Past Paper Compilation – Enzymes

Paper 1

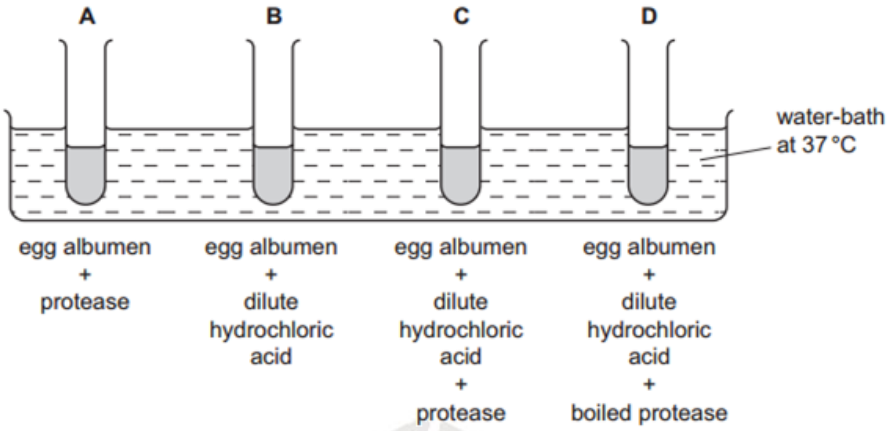
(Paper 2 for Extended Candidates – Revised 2016 Syllabus)

Index

1 The diagram shows an experiment on the digestion of the protein in egg albumen by protease.

The protease was taken from a human stomach.

In which test-tube will the protein be digested most quickly?



2 Which effect does a gradual decrease in pH from 13 to 1 have on the action of amylase?

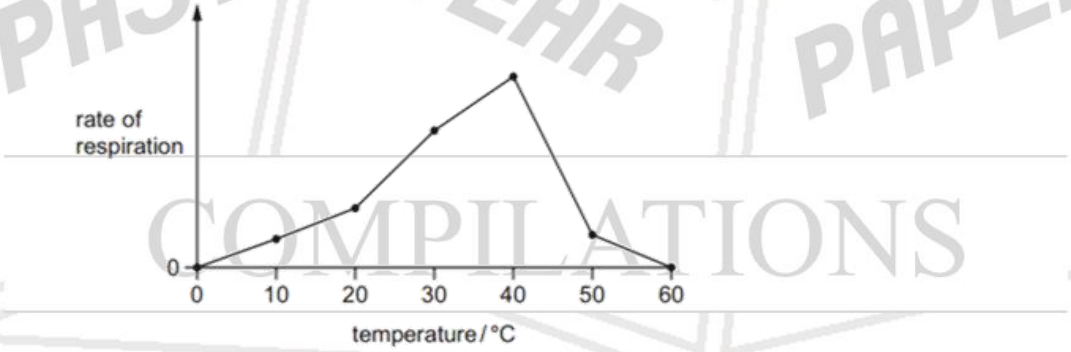
A slows it down only

B slows it down then speeds it up

C speeds it up only

D speeds it up then slows it down

3 The graph shows the results of an experiment to investigate the rate of respiration of an organism at different temperatures.



What explains the difference between the rate of respiration at 50 °C and that at 30 °C?

A enzymes working faster at 50 °C

B enzymes working more slowly at 50 °C

C less oxygen available at 50 °C

D more oxygen available at 50 °C

4 A human digestive enzyme breaks down its substrate at a fast rate at 35 °C.

What would occur if the enzyme and substrate were kept at 75 °C?

A The enzyme would stop working and be denatured.

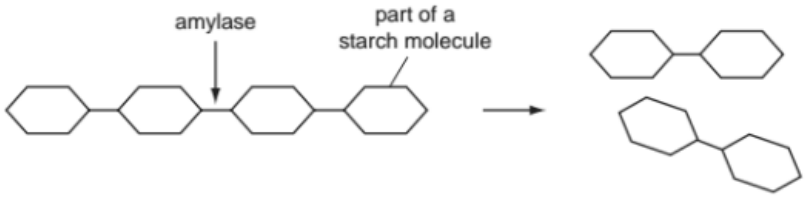
B The reaction would continue at the same rate.

C The reaction would take place more quickly.

D The reaction would take place more slowly.

SOLUTIONS

5 The diagram shows the action of amylase.



What is the function of the enzyme amylase?

A breaks down the substrate into amino acids

B changes the product into the substrate

C increases the rate of starch breaking down into glucose

D increases the rate of starch breaking down into maltose

6 What happens to most enzymes above 60 °C?

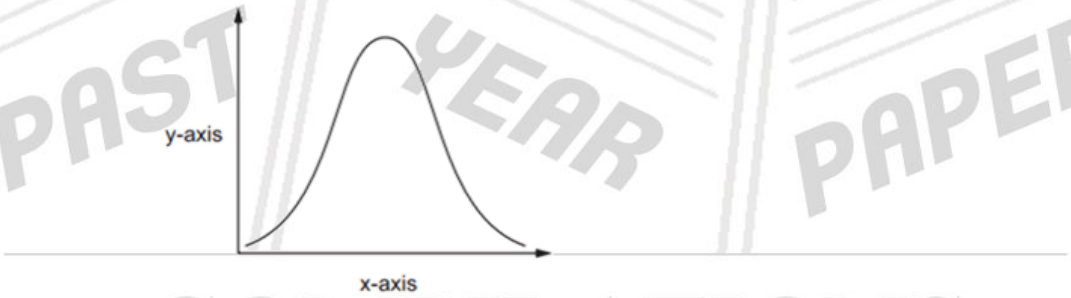
A They are denatured.

B They are destroyed by white blood cells.

C They are digested.

D They are made more active.

7 An experiment was carried out to investigate the effect of pH on enzyme action. The graph shows the results.



What are the labels for the x-axis and the y-axis?

	x-axis	y-axis
A	pH	rate of reaction
B	pH	time
C	rate of reaction	pH
D	time	pH

8 Some plants digest insects and use the nutrients for growth.

What must these plants produce to digest the insects?

A acids

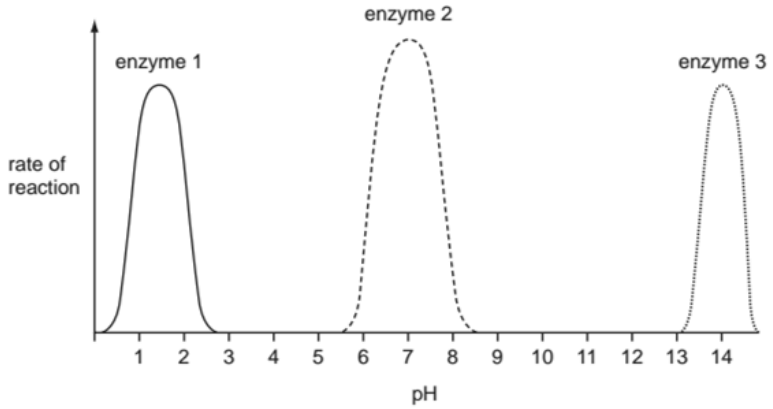
B alkalis

C enzymes

D hormones

SOLUTIONS

9 The graph shows the effect of pH on the rate of reaction of three different enzymes.



What does the graph show?

A Each enzyme works best at a different pH.

B Each enzyme works best over a narrow temperature range.

C Enzymes work best in acid conditions.

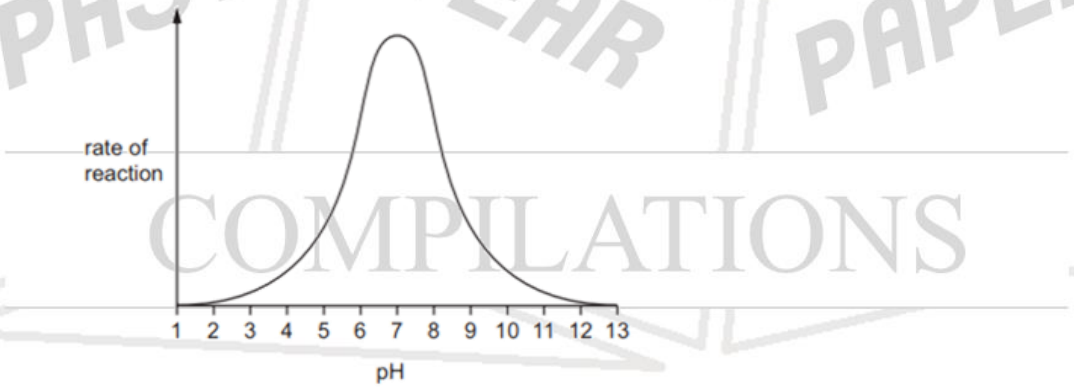
D Enzymes work best in alkaline conditions.

10 Lactase is a human enzyme that catalyses the breakdown of lactose in milk.

At which temperature does lactase work fastest?

A 0 °C **B** 18 °C **C** 37 °C **D** 100 °C

11 The graph shows the effect of pH on a particular enzyme-controlled reaction.



When is the enzyme **not** active?

A at pH 1 and pH 13

B at pH 3 and pH 11

C at pH 5 and pH 9

D at pH 7

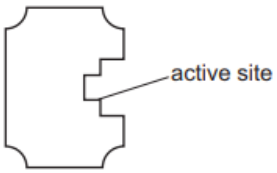
12 The table shows the conditions in four test-tubes containing equal amounts of starch and salivary amylase.

In which test-tube is the starch broken down fastest?

	pH	temperature /°C
A	2	27
B	2	37
C	7	27
D	7	37

SOLUTIONS

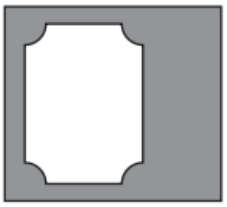
13 The diagram represents the shape of an enzyme molecule.



With which substrate would this enzyme most easily form an enzyme-substrate complex?

A

B



C

D

14 Many enzymes do not work at temperatures above 60 °C.

Which statement explains this?

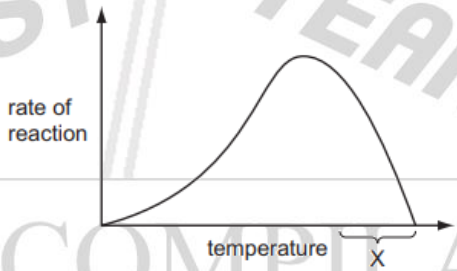
A Product molecules are not made because the active site has changed shape.

B Product molecules change shape so they do not fit the active site.

C Substrate molecules are moving too fast.

D Substrate molecules are moving too slowly.

15 The graph shows how the rate of an enzyme-controlled reaction changes with temperature.



What is happening within the temperature range marked X?

A The enzyme is becoming denatured.

B The enzyme is being used up.

C The reaction is occurring at body temperature.

D The reaction is occurring at the optimum temperature.

16 A protease is added to a suspension of egg protein in a test-tube and kept at 37 °C.

After 8 minutes, the protein changes from cloudy to transparent.

Which product, or products, will now be present in the test-tube?

A amino acids

B a simple sugar

C fatty acids and glycerol

D water

SOLUTIONS

17 A human cell contains a length of DNA that carries the code for making which substance?

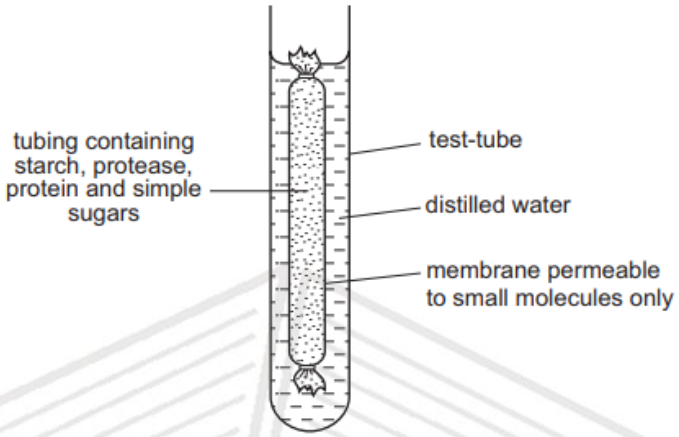
A fat

B glycogen

C lipase

D starch

18 The diagram shows an experiment kept at room temperature.



What is present in the water surrounding the membrane after 45 minutes?

A amino acids and simple sugars

B protein and amino acids

C protein and simple sugars

D starch and simple sugars

19 What is a characteristic of all catalysts?

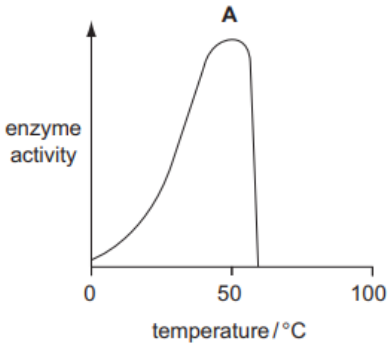
A They are broken down in the reaction.

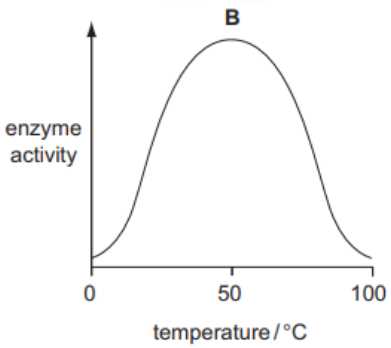
B They are made of protein.

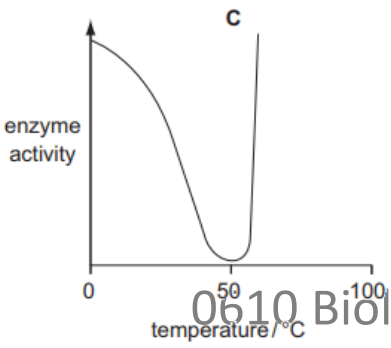
C They are not changed by the reaction.

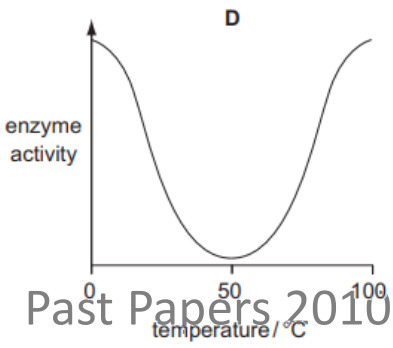
D They do not change the rate of the reaction.

20 Which graph shows the effect of temperature on the activity of an enzyme?

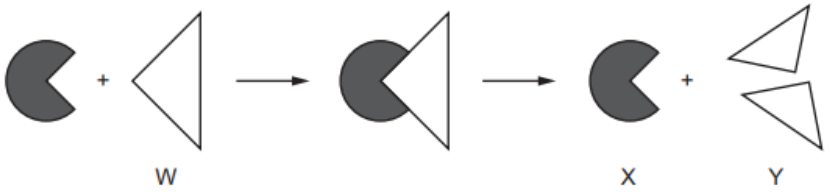








21 The diagram represents enzyme action.



What are parts W, X and Y in this chemical reaction?

	enzyme	product	substrate
A	W	X	Y
B	X	W	Y
C	X	Y	W
D	Y	W	X

22 An experiment was carried out to study the effect of temperature on the time taken for protein to be digested by an enzyme.

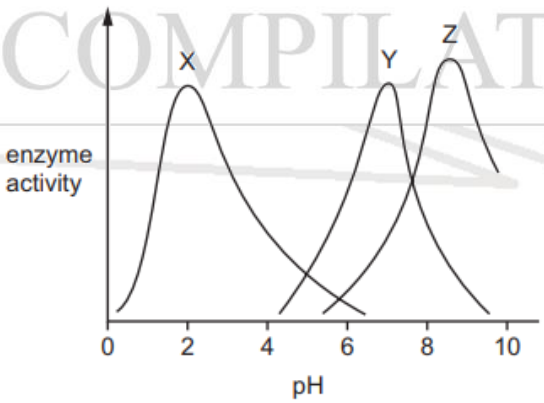
The table shows the results.

temperature / °C	observation
25	4 hours for complete digestion
35	2 hours for complete digestion
45	3 hours for complete digestion
55	no digestion takes place

For these results, at which temperature does the enzyme denature?

A 20 °C **B** 30 °C **C** 40 °C **D** 50 °C

23 The graph shows the effect of pH on the activity of three different enzymes.



The table shows the pH of different parts of the alimentary canal.

part of the alimentary canal	pH
mouth	7.0
stomach	2.0
small intestine	8.5

Which enzymes in the graph are likely to be protease enzymes?

A X, Y and Z **B** X and Z only **C** Y and Z only **D** Z only

SOLUTIONS

24 Two enzyme-controlled reactions are shown.

$$\text{amino acids} \xrightarrow{\text{enzyme 1}} \text{proteins}$$

$$\text{proteins} \xrightarrow{\text{enzyme 2}} \text{amino acids}$$

From these reactions, what deduction can be made about enzymes?

A Enzyme 1 has been changed to enzyme 2.

B Enzyme 2 slows down the production of amino acids.

C Enzymes can build up large molecules.

D Enzymes only break down large molecules.

25 Six test-tubes were set up at different temperatures. Each contained identical solutions containing starch and amylase mixtures. The table shows the time taken for the reactions to finish in each test-tube.

temperature / °C	15	25	35	45	55	65
time / seconds	35	22	13	5	35	66

At which temperature does the amylase work best?

A 15 °C **B** 35 °C **C** 45 °C **D** 65 °C

26 What does the digestion of starch produce?

A fatty acids

B glucose

C mineral salts

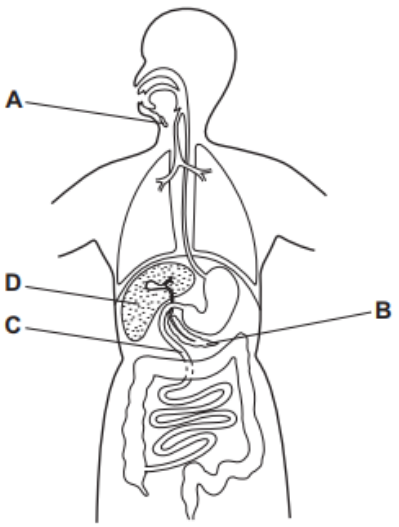
D water

27 What is true of **all** enzymes?

	they are sugars	they are most effective at pH7
A	✓	✓
B	✓	✗
C	✗	✓
D	✗	✗

28 The diagram shows the human alimentary canal.

Which structure does **not** secrete digestive enzymes?



SOLUTIONS

29 Which of the following helps enzyme to function well?

Antara yang berikut, yang manakah membantu enzim berfungsi dengan baik?

A Product
Hasil

B Cofactor
Kofaktor

C Inhibitor
Perencat

D Substrate
Substrat

30 Diagram 5 shows two shirts, P and Q, that were stained with butter. The shirts were washed with washing powder that contains enzyme X at different temperatures.

Rajah 5 menunjukkan dua helai baju, P dan Q, yang dikotori oleh mentega. Baju-baju tersebut dicuci dengan serbuk pencuci yang mengandungi enzim X pada suhu yang berbeza.

Diagram 5
Rajah 5

What is enzyme X and the possible temperatures that were used for P and Q?

Apakah enzim X dan suhu yang mungkin telah digunakan untuk P dan Q?

	Enzyme X ***Enzim X***	**Temperature for P (°C)** ***Suhu untuk P (°C)***	**Temperature for Q (°C)** ***Suhu untuk Q (°C)***
A	Lipase *Lipase*	10	35
B	Amylase *Amilase*	10	35
C	Lipase *Lipase*	35	10
D	Amylase *Amilase*	35	10

SOLUTIONS

Paper 3

(Paper 4 for Extended Candidates – Revised 2016 Syllabus)

Index

1 Microorganisms in the soil release enzymes to digest dead leaves.

(a) Explain how enzymes catalyse chemical reactions.

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..... [3]

(b) Protease and cellulase are two enzymes secreted by soil microorganisms. Protease digests protein.

Suggest what part of the dead leaf cells are digested by the enzyme cellulase.

..... [1]

(c) Table 6.1 shows the results of a study comparing the decomposition of dead leaves at two locations **A** and **B**.

Table 6.1

	location **A**	location **B**
protease activity / μmol min^{-1}	2750	2670
cellulase activity / μmol min^{-1}	4790	2500
soil pH	6.0	3.5
soil water content / %	10	77

(i) Compare the enzyme activity at location **A** with the enzyme activity at location **B**.

You will gain credit for using the data from Table 6.1 to support your answer.

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(ii) Suggest possible reasons for any differences in the enzyme activity at location **A** and location **B**.

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..... [3]

(c) The enzyme catalase is found in lettuce leaves.

A student investigated the activity of this enzyme by grinding some lettuce leaves and adding them to a solution of hydrogen peroxide. The volume of oxygen produced was measured until the reaction stopped.

The student's results are shown in Fig. 1.3.

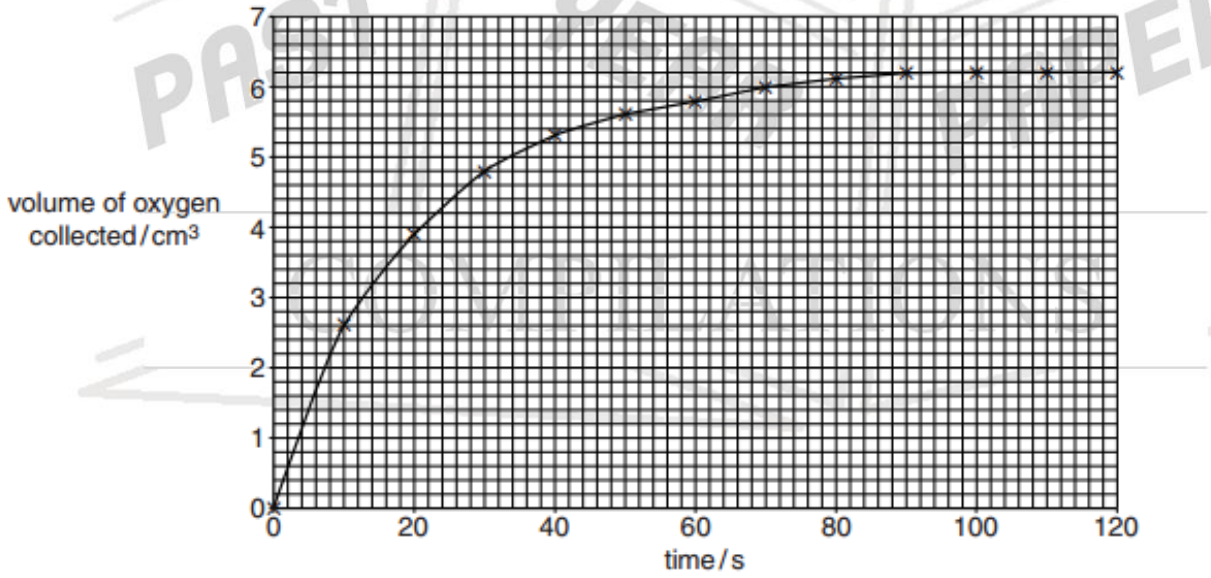

Fig. 1.3

(i) Describe the results shown in Fig. 1.3. You will gain credit if you use the data in your answer.

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.....[3]

(ii) Explain the action of enzymes during a reaction.

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.....[3]

2(a) Fig. 5.1 shows a computer model of the enzyme alcohol dehydrogenase, which is the enzyme responsible for breaking down alcohol.

Fig. 5.1

Enzymes have a specific three dimensional shape.

Explain why the shape of an enzyme is important.

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.....[3]

(b) Table 5.1 shows the enzyme activity of alcohol dehydrogenase at different temperatures.

Table 5.1

temperature / °C	enzyme activity / arbitrary units
30	115
42	175

(i) The information in Table 5.1 shows that an increase in temperature increases the activity of alcohol dehydrogenase.

Explain why an increase in temperature causes an increase in enzyme activity.

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.....[3]

(ii) State **one** factor, **other than** temperature, that affects enzyme activity.

.....[1]

3 (a) Table 6.1 shows some of the enzymes, their substrates, products and where they are produced in the digestive system.

Complete Table 6.1.

Table 6.1

enzyme	substrate	product(s)	location of enzyme production
.....	starch	.....	salivary glands
maltase	maltose	.....	.....
.....	.....	amino acids	stomach wall
.....	.....	amino acids	pancreas and small intestinal wall
lipase	fats	.....	.....

[5]

4 The action of enzymes is often explained in terms of the 'lock and key' model as shown in Fig. 3.2.

Fig. 3.2

Use the information in Fig. 3.2 to explain how enzymes work to break down nutrient materials, such as starch.

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..... [4]

5 Enzymes in bean seeds are activated during germination. Some of these enzymes break down protein stored in the seeds.

A large number of bean seeds were soaked and germinated. Researchers took samples of germinating seeds over a period of 15 days. The seeds were chopped into small pieces and crushed with water to make an extract. Equal quantities of the extracts were placed into protein solutions at pH 5 and at pH 8.

The activity of the enzymes in each extract was determined by recording how quickly the protein was broken down. The results are shown in Fig. 3.3.

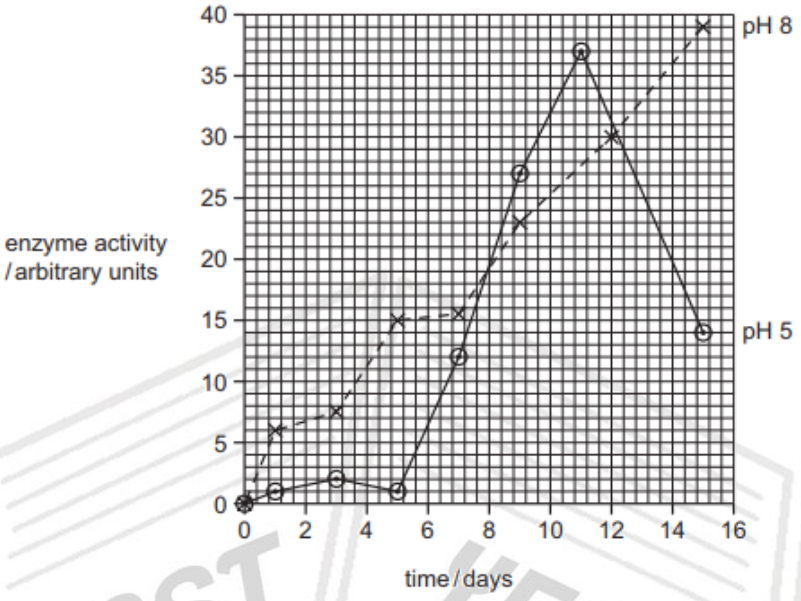

Fig. 3.3

(a) Describe the activity of the enzymes in the extracts at pH 5 over 15 days.

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..... [3]

(b) The researchers concluded that the beans contained two different enzymes that break down protein.

State the evidence from Fig. 3.3 for this conclusion.

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..... [3]

[Total: 15]

SOLUTIONS

6 Enzymes are necessary for many biological processes, such as the digestion of fat.

$$\text{fat} + \text{water} \xrightarrow{\text{lipase}} \text{fatty acids} + \text{glycerol}$$

(a) (i) Explain why enzymes are necessary for biological processes.

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..... [3]

(ii) Lipase, protease and amylase are enzymes secreted into the alimentary canal.

Name **one** organ that secretes each enzyme. Choose your answers from this list.

colon gall bladder liver oesophagus

pancreas rectum salivary glands stomach

You can use each organ **only once**.

lipase .....

protease .....

amylase ..... [3]

7 Microorganisms in the soil release enzymes to digest dead leaves.

(a) Explain how enzymes catalyse chemical reactions.

.....

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..... [3]

(b) Protease and cellulase are two enzymes secreted by soil microorganisms. Protease digests protein.

Suggest what part of the dead leaf cells are digested by the enzyme cellulase.

..... [1]

8 A group of students investigated the digestion of fat in milk.

- They added an alkaline solution to the milk.
- They divided the milk into four test-tubes.
- They added lipase and bile salts to some of the test-tubes, as shown in Table 5.1. They did this at the same time for each test-tube.
- They kept all test-tubes at 40 °C.
- After 5 minutes, they added Universal Indicator solution to each test-tube.

Table 5.1

test-tube	contents	colour of pH indicator after 5 minutes at 40 °C
A	milk, alkaline solution, lipase and bile salts	orange
B	milk, alkaline solution, bile salts and water	blue
C	milk, alkaline solution, lipase and water	yellow
D	milk, alkaline solution and water	blue

Fig. 5.1 shows the colour of the indicator at different pH values.

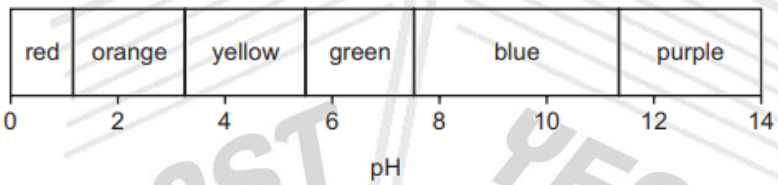

Fig. 5.1

(i) Explain why test-tube **D** was included in the investigation.

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..... [2]

(ii) Explain why the colour in test-tube **A** was orange.

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..... [3]

(iii) Explain the results for test-tubes **B** and **C**.

test-tube **B** .....

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test-tube **C** .....

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..... [4]

9 **(a)** Starch, glucose and fructose are carbohydrates. Fructose syrup is used as a sweetening agent as an alternative to sucrose.

The flow chart in Fig. 3.1 shows how fructose is prepared from maize starch.

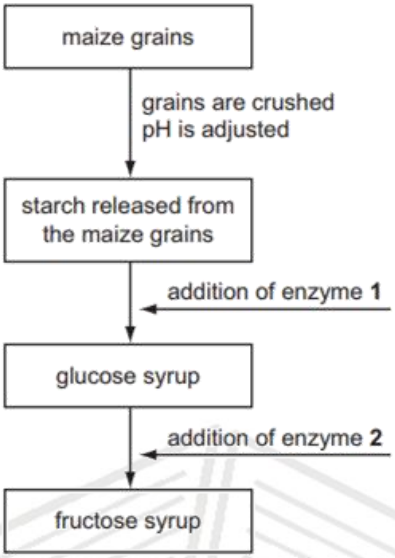

Fig. 3.1

(i) Name enzyme **1**.

.....[1]

(ii) State why it is necessary to adjust the pH before an enzyme is added to the process.

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.....[1]

(b) Maize grains contain protease enzymes. With reference to the processes shown in Fig. 3.1, suggest why it is important that these enzymes do not contaminate the glucose syrup.

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.....[1]

(c) The formation of fructose syrup from glucose syrup is carried out at a temperature of 60 °C.

Suggest an important property of enzyme **2** that allows it to be used at temperatures as high as 60 °C.

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.....[1]

(d) Enzyme **2** is found naturally in many bacteria. Enzymes for use in washing powders are obtained from bacteria.

Describe how bacteria are used to produce enzymes for washing powders.

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.....[3]

Paper 6

Index

1 Catalase is an enzyme found in plant and animal tissues.
It catalyses the breakdown of hydrogen peroxide into water and oxygen.

$$\underset{\text{hydrogen peroxide}}{2H_2O_2} \rightarrow \underset{\text{water}}{2H_2O} + \underset{\text{oxygen}}{O_2}$$

The activity of this enzyme can be measured by collecting the volume of oxygen gas given off as shown in Fig. 1.1.

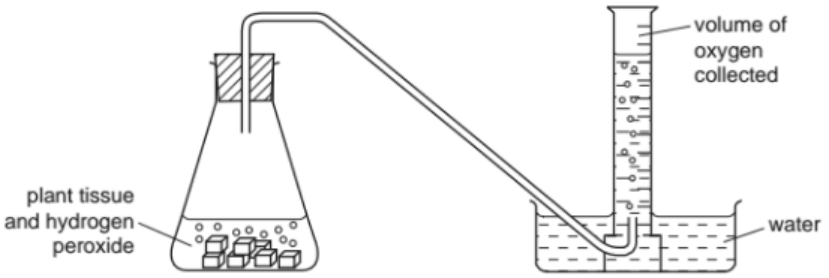


Fig. 1.1

Some students compared the catalase activity in two plant tissues, **sweet potato**, *Ipomoea batanus*, and **Irish potato**, *Solanum tuberosum*.

- 2.0 g of **sweet potato** was cut into small pieces.
- The small pieces were placed in a flask together with 25 cm^3 of hydrogen peroxide.
- The bung and delivery tube were fitted to the flask, as shown in Fig. 1.1.
- The volume of oxygen gas released was measured after 4 minutes (experiment 1).
- This was repeated three times (experiments 2, 3 and 4).
- The same procedure was carried out with 2.0 g of **Irish potato** cut into small pieces.
- The results are shown in Table 1.1.

Table 1.1

experiment	volume of oxygen gas / cm^3	
	sweet potato	**Irish potato**
1	32.0	12.5
2	20.0	9.0
3	35.5	8.5
4	28.0	10.0
total	115.5	
mean	28.9	

(a) (i) The total volume of oxygen gas and the mean volume of oxygen gas have been calculated for the **sweet potato**.

Calculate these values for the **Irish potato**.

Show your working below.

Write your answers in Table 1.1. [2]

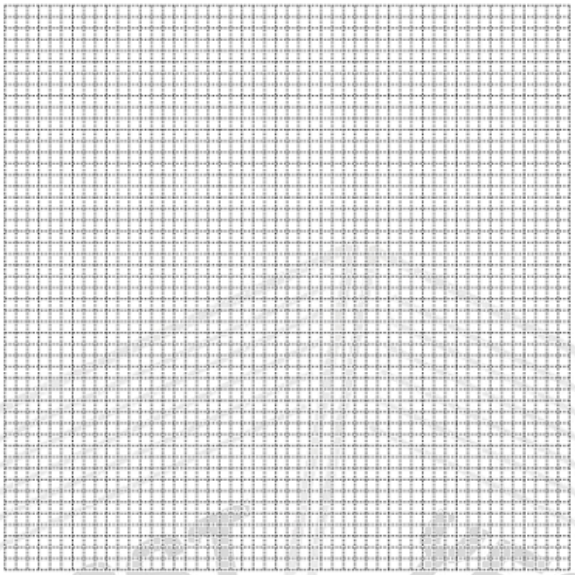
(ii) Suggest why the tissues were cut into small pieces before being added to the flask.

.....

..... [1]

(b) (i) Draw a bar chart to show the volumes of oxygen gas collected for the **sweet potato**.

Draw a horizontal line across your bar chart to show the mean value.



[5]

(ii) Suggest two reasons for the variation in the results of the four **sweet potato** experiments.

1 .....

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2 .....

..... [2]

(c) Suggest and explain **two** ways in which a similar investigation could be planned to collect more reliable data.

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..... [4]

[Total: 14]

2 Living cells produce catalase to break down the toxins, such as hydrogen peroxide, that are formed in cells.

Catalase breaks down hydrogen peroxide to form oxygen and water.

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

An investigation was carried out to find out if ripe fruits produce more catalase than unripe fruits.

The unripe pepper fruits of *Capsicum annuum* are green in colour when they start developing. As the fruit ripens it turns red and tastes sweeter.

Extracts were prepared from both green and red pepper fruits.

Small squares of filter paper were soaked in the extracts and dried for testing.

The pieces of filter paper were placed in hydrogen peroxide solution as shown in Fig. 1.1.

As the catalase in the extracts breaks down the hydrogen peroxide, the pieces of filter paper rise to the surface. The time taken for each piece of filter paper to reach the surface was measured.

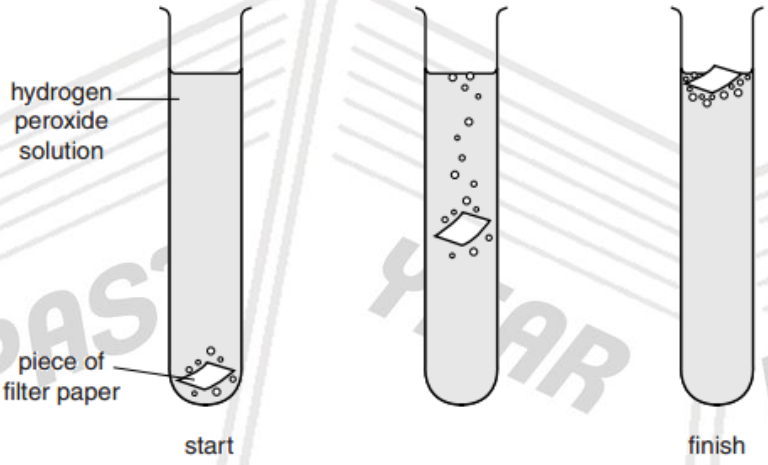

Fig. 1.1

The procedure was carried out to obtain three results for red pepper fruits and three results for green pepper fruits.

The measurements are shown in Table 1.1.

Table 1.1

pepper extract	time / s		
	filter paper 1	filter paper 2	filter paper 3
red	50	35	30
green	75	60	62

(a) Calculate the total time and the mean time for each extract.

Give your answers to the nearest whole number.

red pepper extract: total time ..... s

mean time ..... s

green pepper extract: total time ..... s

mean time ..... s [2]

(b) Describe and explain whether this investigation supports the statement 'ripe fruits produce more catalase than unripe fruits'.

.....

.....

.....

.....

.....

.....[3]

(c) State **two** variables that must be controlled to compare the catalase activity in the extracts.

1.....

2.....

[2]

3 Some students investigated the effect of temperature on the activity of amylase.

Amylase is an enzyme that catalyses the break down of starch.

Starch changes the colour of iodine solution from orange-brown to blue-black.

Step 1 The students added 2 cm^3 of starch solution to a test-tube, labelled it **W**, and placed it into a beaker of warm water.

Step 2 They added 2 cm^3 of starch solution to a second test-tube, labelled it **C**, and placed it into a beaker of iced water.

Step 3 The students placed one dropping pipette into each of test-tubes **W** and **C**.

Step 4 They waited five minutes before continuing.

Step 5 The students added 10 drops of amylase solution to each of test-tubes **W** and **C** and shook both test-tubes gently.

Step 6 They started a timer.

Step 7 The students immediately tested the liquids in test-tubes **W** and **C** for starch using iodine solution.

Step 8 The students repeated step 7 after 2, 4, 6 and 8 minutes.

(a) Iodine solution can affect the activity of amylase.

The students tested the liquids in test-tubes **W** and **C** using iodine solution without affecting the activity of the amylase.

Describe how the students did this.

.....

.....

.....

.....

.....[2]

The students observed that the liquid from test-tube **W** turned the iodine solution blue-black after 0 minutes, dark brown after 2 minutes, and it remained orange-brown after 4, 6 and 8 minutes.

The liquid from test-tube **C** turned the iodine solution blue-black after 0, 2 and 4 minutes and dark brown after 6 and 8 minutes.

(b) Prepare a table to record these observations in the space below.

[4]

(c) Suggest reasons for:

(i) waiting for five minutes at step 4

.....

.....

.....[1]

(ii) using separate dropping pipettes for test-tubes **W** and **C**.

.....

.....

.....[1]

(d) Explain the observations for test-tube **W**.

.....

.....

.....

.....

.....[3]

(e) The students concluded:

"The higher the temperature, the greater the activity of amylase."

Do you agree with this conclusion?

Give a reason for your answer.

.....

.....

.....[1]

(f) There is a source of error in step 5 of the method.

(i) Identify this source of error.

.....

.....

.....[1]

(ii) Suggest apparatus that could be used to minimise this source of error.

.....[1]

(g) State **one** other source of error in the method used in this investigation.

Suggest how to improve the method to minimise this source of error.

error .....

.....

.....

improvement .....

.....

.....

.....

[2]

(h) Some students stated:

"The activity of amylase is greatest at 40°C."

Describe an investigation to test whether this statement is correct.

The investigation should be similar to that described in steps 1–8.

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.....[6]

(i) Amylase breaks starch down into reducing sugars.

Outline how the students could show that reducing sugars are present in a solution.

.....

.....

.....

.....

.....[2]

SOLUTIONS – PAPER 1

1. C
2. D
3. B
4. A
5. D
6. A
7. A
8. C
9. A
10. C
11. A
12. D
13. D
14. A
15. A
16. A
17. C
18. A
19. C
20. A
21. C
22. D
23. B
24. C
25. C
26. B
27. D
28. D
29. B
30. A

BACK

SOLUTIONS – PAPER 3

1 (a)	lock and key mechanism; substrate fits into enzyme; (shape of) substrate is complementary to, enzyme/active site; ref to active site; substrate breaks/product(s) forms/product(s) leaves enzyme; enzyme, free for next reaction/not used up/remains unchanged; AVP;	max 3	e.g. lowers activation energy
(b)	(cellulose) cell wall;	1	

(c) (i)	protease activity, similar/AW, on both sites; all enzyme activity is, greater/better/faster, in site **A**; cellulase activity on site **A** greater than protease activity on site **A**; cellulase activity, higher on site **A**, than site **B**/ORA; cellulase and protease activity on site **B** similar; use of data with units to support any of these marking points;	max 3	do not award data quote unqualified
(ii)	pH/water content, no effect on protease activity; cellulase more active, at higher pH/less acidic environment; cellulase more active, at lower soil moisture; ref to optimum pH of, protease/cellulase/enzymes; low pH may denature cellulase; idea of different leaf composition; size of leaves/surface area/ species of leaf; different stage of decomposition;	max 3	

(c) (i)	volume of, oxygen/gas, increases (with time); levels off/reaches a plateau/AW; increases rapidly at start and then slows down; use of data;	max 3	**I** 'reaction stops' e.g. levels off at 6.2 cm^3 of oxygen at 90 seconds data quotes must have units
(ii)	substrate/hydrogen peroxide/reactant/AW, fits into enzyme; active site; shape is, complementary/AW; any reference to lock and key; product(s)/oxygen and water, formed and leaves the enzyme; AVP;	max 3	**A** answers in the context of catalase **I** 'speeds up the reaction' **R** if shape is the same **A** product and enzyme separate e.g. enzyme can work again/enzyme not used up/enzyme is not changed during reaction/lowers activation energy

BACK

SOLUTIONS – PAPER 3

2 (a)

correct ref to active site ;
enzyme must be complementary shape to, substrate / alcohol ;
to make enzyme – substrate complex / to allow substrate to bind to enzyme ;
ref to only fits one substrate / specific to one substrate ;

3

A 'lock and key'

2 (b)(i)

increased kinetic energy ;
molecules move faster ;
increased frequency of collisions ;
increased number of successful collisions ;

3

(ii)

pH ;

1

3 (a)

enzyme	substrate	product / s	location of enzyme production	
(salivary) amylase	starch	maltose	salivary glands	;
maltase	maltose	glucose	small intestinal wall	;
pepsin	protein	amino acids	stomach (wall)	;
trypsin	protein	amino acids	small intestinal (wall)	;
lipase	fats	fatty acids and glycerol	pancreas / small intestinal wall	;

5

A polypeptides for protein

A peptides for protein

4

MP1 substrate, 'fits' into enzyme ;
MP2 active site (of enzyme);
MP3 shape is complementary ;
MP4 substrate is key, enzyme is lock ;
MP5 substrate / starch / nutrient, converted (into products) / AW ;
MP6 (2) products (molecules) leave ;
MP7 enzyme / amylase, can work again on another substrate ;

[max 4]

5) a

very little activity until day 5 ;
increase to day 11 / peak at day 11 ;
decrease to day 15 ;
data quote with day and activity ;

[max 3]

5) b

ref to different shapes of the lines ;
(therefore) there is enzyme activity in both pH ;
enzyme activity influenced by / specific to, pH ;
data quote ; e.g. quote of activity at pH 8 and pH 5 on a specified day ;
suggesting one enzyme prefers acid conditions, but by day 15 less enzyme, produced / available ;

BACK

[max 3]

SOLUTIONS – PAPER 3

6	(a) (i)	1 2 3 4	without enzymes reactions, occur too slowly / not at all ; **A** enzymes speed up reactions reduce, activation energy / energy needed for a reaction ; reactions take place at lower temperatures ; enzymes are catalysts ;	[max 3]	**MP1 A** some aspect of metabolism as an alternative to reactions, e.g. digestion
	(ii)		lipase – pancreas ; protease – stomach / pancreas ; amylase – salivary gland / pancreas ;	[3]	organs have to be different if the answer for lipase is incorrect **A** pancreas for either protease or amylase but not both

7	(a)	lock and key mechanism; substrate fits into enzyme; (shape of) substrate is complementary to, enzyme/active site; ref to active site; substrate breaks/product(s) forms/product(s) leaves enzyme; enzyme, free for next reaction/not used up/remains unchanged; AVP;	**max 3**	e.g. lowers activation energy
	(b)	(cellulose) cell wall;	**1**	

8	(i)	control ; **R** control(led) variable to show differences in, colour / pH / fat, due to, enzyme / lipase ; to use for comparing, colours / pH ;	[max 2]	**A** to show what happens without, enzyme / lipase, and bile salts
	(ii)	acid pH / below pH 5 / lowers the pH / becomes acidic ; fat has been, digested / broken down ; fatty acids (and glycerol) ;	[3]	**R** ref to lipase / bile salts being acidic
	(iii)	1 ref to specific, pH / colour in, **B** / **C** ; i.e. **B** is blue / 8-10 / alkaline i.e. **C** is yellow / 4-5 / slightly acid **ignore** bile salts / lipase is alkaline in **B** **B** 2 no, (chemical) digestion / breakdown (of fat) ; 3 no fatty acids ; 4 no lipase ; **C** 5 some, (chemical) digestion / breakdown (of fat) ; 6 fat not emulsified ; 7 so slower reaction (than A) ; 8 fewer fatty acids produced ; *award for **B** / **C*** 9 bile salts emulsify fats ; 10 ref to increasing surface area of fat (globules / AW) ; 11 bile salts are not enzymes ;	[max 4]	

test-tube	contents	colour of pH indicator after 5 minutes at 40 °C
A	milk, alkaline solution, lipase and bile salts	orange
B	milk, alkaline solution, bile salts and water	blue
C	milk, alkaline solution, lipase and water	yellow
D	milk, alkaline solution and water	blue

BACK

SOLUTIONS – PAPER 3

9	(a) (i)	amylase ;	[1]	
	(ii)	pH is a factor that influences / affects enzyme activity / AW; to give the optimum pH ; extreme pH could denature enzyme / **AW** ;	[max 1]	**ORA**
	(b)	*idea that* protease , would break down, enzymes / enzyme 2 ;	[1]	
	(c)	stable at high temperatures / does not denature at 60 °C / optimum temperature near 60 °C ;	[1]	**I** bears / tolerates hot temperatures **I** heat resistant **I** ref to denatures > 60 °C
	(d)	**1** (bacteria grown in) fermenters ; **2** (bacteria provided with) substrate / food (substances) / glucose / minerals / whey / waste substances / nutrients / culture medium / AW ; **3** oxygen / aerobic conditions ; **A** air bubbled through **4** (bacteria) grow / reproduce / increase in number ; **5** enzymes, secreted / released / AW ; **6** enzymes separated from, bacteria / mixture ; **A** ref to filtration **7** AVP ; e.g. conditions – 26 °C / pH 5–6	[max 3]	**A** extracted by crushing bacteria
	(e)	extracts more juice / speeds up juice extraction ; pectin converted to sugars ; so juice is sweeter ; cell wall material is removed from juice / pectin digested to soluble product(s) ; so the juice is clearer ; AVP; humans don't produce pectinase i.e. humans can digest the juice.	[max 3]	**I** easier…….

BACK

SOLUTIONS – PAPER 6

<table>
<tr><th>Question</th><th>Mark scheme</th><th>Mark allocation</th><th>Guidance</th></tr>
<tr><td>1 (a) (i)</td><td>
<table>
<tr><td rowspan="2">Mass of tissue g</td><td colspan="2">Volume of oxygen cm^3 per 4 minutes</td></tr>
<tr><td>Sweet potato</td><td>Irish potato</td></tr>
<tr><td>2.0</td><td>32.0</td><td>12.5</td></tr>
<tr><td>2.0</td><td>20.0</td><td>9.0</td></tr>
<tr><td>2.0</td><td>35.5</td><td>8.5</td></tr>
<tr><td>2.0</td><td>28.0</td><td>10.0</td></tr>
<tr><td>total</td><td>115.5</td><td>40.0 ;</td></tr>
<tr><td>mean</td><td>28.875</td><td>10.0 ;</td></tr>
</table>
</td><td>[2]</td><td></td></tr>
<tr><td>(ii)</td><td>Larger surface or area / to release more enzyme / faster reaction;</td><td>[1]</td><td>Accept enough surface area to react
Ignore to make the tissues more uniform in texture / easier to measure / reference to skin of potato
Accept more contact
Ignore easier reaction</td></tr>
</table>

Question	Mark scheme	Mark allocation	Guidance
(b) (i)	Simple column graph to show the range of readings for the sweet potato. **A –** labelled axes with units; **S –** scale; **P –** accurate plot of columns, ±½ square; **B –** neat bars of equal width, not touching and equal interspaces; **M –** mean line shown ± ½ square;	[5]	**A – accept** experiment and volume gas or O_2 / cm^3 – numbers should be placed centrally under columns **S –** scale on *y* axis must be even and bars plotted to fill half or greater than half of grid on both axes. **Ignore** orientation of bars **P – deduct** mark if any incorrect **Accept** line columns Mean line does not need to be labelled If line graph allow **A**, **P** and **M** only **max 3** If results for Irish potato allow **A**, **B** and **M** only
(ii)	**two from:** reference to temperature; different tubers / part of tuber / amounts catalase; reference to pH; difference in surface area; gas or oxygen escaping or difficulties in accurate measurement of gas volume / AW;	[2]	**Ignore** 'conditions were not the same' unless qualified **Ignore** references to activity / concentration of H_2O_2 **Accept** enzymes for catalase **Ignore** different amounts of potato **Accept** correct reference to size or no: pieces for surface area **Ignore** difficulties in reading measurements

BACK

SOLUTIONS – PAPER 6

Question	Mark scheme	Mark allocation	Guidance
(c)	**Two from:** **S:** use of water bath / AW; **E:** correct reference to maintaining temperature / AW; **S:** use of stopwatch / data logger / computerised or monitoring system / AW; **E:** correct reference to accurate timing / AW; **S:** use of stirring device / same agitation or shaking / AW; **E:** to avoid tissue settling on bottom of flask; **S:** use the same size / similar apparatus; **E:** different apparatus or sizes would affect result; **S:** use burette / syringe / pipette / AW; **E:** for accurate measurement of volume of hydrogen peroxide; **S:** cut even size potato pieces / grind potato / AW; **E:** to keep surface area the same / AW; **S:** add buffer / pH controller / acid or alkali / AW; **E:** to maintain constant pH / AW; **S:** use funnel through bung to add H_2O_2 / AW; **E:** to save removing bung / prevent gas escape; **S:** use same concentration H_2O_2; **E:** to control substrate / make the experiment the same; **S:** repeat **more** times; **E:** to reduce anomalies / AW; AVP;	**[max 4]** **[Total:14]**	***Mark in couplets – improvement with appropriate explanation*** If not in couplets, **max 2** for **S** or **E** answers only **Ignore** more frequent / longer timings **Accept** maximising surface area for 'grinding' potato **Accept** reduce mistakes **Ignore** use of different tissues / plants

BACK

SOLUTIONS – PAPER 6

2) a

	red	green
total time	115	197
mean time	38	66

one mark per row;;

2

A ecf for means

2) b

supports statement / ripe fruits do produce more catalase; (paper from) red / ripe fruit are faster (to rise) / takes less time (to rise); ora faster speed / less time linked to more catalase (in red / ripe fruit); ora (more) catalase causes more oxygen / gas / bubbles to be released; ora correct use of manipulated figures;	**max 3**	**A** (mean for) red (fruit) is 28 s less / green filter paper 1 takes 25 s longer / ripe fruits take 82 s less than unripe fruits

2) c

mass of fruit / extract; volume of water (suspending fruit); size / SA filter paper / AW; volume / concentration of hydrogen peroxide; tube size / depth (of hydrogen peroxide); temperature; any other correct controlled condition;	**max 2**	**A** size / amount / weight of extracts **A** amount of hydrogen peroxide e.g. time to soak filter paper in extract **I** pH / light

BACK

SOLUTIONS – PAPER 6

3)	(a)	*idea of* withdrawing a sample to test ; aspect of appropriate method described ;	[2]	
	(b)	**1** one table with ruled lines for at least 6 rows and 3 columns ; **2** a column / row, with header: time / min ; **3** two, columns / rows headings as, colour / observation, **W** / **C** ; **4** correct completion of information into table ;	[4]	**R** units in any data cell / m for min **R** if colour and letter not both a 'header'
	(c) (i)	*idea of* equilibration ;	[1]	
	(ii)	*idea of* minimising contamination ; *idea of* allowing simultaneous measurement ;	[max 1]	
	(d)	(blue-black shows) starch present at, 0 min / start ; (dark brown shows) some starch present at 2 min ; (orange-brown shows) no starch present, after 2 min / from 4 min ;	[3]	
	(e)	*yes :* **C** stayed blue-black for longer / slower colour change ; **ORA** OR *no :* there is not a large enough range of temperatures ;	[max 1]	
	(f) (i)	drop / dropping pipettes, are imprecise / volume of amylase may vary ; shaking can, cause spillage / inconsistent mixing ;	[max 1]	**I** miscounting (of drops)
	(ii)	appropriate apparatus to measure precise volume ; e.g. syringe / burette / graduated pipette / measuring cylinder ; appropriate apparatus to stir carefully / consistently; e.g. (magnetic) stirrer / glass rod / bung / test-tube shaker ;	[max 1]	
	(g)	*Source of error* / *Improvement* experiment was done only once ; / repeat entire experiment (at least 3 times in total) to calculate an average ; shaking, can cause spillage / inconsistent mixing ; / (magnetic) stirrer / glass rod bung / flask to swirl; drops / dropping pipettes, are imprecise / volume of amylase may not be the same ; / use syringe / burette / graduated pipette / measuring cylinder ; (long) intervals between testing / AW ; **A** reaction finishes between points / test, more often / every minute / 30 seconds; colour changes are subjective ; **A** endpoint hard to judge / colour chart / standards / control with no starch / colorimeter ; trying to do, **W** and **C** simultaneously ; / do **W** and **C** separately / second person to do second tube ; (water) temperature changes ; / insulate beakers / use (thermostatically controlled) water-bath ; AVP ; e.g. contents in pipette might contaminate spotting tests / AVP ; e.g. use clean pipettes each time	[max 2]	**R** improvement if it contradicts error **A** errors and improvements 2 and 3 if not already awarded in **1(f)**

BACK

SOLUTIONS – PAPER 6

3)	(h)	**1** test at 40 °C ; **2** test at least one temperature below 40 °C and one above ; **3** use of water-bath (to maintain different temperatures) / AW ; **4&5** named controlled variables ;; **6** measure time taken until iodine becomes orange brown / no longer changes colour ; **7** by repeated sampling at interval of less than 2 mins ; **8** repeat entire experiment / replicates ; **9** relevant stated safety procedure ;	[max 6]	Units must be stated correctly once **4&5** – e.g. equilibration time ; pH ; volume / concentration, iodine / amylase / starch ; **I** amount / quantity **I** regular
	(i)	Benedict's solution turns (brick) red ; with heat ;	[2]	**A** orange / yellow / green

BACK