.1 is catalysed by the enzyme sucrase. Fig. 1.2 shows an enzyme-catalysed reaction.

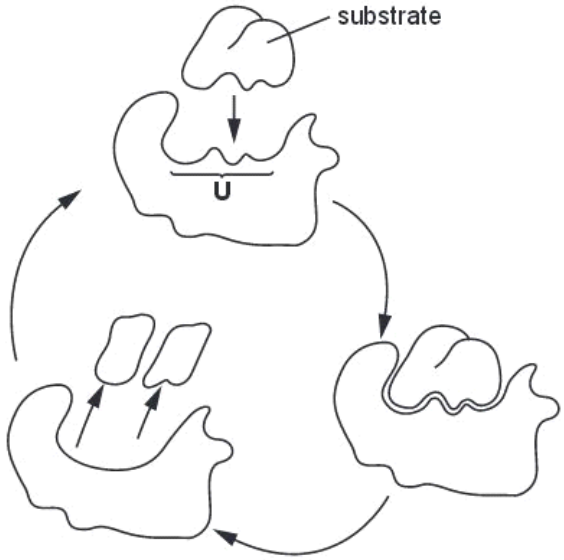


Fig. 1.2

(i) Name the part of the enzyme labelled **U**.

.....[1]

(ii) With reference to Fig. 1.2, explain the mode of action of enzymes.

.....

.....

.....

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.....[4]

Q6.

(c) The enzyme urease is known to be affected by competitive inhibitors. A student carried out an investigation to determine the percentage of urea hydrolysed by urease at various time intervals

- without any inhibitor
- with a competitive inhibitor.

The experiment was carried out in test tubes set up as follows:

Tube **A** – 1 cm^3 of urease solution, 10 cm^3 pH 7.5 buffer solution, 1 cm^3 urea solution.
Tube **B** – 1 cm^3 urease solution, 9 cm^3 pH 7.5 buffer solution, 1 cm^3 inhibitor, 1 cm^3 urea solution.
Tube **C** – 1 cm^3 water, 10 cm^3 pH 7.5 buffer solution, 1 cm^3 urea solution.

The results are shown in the table below.

time/min	percentage of urea remaining		
	Tube **A**	Tube **B**	Tube **C**
0	100	100	100
5	55	99	100
10	29	98	100
15	14	96	100
20	8	95	100
25	5	92	100
30	3	90	100

(i) State how Tube **C** acts as a control for this investigation.

.....

.....[1]

(ii) Explain the difference in results between Tube **A** and Tube **B**.

.....

.....

.....

.....

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.....

.....[4]

Q7.

4 The enzyme sucrase catalyses the breakdown of the glycosidic bond in sucrose.

A student investigated the effect of increasing the concentration of sucrose on the rate of activity of sucrase.

Ten test-tubes were set up with each containing $5\,cm^3$ of different concentrations of a sucrose solution. The test-tubes were placed in a water bath at 40 °C for ten minutes. A flask containing a sucrase solution was also put into the water bath.

After ten minutes, $1\,cm^3$ of the sucrase solution was added to each test-tube. The reaction mixtures were kept at 40 °C for a further ten minutes.

After ten minutes, the temperature of the water bath was raised to boiling point. Benedict's solution was added to each test-tube. The time taken for a colour change was recorded and used to calculate rates of enzyme activity.

The results are shown in Fig. 4.1.

The results are shown in Fig. 4.1.

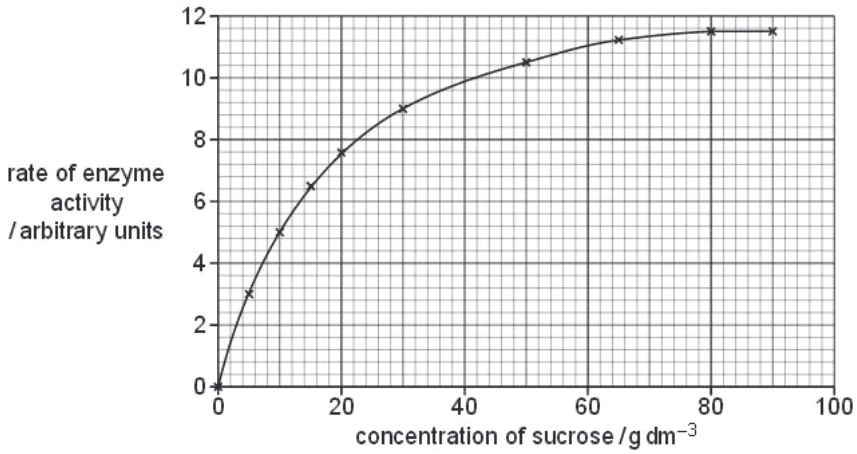

Fig. 4.1

(a) (i) Name the type of reaction catalysed by sucrase.

.....[1]

(ii) Explain why the temperature of the water was raised to boiling point.

.....

.....

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.....[2]

(b) Describe **and** explain the results shown in Fig. 4.1.

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.....[5]

[Total: 8]

Q8.

A student carried out an investigation into the digestion of triglycerides using lipase.

Ten cm^3 of olive oil, adjusted to pH 8.0, was added to a test-tube, which was then put in a water bath at 37 °C for ten minutes.

One cm^3 of lipase solution was incubated at the same temperature in a separate test-tube before being added to the olive oil.

The initial pH of the reaction mixture was measured using a pH meter. The pH was recorded at five minute intervals for 60 minutes.

(c) Suggest why the olive oil was adjusted to pH 8.0 before the lipase was added.

.....[1]

(d) Fig. 5.2 shows the results of the investigation.

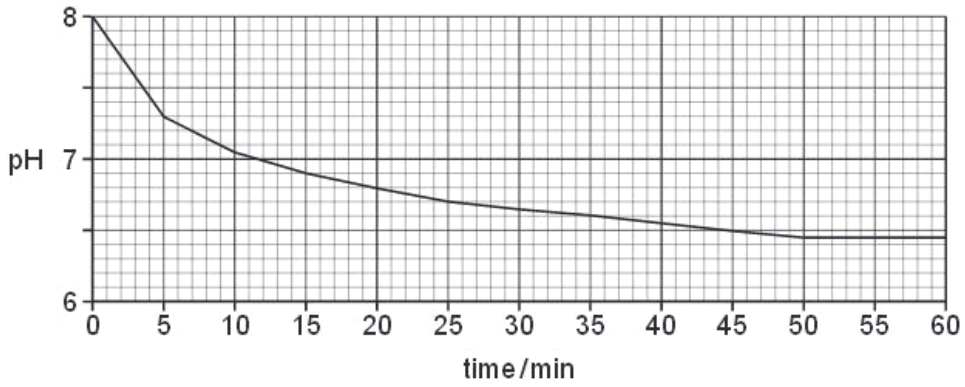

Fig. 5.2

With reference to Fig. 5.2,

(i) describe the results of the investigation

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.....

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.....

.....

.....[2]

(ii) explain the results of the investigation.

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.....[4]

Q9.

4 Penicillin is an antibiotic that interferes with the synthesis of cell walls in bacteria. Even before penicillin became widely available in the 1940s, the enzyme penicillinase which breaks down penicillin had been isolated. This enzyme is now found in many bacteria and gives them resistance to penicillin.

Fig. 4.1 is a ribbon model of the structure of the enzyme penicillinase. The arrow indicates the active site of the enzyme.

Fig. 4.1

(a) Explain why the shape of the active site of an enzyme, such as penicillinase, is important.

.....

.....

.....

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.....

.....[3]

(b) With reference to Fig. 4.1, identify the aspects of protein structure that are shown and those that are **not** shown.

aspects of protein structure shown

.....

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.....

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aspects of protein structure not shown

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.....[3]

Fig. 4.2 shows the changes in energy during the progress of an uncatalysed reaction.

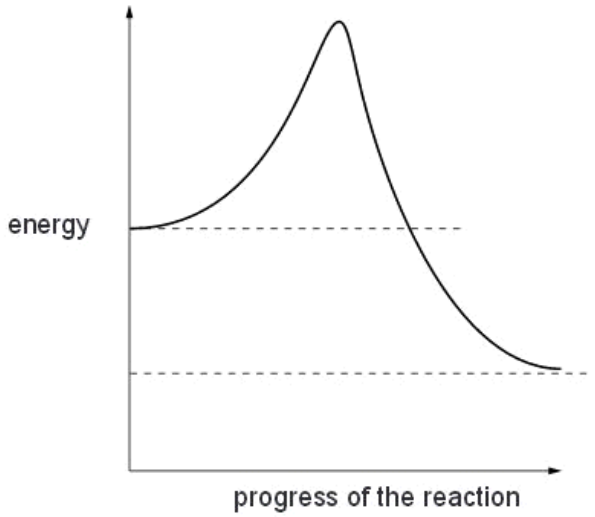

Fig. 4.2

(c) **(i)** Draw on Fig. 4.2 a curve to show changes in energy during the progress of the same reaction when catalysed by an enzyme. [2]

(ii) State the term given to the energy level that must be overcome before a reaction can progress.

.....[1]

(d) Antibiotic resistance is a serious worldwide problem.

Suggest how antibiotics can be used effectively to avoid the development of widespread resistance in bacteria.

.....

.....

.....

.....[2]

[Total: 11]

Q10.

(d) Freezing temperatures can also completely stop enzyme activity by causing the molecules to undergo 'cold denaturation'. Enzyme activity is not recovered when temperatures are increased to a normal working temperature range.

(i) Explain the mode of action of enzymes.

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.....

..... [3]

(ii) Suggest how the molecular structure of the enzyme changes during 'cold denaturation'.

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..... [2]

(e) Cryoprotectants, such as trehalose, are of particular interest in their application to preserving cells, tissues or organisms for future use.

An investigation was carried out to find the protective effect given by different concentrations of two cryoprotectants, trehalose and glycerol, on a respiratory enzyme.

The enzyme was subjected to a freezing temperature and then returned to its optimum temperature. The activity of the enzyme was measured at its optimum temperature.

Fig. 4.2 is a graph showing the results of the investigation.

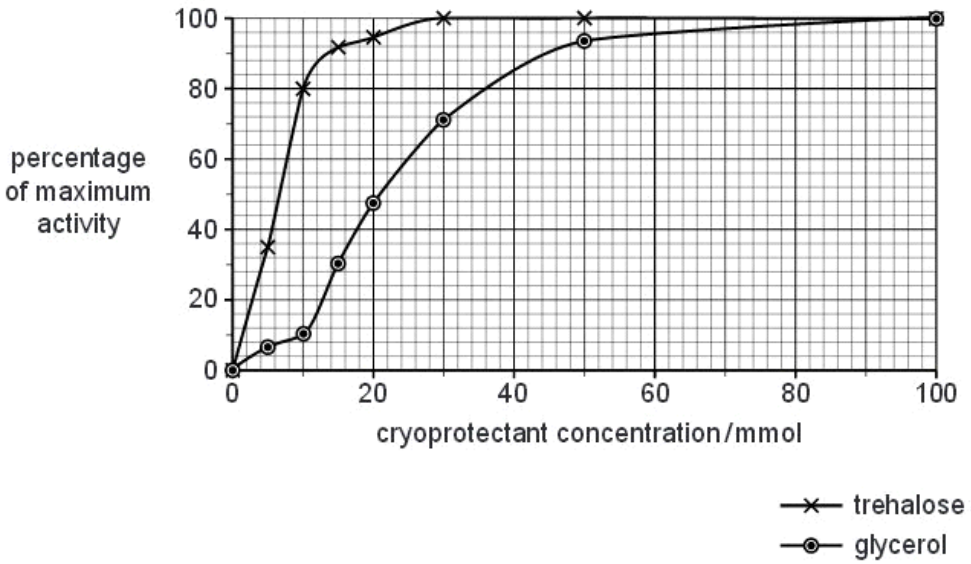

Fig. 4.2

With reference to Fig. 4.2, **describe** the results of the investigation.

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..... [4]

Q11.

4 The enzyme, catechol oxidase, causes a brown colour to develop when slices of many fruits, such as apples, are exposed to air.

The enzyme catalyses the following reaction:

$$\text{catechol} + \text{oxygen} \xrightarrow{\text{catechol oxidase}} \text{quinone} + \text{water}$$

Quinone is then immediately further oxidized in air to a brown-coloured substance. Catechol and quinone are colourless.

A student investigated the rate of this reaction under different conditions.

(a) State how the student could follow the progress of this reaction.

.....

..... [1]

In the first investigation, the student measured the initial rate of the reaction in varying concentrations of catechol. The results are shown in Fig. 4.1.

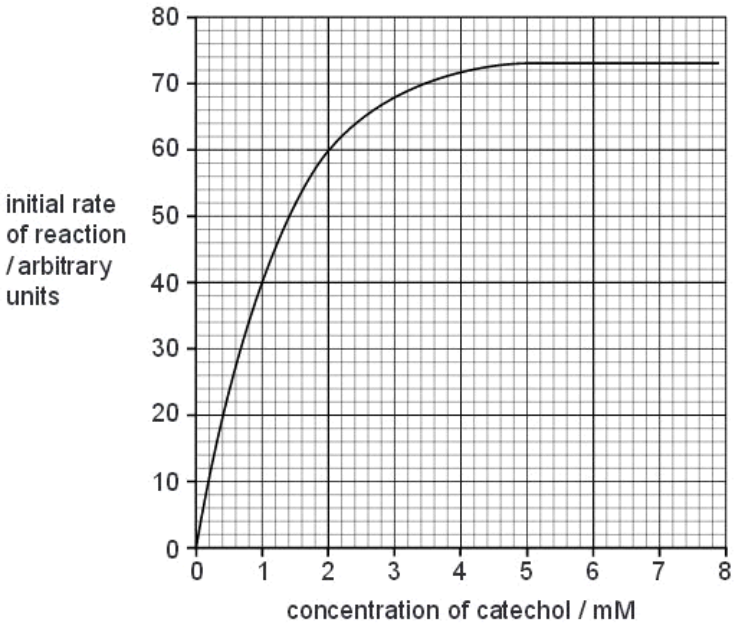

Fig. 4.1

(b) Explain the results shown in Fig. 4.1.

.....

.....

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.....

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.....

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.....

.....

..... [5]

(c) In a second investigation, the student repeated the experiment, but this time added a competitive inhibitor, para-hydroxybenzoic acid (PHBA), to each reaction mixture.

(i) Sketch **on Fig. 4.1** the results that would be obtained for this second investigation. [2]

(ii) Explain the effect that PHBA will have on the action of phenoloxidase.

.....

.....

.....

..... [2]

(d) Lemon juice contains citric acid. Adding even a small amount of diluted lemon juice to apple slices slows the appearance of the brown colour.

Suggest an explanation for this observation.

.....

.....

.....

..... [2]

[Total: 12]

Q12.

4 Enzymes are globular proteins that catalyse specific reactions.

(a) Explain how enzymes catalyse specific reactions.

.....

.....

.....

.....

.....

.....[3]

(b) Restriction enzymes cut DNA into fragments. They cut at specific sites determined by the sequence of bases. Fig. 4.1 shows the base sequences cut by three restriction enzymes and a section of DNA cut by one of these enzymes.

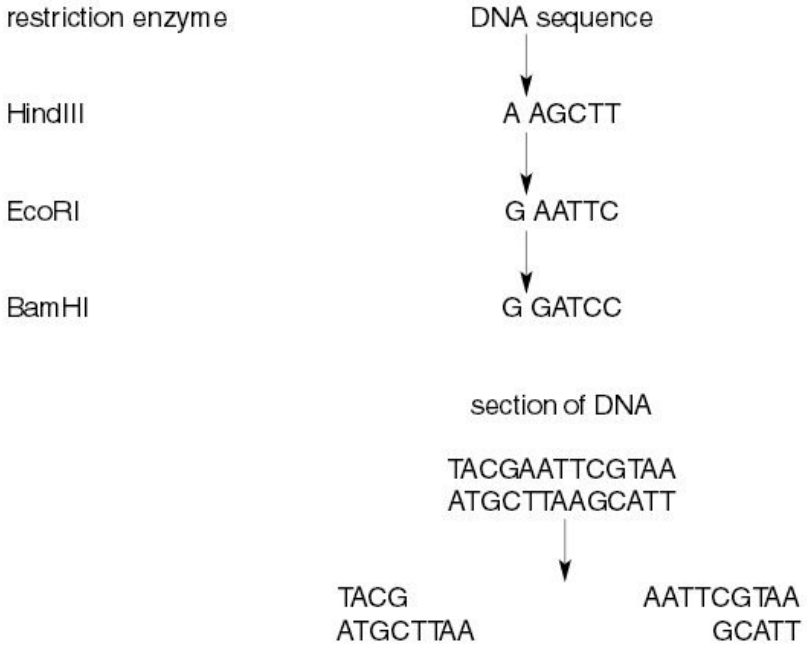

Fig. 4.1

(i) Identify the restriction enzyme that has cut the section of DNA shown in Fig. 4.1.

.....[1]

(ii) State the name given to the unpaired base sequences that remain after DNA has been cut by the three restriction enzymes shown in Fig. 4.1.

.....[1]

(c) Human genes may be cloned by inserting lengths of DNA into bacteria. This may be carried out by inserting the DNA into a plasmid.

Explain how lengths of DNA, cut by restriction enzymes, are inserted into plasmids.

.....

.....

.....

.....

.....

.....[3]

[Total : 8]

Q13.

5 Enzymes catalyse reactions in which substrate molecules are converted to products.

(a) There are two main approaches to investigation of the activity of an enzyme. State the two ways in which the activity of an enzyme can be found.

1 .....

.....

2 .....

.....[2]

Phosphatase enzymes remove phosphate groups from a wide range of organic compounds that contain phosphate. This makes available a supply of phosphate ions within cells. The reaction catalysed by phosphatase enzymes is as follows:

$$XPO_4 \xrightarrow{\text{phosphatase enzyme}} X + PO_4^{3-}$$

X = an organic compound

The activity of phosphatase was measured at different values of pH by using nine different buffer solutions. The temperature was kept constant at 30 °C. The results are shown in Fig. 5.1.

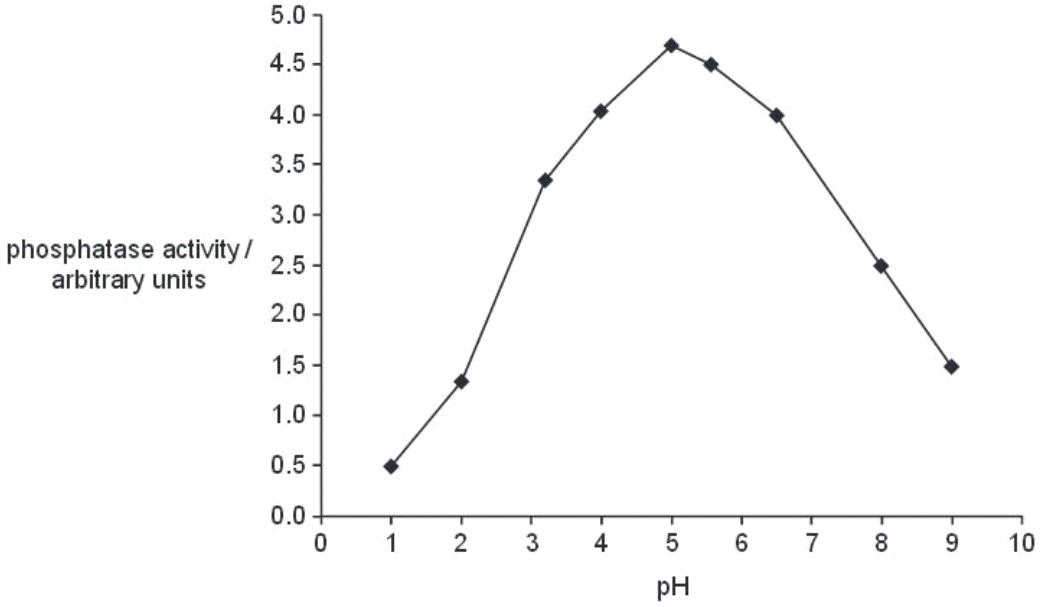

Fig. 5.1

(b) Using the data in Fig. 5.1, describe the effect of pH on the activity of phosphatase.

.....

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.....

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.....

.....[3]

(c) Explain why the activity of phosphatase is very low at pH 1.

.....

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.....

.....[4]

(d) Draw a curve on Fig. 5.1 to show the results you would expect if the experiment was repeated in exactly the same way but at a temperature of 20 °C. [2]

(e) Explain how competitive inhibitors affect the activity of enzymes, such as phosphatase.

.....

.....

.....

.....

.....

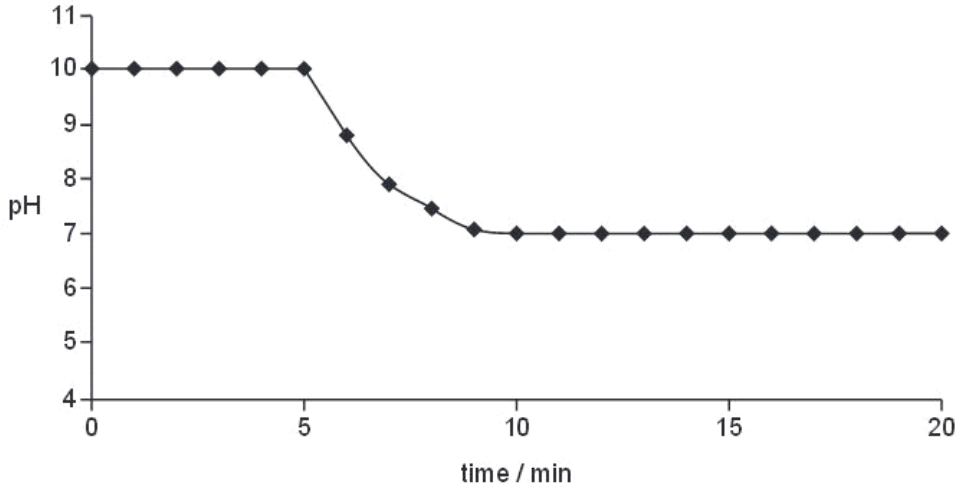
.....[3]

[Total : 14]

Q14.

The enzyme lipase catalyses the hydrolysis of ester bonds in triglycerides. As the reaction proceeds there is a decrease in pH. The progress of the reaction may be followed by using a pH meter.

A solution containing tristearin was placed in a water bath at 25 °C. When the solution had reached this temperature, lipase was added and the mixture stirred. The pH of the reaction mixture was recorded every minute for 20 minutes. The results are shown in Fig. 2.2.



(d) Using the data in Fig. 2.2, state the time when

(i) lipase was added;

.....[1]

(ii) the reaction ended.

.....[1]

(e) Explain why the pH decreases during this reaction.

.....

.....[1]

(f) A similar solution was placed in a water bath at 35 °C and left for the same length of time to reach this temperature. Lipase was added as before.

Sketch on Fig. 2.2 the results that you would expect. [2]

Q15.

3 Trypsin is a protease enzyme, which hydrolyses protein molecules, such as albumen, to amino acids.

A student investigated the effect of substrate concentration on the activity of trypsin. Six different concentrations of albumen were prepared and trypsin was added to each in turn. The student measured the time for albumen to break down and then calculated the rate of reaction. The investigation was carried out at 35 °C.

The student's results are shown in Fig. 3.1.

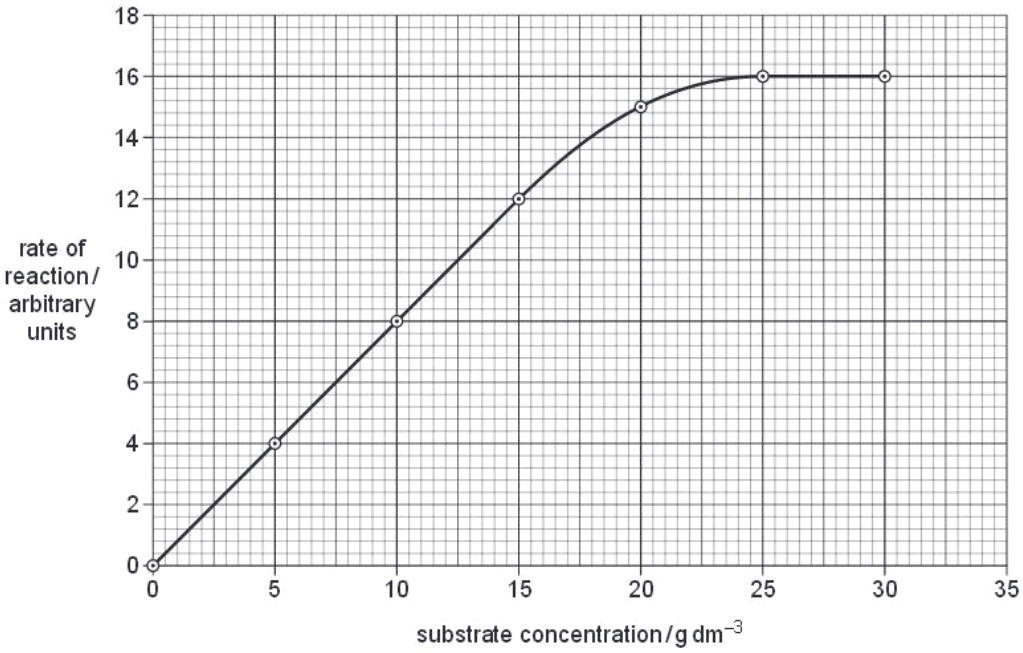


Fig. 3.1

(a) Explain the results shown in Fig. 3.1.

.....

.....

.....

.....

.....

..... [3]

(b) The student repeated the investigation at 25 °C.

Draw on Fig. 3.1 a curve to show the results that you would expect. [2]

During infections of the lungs, phagocytes move from the blood to the lining of the alveoli.

Phagocytes release the enzyme elastase (a protease) in order to digest a pathway through the alveolar wall. Most people produce a glycoprotein, alpha 1-antitrypsin (AAT), in the lung which inhibits elastase and so prevents widespread breakdown of alveoli. The inhibitory action of AAT was investigated using the enzyme trypsin.

(c) Describe **one** way in which AAT may act to inhibit the enzyme elastase.

.....

.....

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.....

..... [3]

(d) Explain how you would adapt the student's investigation with trypsin to find out how AAT acts as an inhibitor.

You may use the space below to sketch the graph of the results that you might expect.

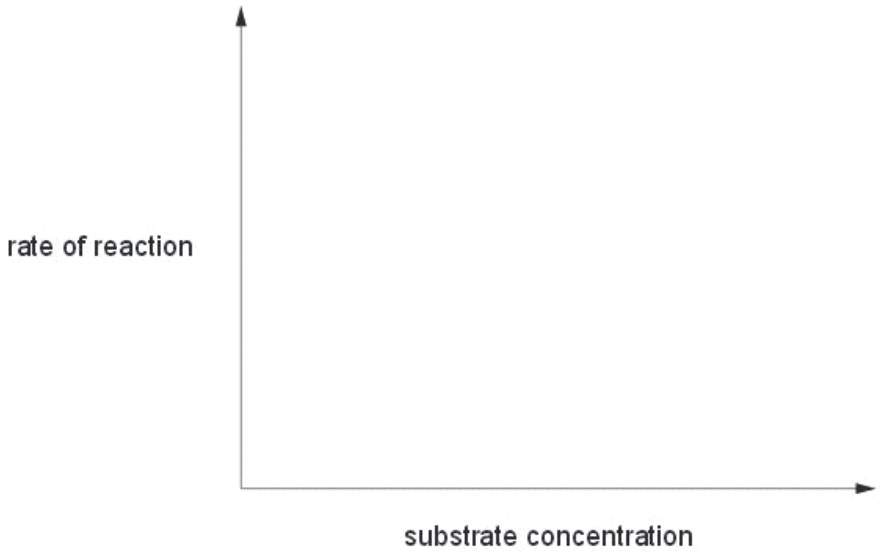
.....

.....

.....

.....

.....



(e) Elastase breaks down the protein elastin. Describe the function of elastin in the lungs.

.....

.....

.....

.....

..... [2]

(f) Tobacco smoke inactivates AAT. In long-term smokers this can result in the breakdown of much of the elastin in the lungs.

State the name of the condition that results from breakdown of elastin that occurs in some long-term smokers.

..... [1]

[Total: 15]

Q16.

3 Lysozyme is an enzyme found in many places within the human body. It consists of a single polypeptide folded into a complex shape.

Fig. 3.1 shows a ribbon model of lysozyme.

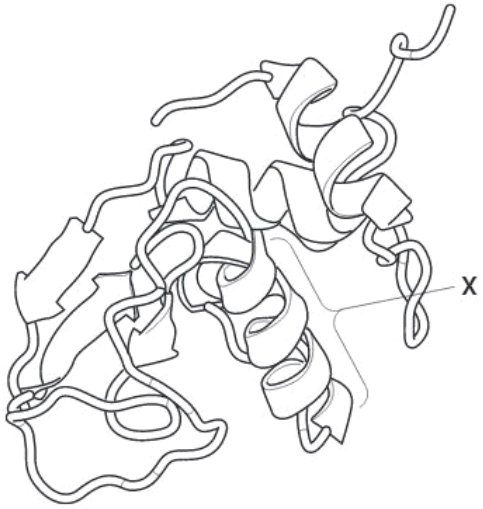


Fig. 3.1

(a) With reference to Fig. 3.1, state the name given to the level of organisation shown,

(i) by the whole polypeptide

..... [1]

(ii) at region **X**.

..... [1]

(b) Name the part of the enzyme where the reaction occurs.

..... [1]

(d) In an investigation of the effects of lysozyme, researchers isolated the enzyme from mice to find how effective the enzyme was at destroying bacteria. Lysozyme catalyses the hydrolysis of glycosidic bonds in certain polysaccharides found in the cell walls of some bacteria. Ex

Four different concentrations of lysozyme were made. Two pathogenic bacteria, *Escherichia coli* and *Staphylococcus aureus*, were incubated in each concentration for three hours at 37 °C. At the end of the incubation, the researchers determined the number of bacteria still alive and expressed their results as percentages of the number of bacteria present at the start of the incubation.

The results are shown in Fig. 3.3.

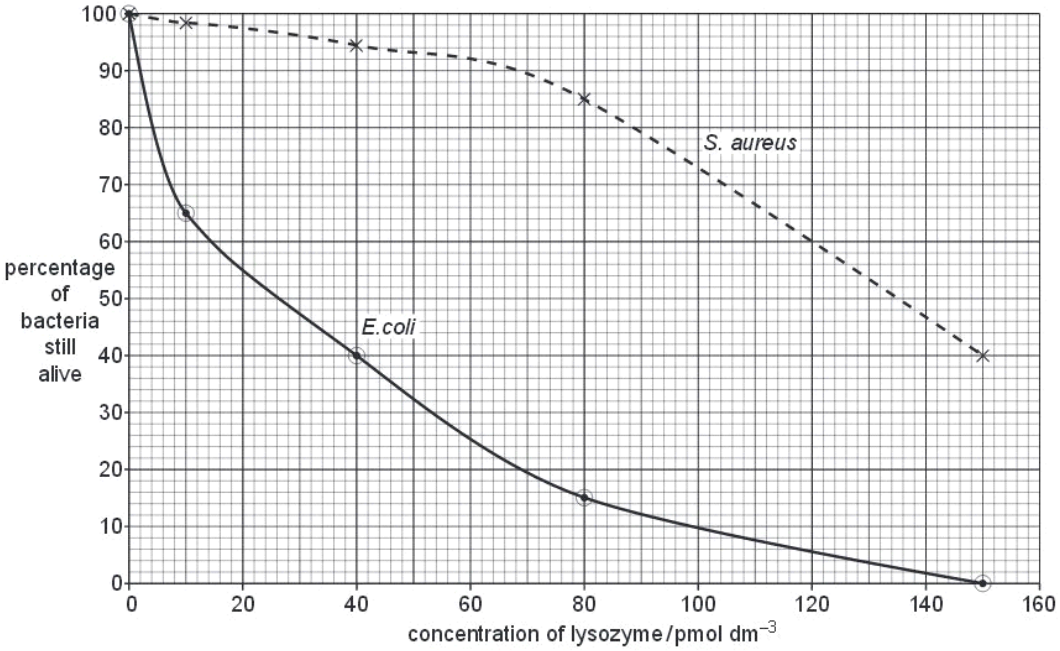


Fig. 3.3

(i) Using the information in Fig. 3.3, describe the effect of the different concentrations of lysozyme on *E. coli* and *S. aureus*.

.....

.....

.....

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.....

.....

..... [4]

(ii) Suggest a possible explanation for the different effects of lysozyme on *E. coli* and *S. aureus*.

.....

.....

.....

..... [2]

Q17.

2 Amylase is an enzyme that catalyses the hydrolysis of starch. A student investigated the effect of pH on the activity of the enzyme.

Eight test-tubes were set up each containing 5 cm^3 of the same concentration of amylase solution but in buffer solutions of different pH values. The test-tubes were left in a water-bath at 30 °C for 10 minutes.

After 10 minutes, 5 cm^3 of a starch suspension at 30 °C was added to each test-tube. Immediately, the student took a sample from each test-tube and tested the reaction mixture for the presence of starch. Samples were then taken every minute for 10 minutes and tested in the same way.

The student's results are shown in Table 2.1.

Table 2.1

pH	time / min										
	0	1	2	3	4	5	6	7	8	9	10
2.0	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
3.0	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗
4.0	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✗
5.0	✓	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗
6.0	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗
7.0	✓	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗
8.0	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗
9.0	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

key
✓ = starch present
✗ = starch absent

(a) Describe how the student would test for the presence of starch.

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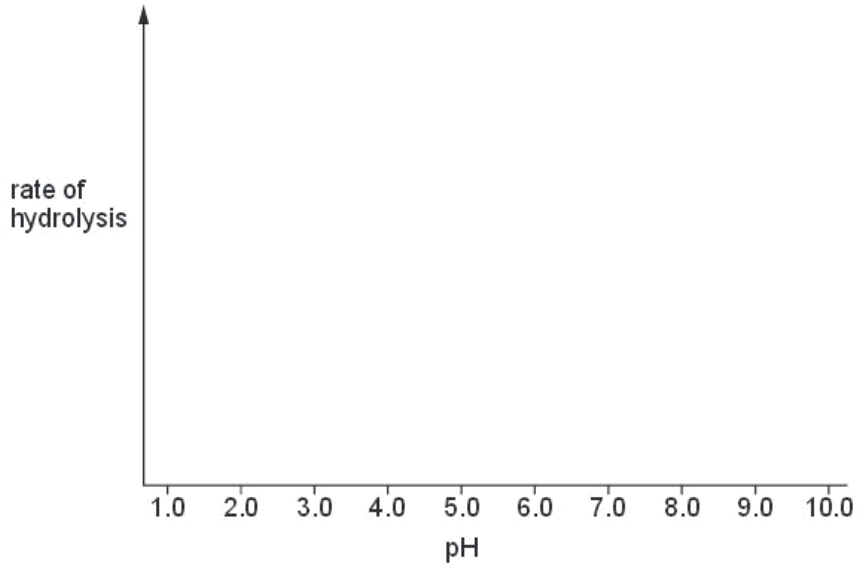
.....[2]

(b) Use the axes below to sketch a graph to show the effect of pH on the **rate of hydrolysis** of starch by amylase.



[2]

(c) With reference to the student's results, describe **and** explain the effect of pH on the rate of hydrolysis of starch by amylase.

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[Total: 9]

Q18.

2 Sucrase is the enzyme that catalyses the hydrolysis of sucrose. A student investigated the effect of substrate concentration on the activity of this enzyme.

Six test-tubes were set up each containing $10\,cm^3$ of different concentrations of sucrose solutions. The test-tubes were left in a water bath at 30 °C for ten minutes.

After ten minutes, $5\,cm^3$ of a sucrase solution at 30 °C was added to each test-tube and the reaction mixtures were stirred.

After a further five minutes, the temperature of the water-bath was raised to above 85 °C and the same volume of Benedict's solution added to each test-tube in turn. The student recorded the time when a green colour first became visible in each test-tube.

The concentrations used and the student's results are shown in Table 2.1.

Table 2.1

concentration of sucrose / g dm^{-3}	time taken for green colour to appear / s
5	278
10	145
15	95
20	75
50	47
100	45

(a) Explain why the temperature of the water-bath was raised to above 85 °C.

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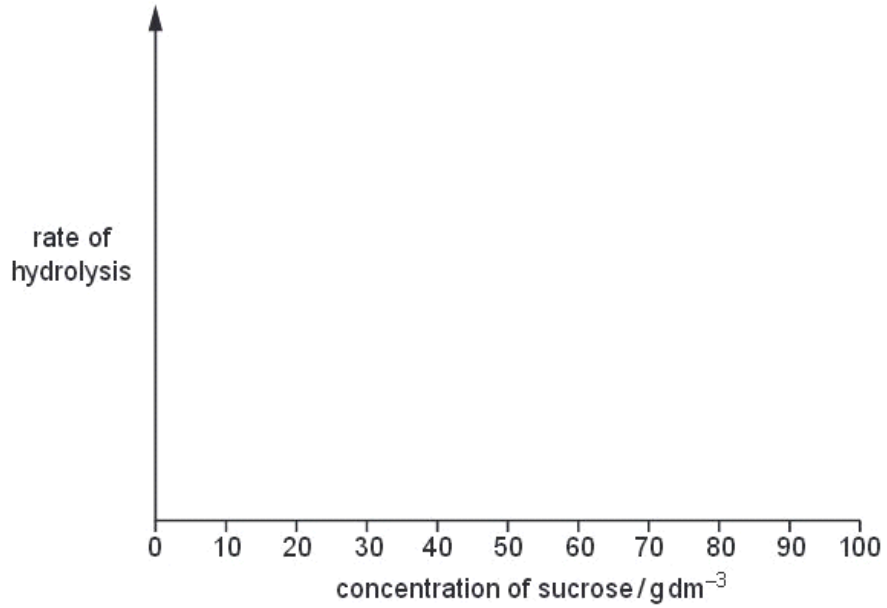
.....[2]

(b) Use the axes below to sketch a graph to show the effect of substrate concentration on the **rate of hydrolysis** of sucrose by sucrase.



[2]

(c) With reference to the student's results, describe **and** explain the effect of increasing substrate concentration on the rate of hydrolysis of sucrose by sucrase.

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[Total: 9]

Q19.

3 **(a)** Enzymes are globular proteins that catalyse metabolic reactions.

Describe the features of globular proteins.

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..... [3]

(b) Enzymes can be used to remove cell walls from plant and fungal cells. The cells are incubated in a solution that contains a mixture of enzymes.

(i) Suggest an explanation for the fact that a different mixture of enzymes is required to remove the walls of plant cells compared to the walls of fungal cells.

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(ii) Explain why, when plant cells are incubated with enzymes to remove their cell walls, it is important to maintain an optimum pH.

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Q20.

3 The enzyme sucrase is used by many organisms for the hydrolysis of sucrose. Fig. 3.1 shows a diagram of the enzyme and its substrate.

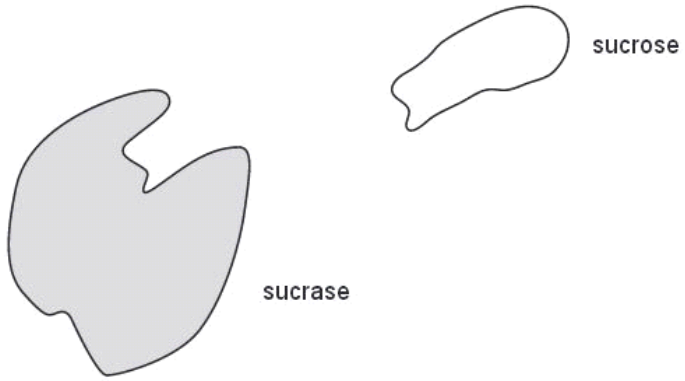

Fig. 3.1

(a) (i) State the names of the products of the hydrolysis of sucrose.

.....[1]

(ii) With reference to Fig. 3.1, describe the mechanism of action of the enzyme in converting the substrate to products.

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.....[4]

(iii) Copper ions (Cu^{2+}) will inhibit the enzyme sucrase.
Suggest which type of inhibition occurs.

.....[1]

(b) Sucrose is one of the assimilates transported in the phloem sieve tubes of plants from source to sink. Sucrase is found in sinks.

(i) Suggest the role played by sucrase in the process of unloading of sucrose at sinks.

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.....[2]

(ii) Plant sink organs convert excess products of sucrose hydrolysis to storage molecules, such as starch.

Explain why these products of hydrolysis themselves cannot be stored in plant tissue.

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.....[3]

[Total: 11]

Q21.

2 A student investigated the initial rate of reaction of catalase in breaking down hydrogen peroxide into oxygen and water:

$$2H_2O_2 \xrightarrow{\text{catalase}} O_2 + 2H_2O$$

The volume of oxygen collected was recorded over a period of 140 seconds. The results are shown in Fig. 2.1.

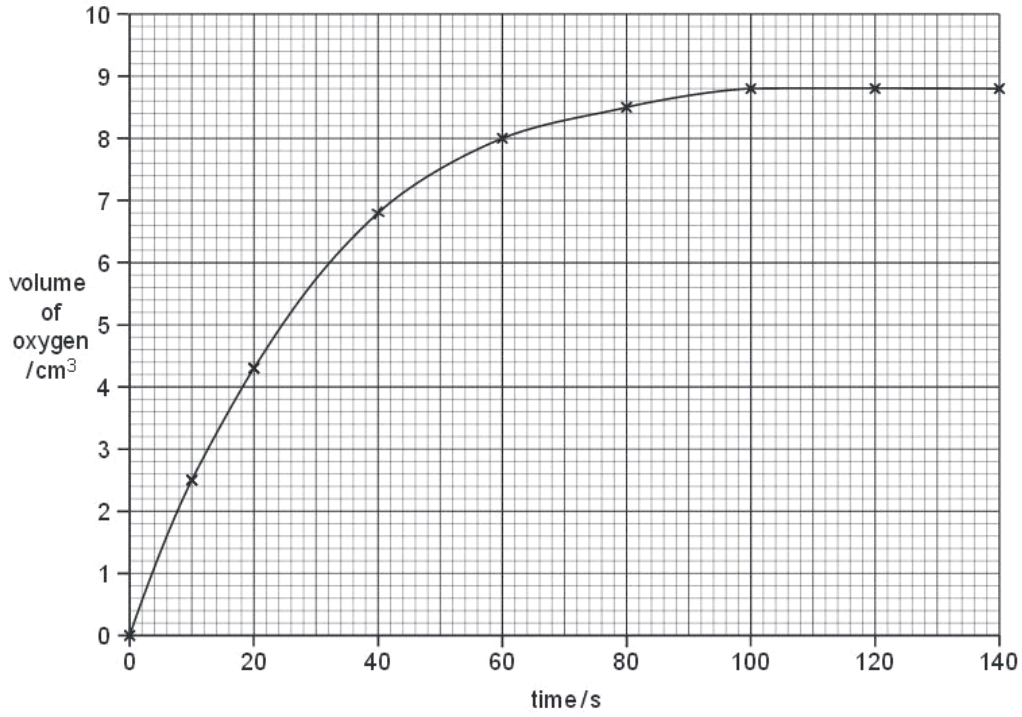

Fig. 2.1

(a) (i) Use the information in Fig. 2.1 to calculate the **initial rate of reaction** in $cm^3\ s^{-1}$.

Show your working.

answer ..... $cm^3\ s^{-1}$ [2]

(ii) Explain the change in volume of oxygen collected as shown in Fig. 2.1.

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The student continued the investigation by determining the initial rates of reaction for five different concentrations of hydrogen peroxide. The line marked **W** in Fig. 2.2 shows the results.

The whole procedure was repeated after adding copper ions to the different concentrations of hydrogen peroxide. The line marked **V** on Fig. 2.2 shows the results.

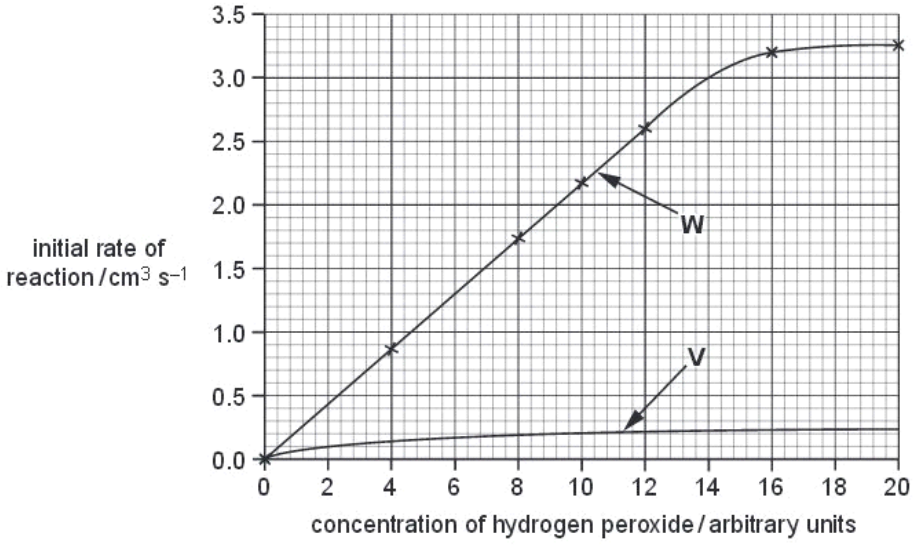

Fig. 2.2

(b) Use the information in Fig. 2.2 to explain the effect of copper ions on the action of an enzyme, such as catalase. [4]

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(c) Enzyme molecules in cells eventually stop working and are broken down.

Outline how cells replace the enzymes that are broken down.

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[Total: 12]

Q22.

(e) DNA polymerase is an enzyme involved in the replication of DNA.

One of the substrates required by DNA polymerase is ATP.

ara-ATP is a chemical that affects DNA polymerase activity.

In an investigation, the effect of different concentrations of ATP on the rate of DNA synthesis was determined:

- with no ara-ATP
- with a low concentration of ara-ATP
- with a high concentration of ara-ATP.

The results of the investigation are shown in Fig. 5.1.

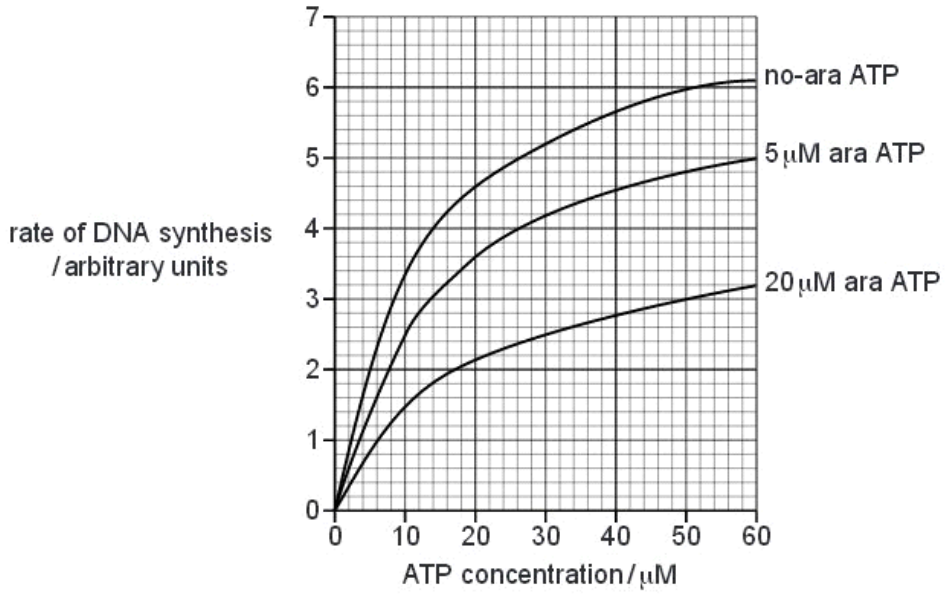

Fig. 5.1

Explain, in terms of the mode of action of enzymes, the results of the investigation shown in Fig. 5.1.

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Q23.

(b) The enzyme nitrogenase is found in free-living and symbiotic nitrogen-fixing bacteria. Nitrogenase catalyses the reaction:

$$N_{2\,(g)} + 6\,e^- + 8H^+_{(aq)} \rightarrow 2NH_4{}^+_{(aq)}$$

Some nitrogenase enzymes have vanadium ions in their active sites; others have molybdenum ions.

Explain how the enzyme nitrogenase functions in the fixation of nitrogen.

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Q24.

(b) Chitin and the products of chitin hydrolysis have many useful medical and environmental applications. Chitinase enzymes can be used commercially to hydrolyse chitin. Enzyme stability and activity are important considerations in technological applications of chitinase.

Fig. 2.2 is a graph showing the effects of temperature on chitinase extracted from a soil bacterium.

The relative activity of the enzyme was measured at different temperatures, with 100% representing maximum enzyme activity.

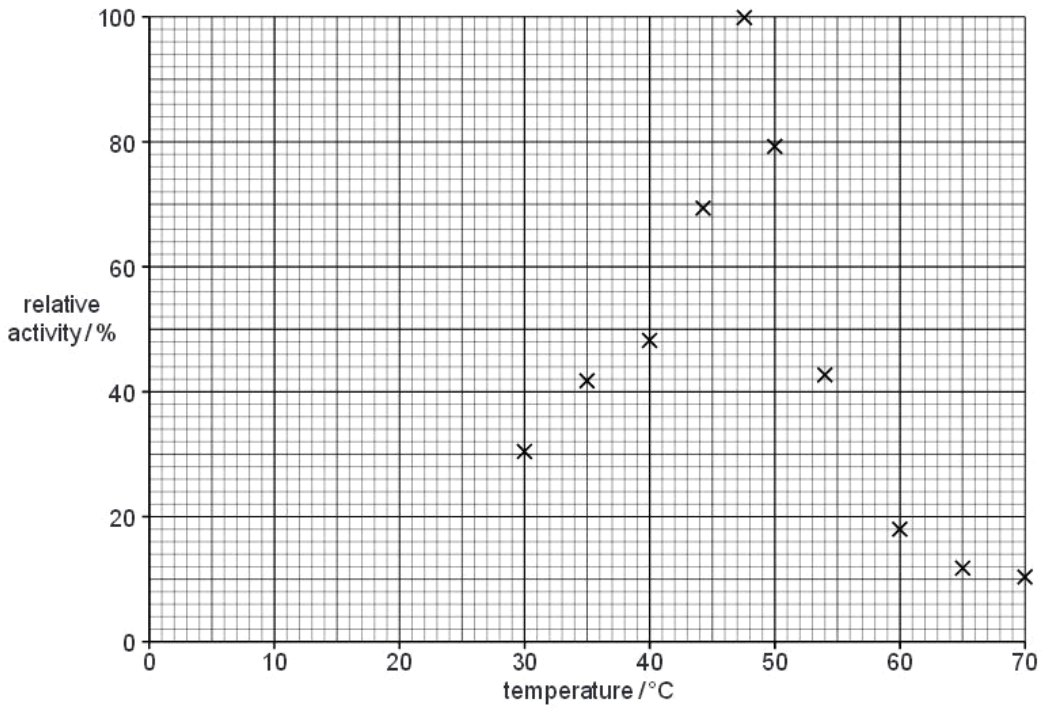

Fig. 2.2

(i) With reference to Fig. 2.2, state the optimum temperature for the chitinase enzyme.

.....[1]

Fig. 2.3 is a graph showing how temperature affects the stability of chitinase. The activity of the enzyme was measured over a time period of 72 hours at each of five different temperatures.

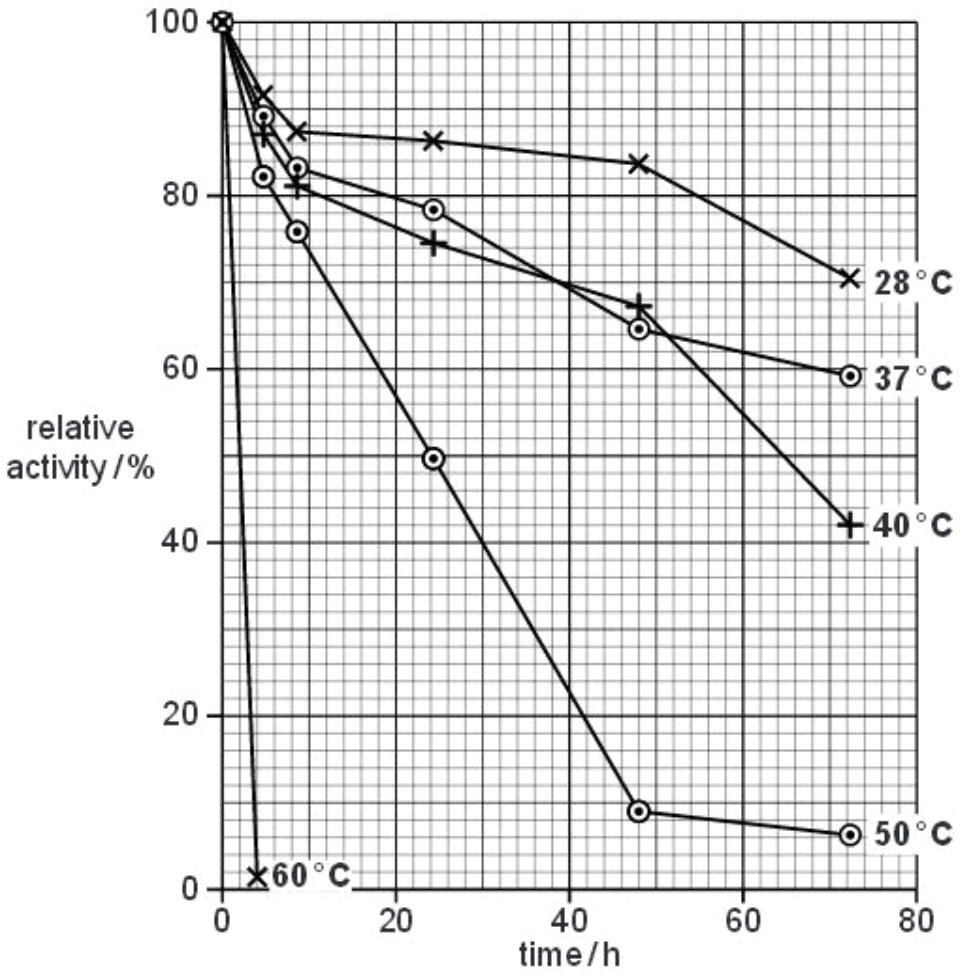
100
80
60
40
20
0
relative activity / %
0
20
40
60
80
time / h
28 °C
37 °C
40 °C
50 °C
60 °C

Fig. 2.3

(ii) With reference to Fig. 2.2 and Fig. 2.3, describe **and** discuss the effect of temperature on chitinase activity **and** stability.

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Q25.

(c) Some enzymes are found in phloem tissue.
Describe how enzymes catalyse reactions.

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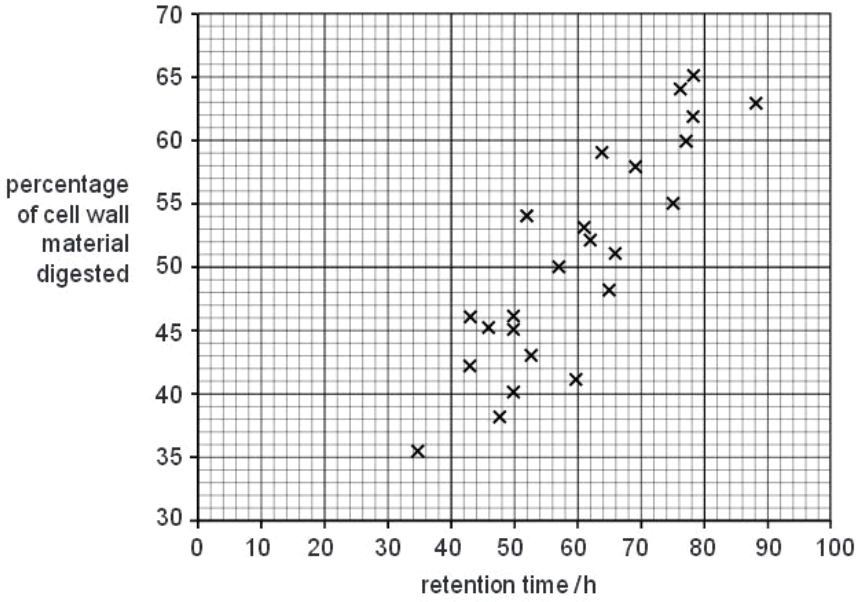
Q26.

Animals do not have the ability to produce enzymes to digest cellulose. Most herbivores have bacteria in their digestive systems that can digest cellulose.

Fig. 5.1 shows the results of a study on 24 different herbivores. The percentage of cell wall material that was digested by each animal was determined. The time taken for the plant material to pass through the digestive system, the retention time, was also recorded.



(b) (i) With reference to Fig. 5.1, describe the results of this study.

For Examiner Use

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