Write your name, centre number and candidate number in the boxes below.

Surname	Other names

Centre number | | | | | |

Candidate number | | | | |

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Enzymes

Time allowed: 1 hour 45 minutes

Subject code **0610**

Biology

Questions from Paper 3, Paper 4 and Paper 6

You must have: a ruler marked in centimetres and millimetres, a protractor, compasses, a pen, an HB pencil and an eraser.

Total marks

/ 97

Instructions

- Answer every question in the space provided on this paper.
- Write in black or dark blue ink. Pencil may be used for diagrams and graphs.
- Fill in your name, centre number and candidate number above.
- Show your working: a correct method can earn marks even if the answer is wrong.

Information

- This paper has 10 questions worth 97 marks in total.
- The marks for each question or part are shown in brackets, for example [3].

Advice

- Read every question through once before you write anything.
- Use the marks in brackets to judge how long to spend on each part.
- If you finish early, go back and check your working.

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Print at 100% (Actual size) so diagrams keep their real measurements.

1 There are many people in the world who are not able to digest lactose, a sugar in milk produced by cows, goats and sheep. These people do not make the enzyme lactase that breaks down lactose in the small intestine.

(a) Describe what is meant by the term *enzyme*.

.....

.....

.....

..... [2]

(b) People who cannot digest lactose sometimes drink a liquid containing the enzyme lactase before they eat food containing milk products.

The aim of this treatment is to digest any lactose in the food, but it is not likely to be successful.

Suggest why this treatment is **not** likely to be successful.

.....

.....

.....

.....

.....

..... [3]

[Total: 5]

Enzymes Click for more variations

Reduced to 78% to fit the page (wider than A4).

1 **(a)**	made of protein; functions as a biological catalyst / speeds up chemical reactions in organisms; [2]	A – not used up in reaction
(b)	lactase could be coagulated / denatured in stomach; because of very low / acidic pH; as it normally works in alkaline conditions in small intestine; protease in stomach may digest it; any three – 1 mark each [3] **[Total: 5]**	

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2 **(a)** Complete the sentences about enzymes by filling in the gaps.
Use words or phrases from the list.

catalysts **hormones** **not changed**

prevent **protein** **slow down**

speed up **used up**

Enzymes are made of ..... molecules.

They function as ..... which means that they .....

chemical reactions. [3]

(b) Saliva contains an enzyme that digests starch.

A group of students used saliva to investigate the digestion of starch at different pH values.

Their results are shown in Fig. 3.1.

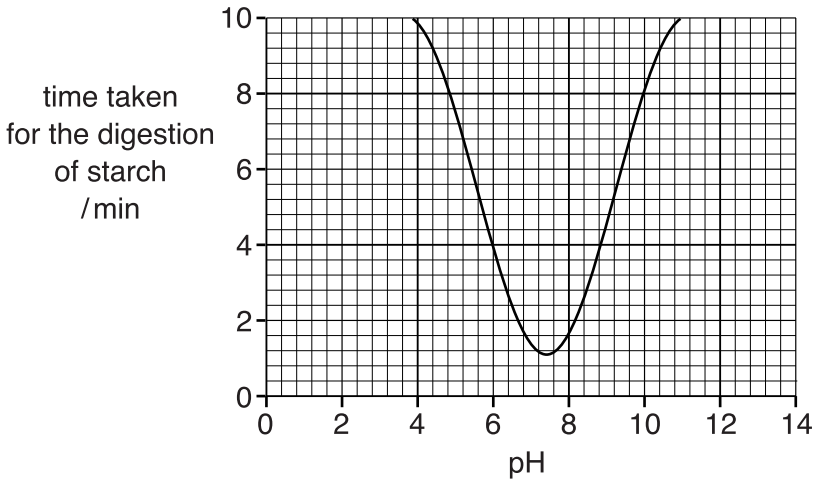


Fig. 3.1

(i) At which pH does the enzyme in saliva work the fastest?

..... [1]

(ii) How long does it take for the starch to be digested at pH 6?

..... min [1]

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(iii) The stomach produces hydrochloric acid.

Use the graph to suggest why the enzyme found in saliva does not work inside the stomach.

.....

.....

.....

.....

.....[2]

(iv) Name the enzyme that digests starch and state where this enzyme is produced.

name of enzyme .....

where produced .....
[2]

(c) Name **one** factor, other than pH, which can change the rate of enzyme activity.

.....[1]

[Total: 10]

Enzymes Click for more variations

Reduced to 78% to fit the page (wider than A4).

2 **(a)**	protein ; catalysts ; speed up ;	[3]	
(b) (i)	(ph) 7.5 ;	[1]	**A** 7.3 – 7.7
(ii)	4 (min) ;	[1]	**A** 3.9 – 4.1
(iii)	hydrochloric acid / stomach, has a low pH / pH ⩽ 4 ; (amylase) enzyme, is denatured / destroyed / will not function / AW ; (amylase) enzyme in saliva works best in neutral / ph 7.5 ;	[max 2]	 **R** 'kills enzyme' ecf from graph reading
(iv)	amylase ; salivary glands / pancreas / small intestine ;	[2]	
(c)	temperature ;	[1] **[Total: 10]**	**A** presence of an inhibitor / heat

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3 **(a)** A researcher investigated the effect of temperature on two different biological washing powders, **A** and **B**.

Two identical pieces of clothing were stained with the same type of food.

The researcher timed how long each washing powder took to remove the stains, at different temperatures.

Fig. 6.1 is a graph of the results.

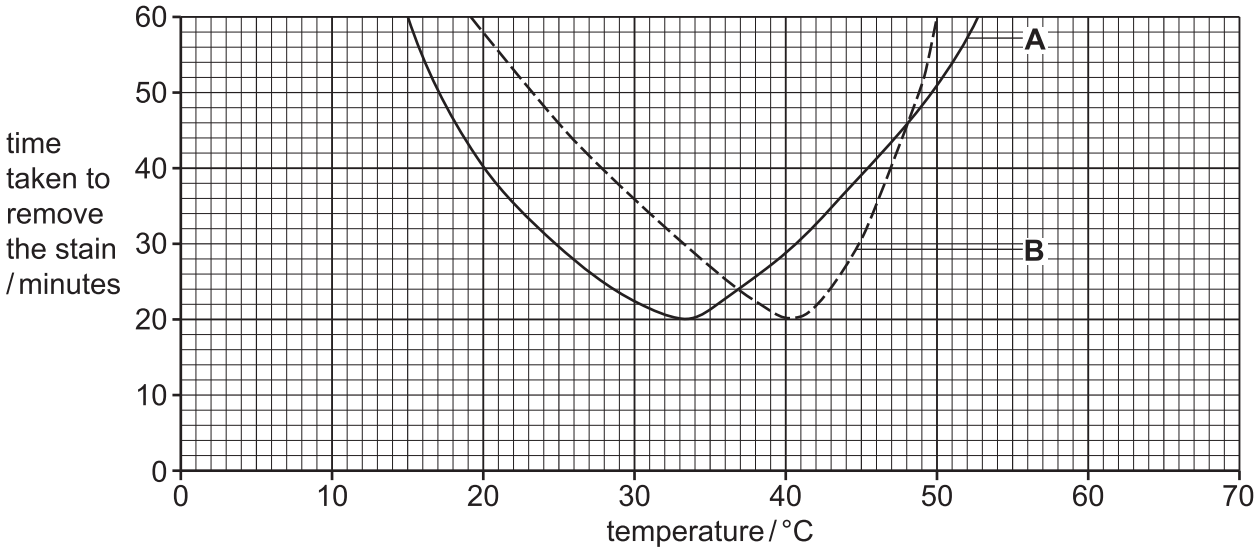


Fig. 6.1

(i) Determine the time taken for washing powder **A** to remove the stain at 20 °C.

..... minutes [1]

(ii) State why 40 °C is the best temperature to use for washing powder **B**.

.....

.....

..... [1]

(iii) A student stated some conclusions for the results shown in Fig. 6.1.

Tick (✓) **two** boxes that show two correct conclusions for the results shown in Fig. 6.1.

Washing powder **B** is active over a greater range of temperatures than washing powder **A**.	
Washing powders **A** and **B** do **not** work at 50 °C.	
Washing powders **A** and **B** have the same activity at 37 °C.	
Washing powder **A** can remove the stain in 15 minutes.	
Washing powder **A** is more effective at lower temperatures than washing powder **B**.	

[2]

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

..... [1]

(c) Enzymes are biological catalysts.

Define the term catalyst.

.....

.....

..... [2]

(d) Fig. 6.2 is a diagram showing the action of an enzyme.

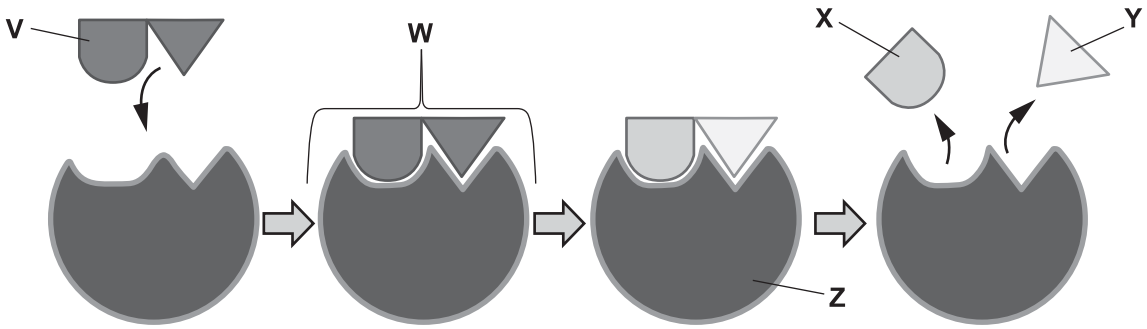


Fig. 6.2

State the letter or letters from Fig. 6.2 that represent the:

substrate .....

enzyme .....

[2]

(e) Lipase is an enzyme commonly found in washing powder.

Complete the word equation for the reaction that involves the enzyme lipase.

..... $\xrightarrow{\text{lipase}}$ ..... + glycerol

[2]

[Total: 11]

Enzymes Click for more variations

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<table>
<tr><td>3(a)(i)</td><td>40 (minutes) ;</td><td>1</td><td></td></tr>
<tr><td>3(a)(ii)</td><td>idea that 40°C gives the shortest time for stain removal ;</td><td>1</td><td></td></tr>
<tr><td>3(a)(iii)</td><td><table>
<tr><td>Washing powder B is active over a greater range of temperatures than washing powder A.</td><td></td></tr>
<tr><td>Washing powders A and B do not work at 50 °C.</td><td></td></tr>
<tr><td>Washing powders A and B have the same activity at 37 °C.</td><td>✓ ;</td></tr>
<tr><td>Washing powder A can remove the stain in 15 minutes.</td><td></td></tr>
<tr><td>Washing powder A is more effective at lower temperatures than washing powder B.</td><td>✓ ;</td></tr>
</table></td><td>2</td><td>R each additional tick</td></tr>
<tr><td>3(b)</td><td>pH / AVP ;</td><td>1</td><td></td></tr>
<tr><td>3(c)</td><td>(a substance that) increases the rate of a chemical reaction / AW ;
and is not changed permanently by the reaction / not used up in the reaction ;</td><td>2</td><td></td></tr>
<tr><td>3(d)</td><td>substrate – V ;
enzyme – Z ;</td><td>2</td><td></td></tr>
<tr><td>3(e)</td><td>fat / oil / lipid ; (→) fatty acids ;</td><td>2</td><td></td></tr>
</table>

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4 **(a)** All organisms depend on enzymes.

Define the term *enzyme* and describe the function of enzymes in living organisms.

.....

.....

.....

.....

.....

..... [3]

(b) Samples of an amylase enzyme were incubated with starch at different temperatures. The rate of starch digestion in each sample was recorded and points plotted on the graph shown in Fig. 8.1.

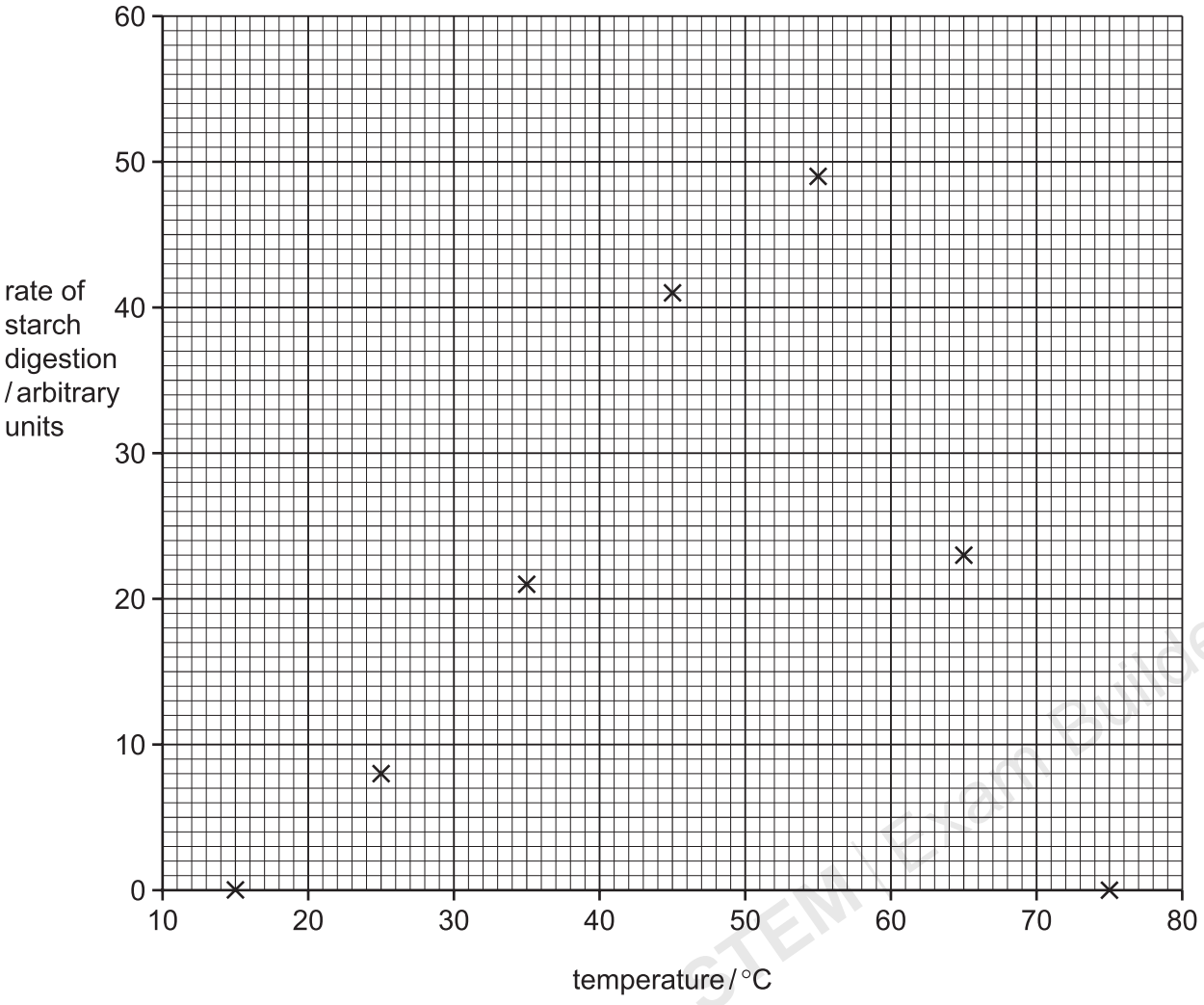


Fig. 8.1

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(i) Complete this line graph to show the effect of temperature on rate of digestion of starch by the amylase enzyme by adding the most appropriate line to Fig. 8.1.

Put your line on Fig. 8.1. [1]

(ii) Using your graph estimate the optimum temperature for this enzyme.

..... [1]

(iii) Suggest the rate of starch digestion at 37 °C.

..... [1]

(iv) Describe the effect of temperature on the rate of starch digestion.

.....

.....

.....

..... [2]

(v) The enzymes originally incubated at 15 °C and 75 °C did not digest any starch. These samples were later incubated at the optimum temperature.

Predict what results could be expected in each sample and suggest reasons for your predictions.

.....

.....

.....

.....

.....

..... [3]

[Total: 11]

Enzymes Click for more variations

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4 **(a)** 1 made of protein;

2 are (biological) catalysts;

3 that speed up chemical reactions;

4 not changed by chemical reaction

any three – 1 mark each [3]

(b) **(i)** completion of curve; [1]

(ii) 55 (°C) if point to point curve; (+/- half square)
check against candidate's graph if free hand curve; [1]

(iii) 24 or 25 or check value from candidate's graph; (+/- half square) [1]

(iv) rise in temperature increases the rate of reaction / ORA;

(rise) above optimum temperature / 55 °C rate falls; [2]

(v) 15 °C sample –

1 at optimum / higher temperature enzyme active;

2 reaction occurs / starch digested;

75 °C sample –

3 no reaction at optimum temp;

4 enzyme destroyed / denatured (by 75 °C);

any three – 1 mark each [max 3]

[Total: 11]

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5 Apple tissue changes colour in the air. Apple cells are thought to contain an enzyme which is a catalyst for the reaction:

$$\text{colourless compounds} + \text{oxygen in the air} \xrightarrow{\text{enzyme}} \text{coloured compounds}$$

Some students investigated this reaction.

The students cut a slice of apple with a knife as shown in Fig. 1.1.

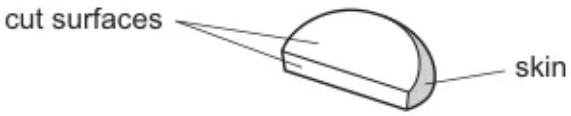


Fig. 1.1

This slice was broken into two pieces as shown in Fig. 1.2.

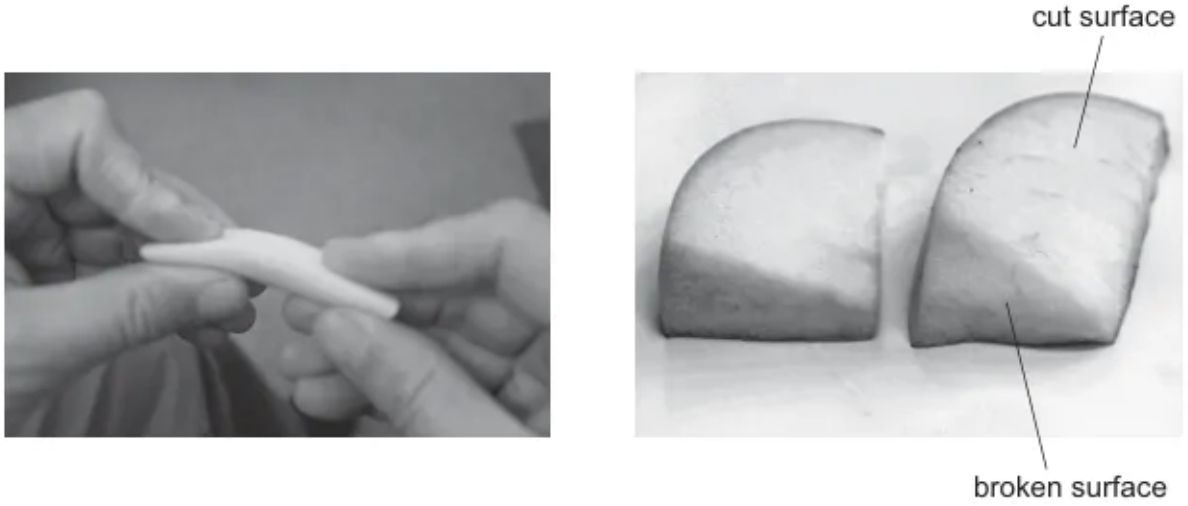


Fig. 1.2

Each piece was put into a different dish. The dishes were labelled **1** and **2**.

A few drops of water were put on the cut surface and the broken surface of the piece of apple in dish **1**.

A few drops of lemon juice were put on the cut surface and the broken surface of the piece of apple in dish **2**.

Every five minutes for 20 minutes the students observed the pieces of apple and recorded their observations in Table 1.1.

STEM

Table 1.1

time / minutes	dish **1**, apple with water		dish **2**, apple with lemon juice	
	broken surface	cut surface	broken surface	cut surface
5	no change	very light brown	no change	no change
10	no change	light brown	no change	no change
15	very light brown	light brown with dark brown patches	no change	no change
20	light brown	dark brown	no change	no change

The lemon juice was tested with litmus paper. It changed colour from blue to red.

(a) State the meaning of this colour change.

.....

..... [1]

(b) Look at Table 1.1. Describe the differences between the appearance of the **cut surfaces** in dish **1** and dish **2** during the experiment.

.....

..... [1]

(c) The colour changes are thought to involve enzyme activity.

(i) Explain how the observations in Table 1.1 and your description in **(b)** support this statement.

.....

.....

.....

.....

.....

..... [3]

STE

(ii) Using your knowledge of enzyme activity, describe another experiment that would test the idea that enzymes are involved in this colour change.

.....

.....

.....

.....

.....

..... [3]

(d) (i) Look at Table 1.1. Describe the differences between the appearance of the broken **surface** and the **cut surface** in dish **1** during the experiment.

.....

.....

.....

..... [2]

(ii) Cutting the apple with a knife damages cells, releasing the contents.

Suggest, from the observations in Table 1.1 and your description in **(d)(i)**, how **breaking** instead of cutting the apple may affect the cells.

.....

..... [1]

[Total: 11]

Measurements, tables, graphs and conclusions Click for more variations

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5	**(a)**	(lemon juice is) **acid**(ic)**;**	[1]	
	(b)	no colour change / less colour change in dish 2 **;**	Max [1]	
	(c) (I)	lemon juice is acidic **;** denature enzyme **;** browning does not happen **;**	[3]	
	(ii)	*Method:* put apples in high or very low temperature **;** *Result:* no or less colour change / not or less brown **;** *Explanation:* high temperatures denature enzymes OR cold temperatures inactivate enzymes / stops enzyme activity **;**	[3]	
	(d) (I)	*Comparative colour change* cut surface goes darker brown / greater colour change **;** *Speed of reaction* cut surface turns brown more quickly **;**	[2]	
	(ii)	cells separated **and** contents remain intact	[1]	
			[Total: 11]	

6 Amylase is an enzyme that catalyses the breakdown of starch to form reducing sugars.

Plan an investigation to determine the effect of pH on the activity of amylase.

Use iodine solution in your method.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [6]

Planning investigations: variables, controls and safety Click for more variations

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6	*total of six from:* **1** *independent variable* at least two pH values **,** tested / stated **;** **2** *dependent variable* time for iodine solution to stay yellow-brown / time for disappearance of starch/colour of iodine (solution) after a set period of time **;** **3, 4 + 5** *variables kept constant* **;;;** • concentration of amylase / enzyme (solution) • volume of amylase / enzyme (solution) • temperature • volume of starch (suspension) • concentration of starch (suspension) • sampling interval time, stated / described • buffer / pH (solution) volume • iodine concentration / volume / number of drops **6 & 7** *method* **;;** • equilibration (both solutions in the water bath before mixing) • take samples • use of, spotting / white, tile • use of buffer **8** repeat investigation twice more / at least two replicates **;** **9** relevant safety precaution **;**	**6**	

7 Pectinase is an enzyme used in the production of fruit juice.

(a) Describe in detail how enzymes function, using pectinase as an example.

.....

.....

.....

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.....

.....[6]

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(b) An experiment to test the effect of the size of apple pieces on the activity of pectinase was performed by a group of students. Some of their apparatus is shown in Fig. 2.1.

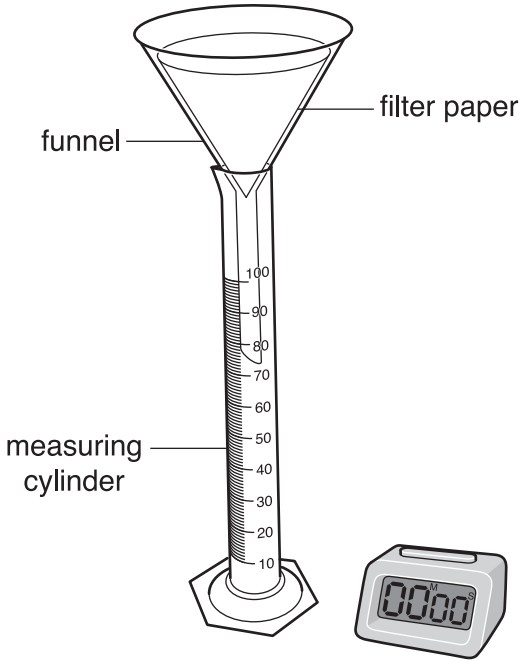


Fig. 2.1

Describe how the students should use the measuring cylinder to obtain **accurate** measurements of volume.

.....

.....

.....

.....

.....[2]

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(c) The students added 1.5 cm^3 of pectinase solution to pieces of apple in a beaker.

They then poured the mixture into the funnel.

They found that it took 10 minutes to collect 19 cm^3 of juice.

(i) Calculate the rate of the enzyme reaction.

Show your working.

Write your answer to the nearest whole number.

..... cm^3 per min [2]

(ii) The students performed four experiments using different ways to prepare the apples.

The same total mass and type of apple was used each time.

A 0.5 cm^3 apple cubes

B 1.0 cm^3 apple cubes

C whole peeled small apples

D whole unpeeled small apples

Predict **and** explain which experiment (**A**, **B**, **C** or **D**) would result in the fastest rate of reaction.

.....

.....

.....

.....

.....[2]

[Total: 12]

Enzymes Click for more variations

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7(a)	1 enzymes are proteins; 2 enzymes can be reused / are unchanged in a reaction; 3 enzymes are specific; 4 (enzymes are) catalyst / speeds up reaction; 5 lowers (activation) energy needed for the reaction; 6 successful collisions; 7 enzyme-substrate complex / ESC; 8 active site; 9 (enzyme and substrate) complementary shape / AW; 10 ref. to optimum, temperature / pH; 11 too much heat results in denatured enzymes; 12 too little kinetic energy / heat, less (successful) reactions; 13 incorrect pH results in denatured enzymes; 14 (substrate) is pectin / cell wall; 15 results / product, is clear juice; 16 mass / cheaper / more (volume) / yield, juice production;	**6**	**R** cellulose
7(b)	read at eye level / avoid error of parallax; read bottom of meniscus; place measuring cylinder on a level / flat, surface; remove funnel / ensure all drops have fallen to the bottom;	**2**	**A** parallel / horizontal to meniscus
7(c)(i)	19 ÷ 10 **or** 17.5 ÷ 10; 2 (cm^3 per min);	**2**	
7(c)(ii)	**A** / 0.5 (cm^3 cubes); large(st) surface area (to volume);	**2**	**A** smallest cubes
		Total: 12	

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8 **(a)** Some students were studying the activity of yeast. They made a fact file, as shown in Fig. 1.1.

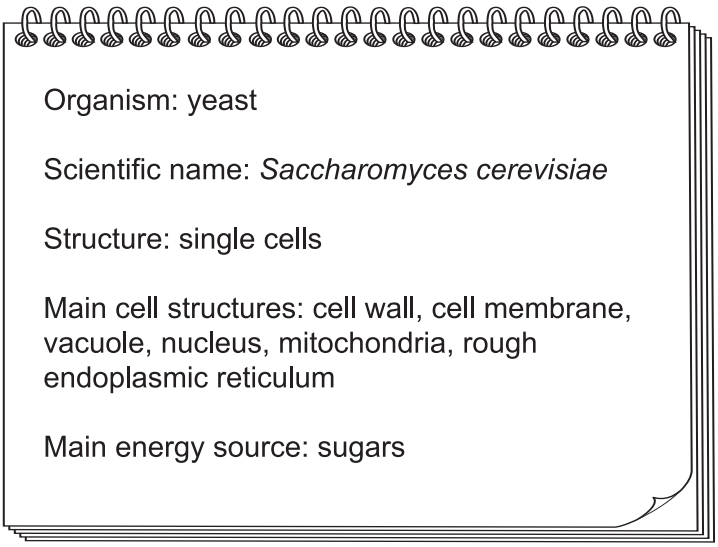


Fig. 1.1

(i) State the kingdom in which yeast is classified.

..... [1]

(ii) State the process that occurs in mitochondria to provide energy for yeast cells.

..... [1]

(b) Yeast cells make the enzyme sucrase. Sucrase catalyses the breakdown of sucrose to glucose and fructose.

Enzymes are made of protein.

Explain how the shape of a sucrase molecule is related to its function.

.....

.....

.....

.....

..... [2]

(c) The students made an extract of sucrase from yeast cells.

They investigated the activity of the sucrase extract at different pH values. They determined the rate of reaction at each pH.

They then calculated the rate of each reaction as a percentage of the fastest reaction, to give the percentage activity of sucrase.

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The results of this investigation are shown in Fig. 1.2.

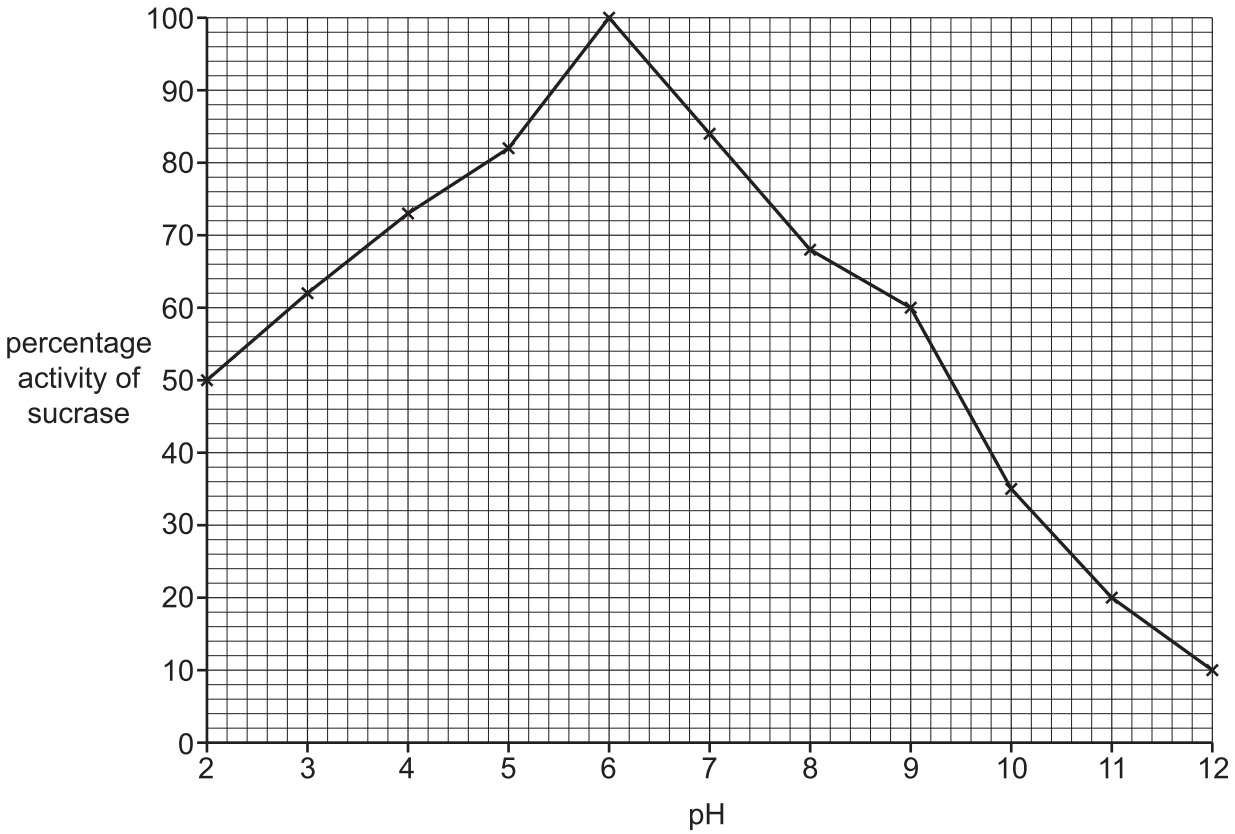


Fig. 1.2

Describe **and** explain the effect of pH on the activity of sucrase shown in Fig. 1.2.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [6]

[Total: 10]

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Enzymes Click for more variations

8(a)(i)	Fungus / Fungi ;	**1**	
8(a)(ii)	aerobic respiration ;	**1**	
8(b)	*any two from:* ref. to specificity (of enyme) ; shape of active site is complementary to, substrate / sucrose ; for, substrate / sucrose, to bind / fit, enzyme / sucrase / active site ;	**2**	
8(c)	*total of six from:* *max. four for description:* 1 sucrase / enzyme, is active between pH2 and pH12 ; 2 activity, increases and decreases / reaches a peak ; 3 peak / maximum or 100% activity, at pH 6 ; 4 steeper increase between pH 5–6 / steeper decrease in activity between pH 9–10 ; 5 minimum / 10%, activity at pH 12 ; 6 more activity in, acidic conditions / low pH, than, alkaline conditions / high pH ; *explanation:* 7 (change in) pH affects the shape of, sucrase / active site / enzyme ; 8 at pH 6, most enzyme-substrate complexes form / AW ; 9 at, low / high / extremes of, pH, enzyme is (partially) denatured ; 10 ref to substrate molecules can no longer bind with enzyme (at low / high / extreme pH, so activity decreases) ; 11 AVP ;	**6**	

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9 A scientist investigated the effect of changes in pH on the activity of two different protease enzymes.

Each enzyme was placed in a hole in the centre of a jelly layer in a Petri dish. The jelly layer was made of protein. The investigation was carried out at a range of different pH values.

After 60 minutes, the area of the jelly layer that had been broken down by enzyme **L** or enzyme **M** was recorded at each pH value tested.

Fig. 6.1 is a diagram of the apparatus.

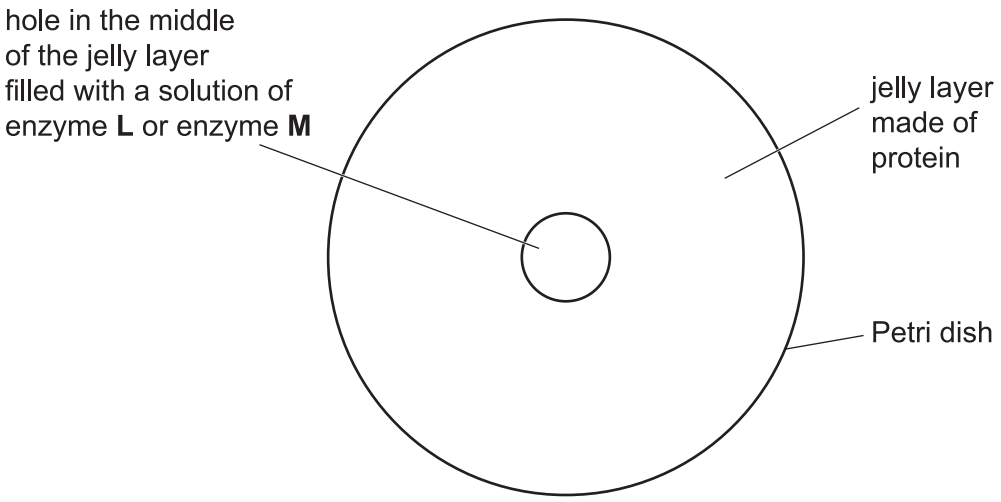


Fig. 6.1

Fig. 6.2 shows the results of the investigation.

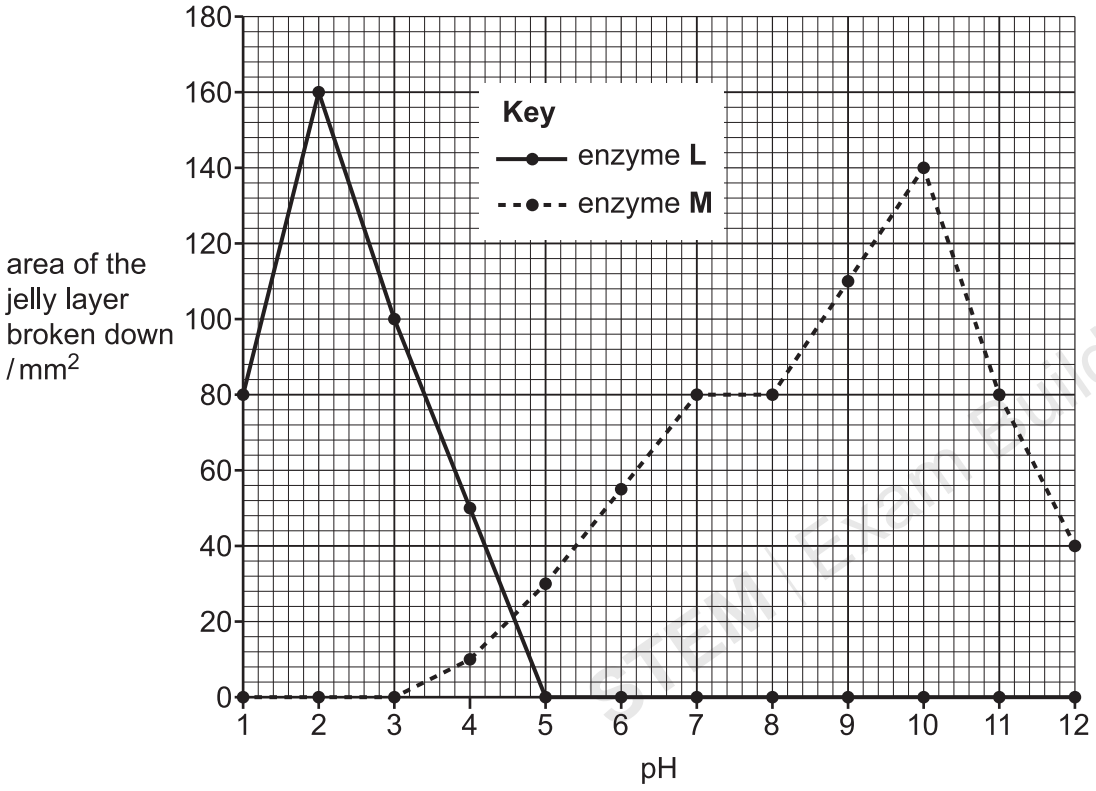


Fig. 6.2

stemexambuilder

(a) Using the information in Fig. 6.2, describe the results of this investigation.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [5]

(b) Explain the result for enzyme **M** at pH 2 shown in Fig. 6.2.

.....

.....

.....

.....

.....

.....

.....

..... [3]

(c) Suggest the name of enzyme **L and** state its location in the human digestive system.

name of enzyme **L** .....

location .....

[2]

[Total: 10]

Enzymes Click for more variations

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9(a)	*any five from:* 1 enzyme activity reaches, peaks / increases and decreases (for **L** / **M**) ; 2 maximum (area digested) / peaks, is pH 2 for **L** and pH 10 for **M** ; 3 **L** has steepest increase in activity between pH 1 and 2 / **M** has most gradual increase from pH 3 to pH 10 / as pH increases / AW ; 4 **L** has higher activity than **M** at their optimum pHs / AW ; ora 5 **L** and **M** are active, between pH 3 and pH 5 ; 6 **L** has no activity, from / at pH 5 (and onwards) OR **M** has no activity, before / at, pH 3 ; 7 **M** is active for a wider pH range (in this investigation than **L**) ; ora 8 no change in activity between pH 7 and 8 for **M** ; 9 data quote with correct units that includes ref to pH and area where the enzyme is active ;	**5**	MP6 **A** denatured for no enzyme activity MP9 examples: • at pH 2 **L** digests 160 mm^2 of jelly • at pH 10 **M** digests 140 mm^2 of jelly • at pH, 7 / 8 **M** digests 80 mm^2 of jelly
9(b)	*any three from:* no jelly is broken down / enzyme has no activity ; enzyme / **M** / active site, is denatured ; enzyme / **M** / active site, has changed shape ; active site, does not fit / does not bind / is not complementary to, the substrate / protein in jelly ;	**3**	
9(c)	*enzyme **L***: pepsin ; *location:* stomach ;	**2**	

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10 Enzymes are biological catalysts.

(a) Describe what is meant by the term catalyst.

.....

.....

.....

.....

..... [2]

(b) A student investigated the effect of temperature on enzyme activity.

A starch suspension was kept at 0 °C.

Amylase solution was added to the starch suspension.

Samples of the starch and amylase mixture were tested with iodine solution at 1-minute intervals for 15 minutes.

The student recorded the time at which the starch and amylase mixture stopped turning a blue-black colour.

The student repeated this investigation at different temperatures.

Table 3.1 shows the results.

Table 3.1

temperature / °C	time at which the starch and amylase mixture stopped turning a blue-black colour / minutes
0	stayed blue-black
10	12
20	8
30	5
40	3
50	10
60	stayed blue-black

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(i) Explain the results between 0 °C and **40 °C** in Table 3.1.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [6]

(ii) This investigation was repeated with protease instead of amylase.

Explain why the samples from the mixture produced a blue-black colour at every temperature.

.....

.....

.....

.....

..... [2]

(c) State **one** factor, other than temperature, that affects enzyme action.

..... [1]

[Total: 11]

Enzymes Click for more variations

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10(a)	increases the rate of a (chemical) reaction ; (and is) not changed (during the reaction) / AW ;	**2**	
10(b)(i)	*any six from:* **1** amylase breaks down starch ; **2** iodine (solution) turns blue-black in the presence of starch ; *idea that at 0 °C / at the start* **3** least, starch break down / enzyme activity / amylase activity ; **4** fewest, successful collisions / enzyme substrate-complexes formed ; **5** *idea that* particles do not have sufficient (kinetic) energy ; *idea as temperature increases* **6** the kinetic energy (of particles) increases ; **7** (starch and amylase) collide more, frequently / successfully or more enzyme-substrate complexes form ; **8** faster break down of starch ; **9** 40 °C is the optimum temperature ;	**6**	
10(b)(ii)	*any two from:* *ref to* specificity ; *idea that* protease has a different shaped active site (to amylase) / starch and the active site (of protease) are not complementary ; unable to bind / unable to form an enzyme-substrate complex ;	**2**	
10(c)	pH / **AVP ;**	**1**	

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