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

Surname	Other names

Centre number | | | | | |

Candidate number | | | | |

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Enzyme experiments (temperature and pH)

Time allowed: 40 minutes

Subject code **0610**

Biology

Questions from Paper 1, Paper 2, 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

/ 34

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 34 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 Which changes could cause an enzyme to denature?

1 change in pH

2 change in temperature

3 change in substrate concentration

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

Enzymes Click for more variations

Answer B

2 A human enzyme was used in an experiment. All factors were kept constant, apart from temperature.

What happened to the rate of reaction when the temperature was reduced steadily from 35 °C to 5 °C?

A It decreased steadily.

B It increased and then decreased.

C It increased steadily.

D It remained the same.

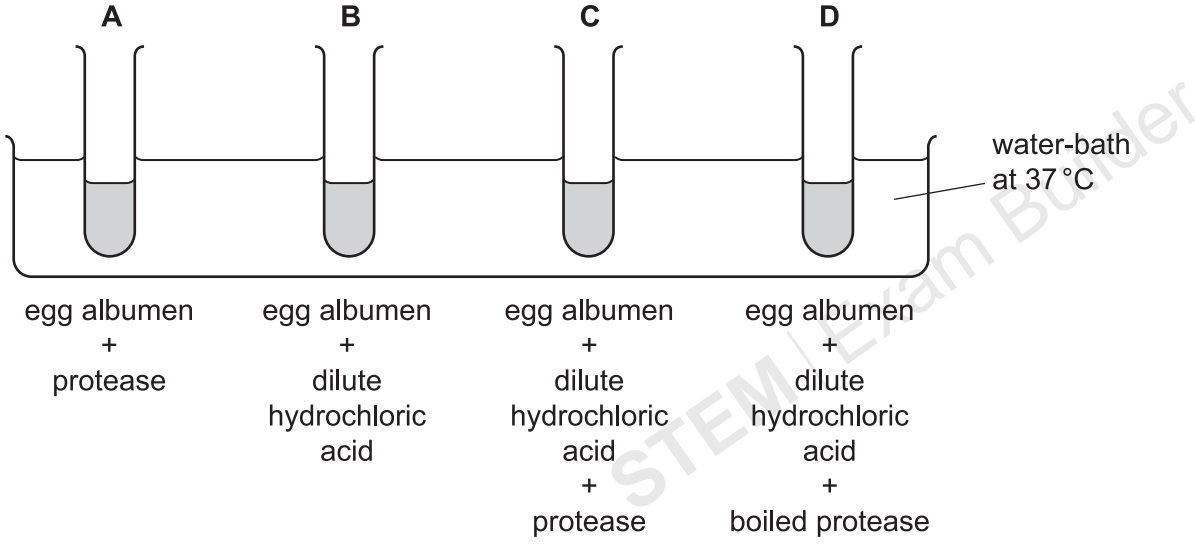
Enzymes Click for more variations

Answer A

3 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 protein be digested most quickly?

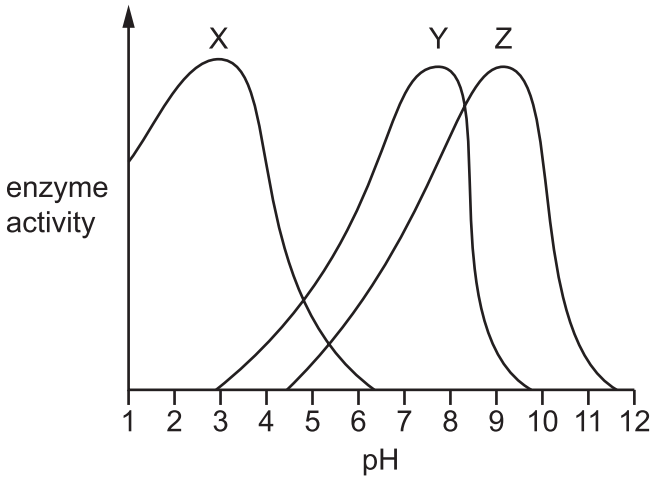


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Answer C

4 The graph shows the activity of three digestive enzymes at differing pH values.



Which statement is correct?

A Enzymes X and Y are both active at pH 7.

B Enzymes X and Z are both active at pH 4.

C Enzymes Y and Z are both active at pH 4.

D Enzymes Y and Z are both active at pH 8.

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Answer D

5 When the temperature increases, the rate of an enzyme-catalysed reaction increases until the optimum temperature is reached.

Which statement explains why the rate increases?

A The enzyme and substrate have more kinetic energy and collide less frequently.

B The enzyme and substrate have less kinetic energy and collide more frequently.

C The enzyme and substrate have more kinetic energy and collide more frequently.

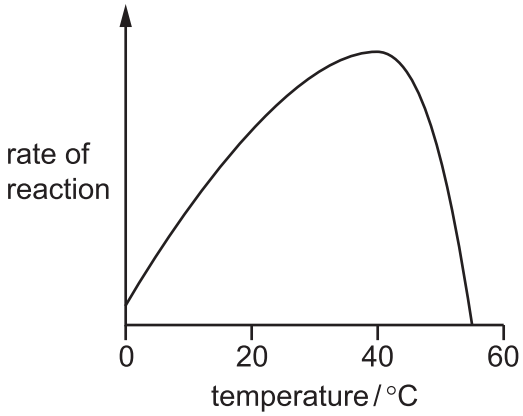
D The enzyme and substrate have less kinetic energy and collide less frequently.

Enzymes Click for more variations

Answer C

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6 The graph shows how enzyme activity is affected by temperature.



How can the change in activity between 40 °C and 55 °C be explained?

A Heat has killed the enzyme.

B The enzyme has been used up.

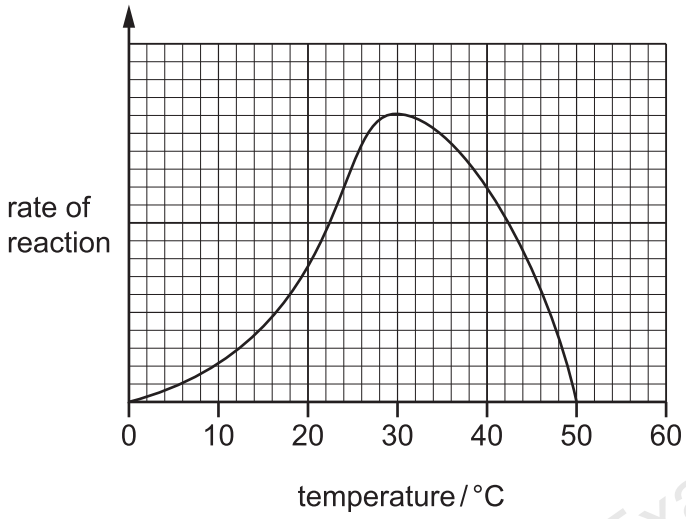
C The reactants are moving faster.

D The substrate is less likely to fit into the active site.

Enzymes Click for more variations

Answer D

7 The graph shows the effect of temperature on an enzyme-controlled reaction.



Which statement describes the effect of temperature on this reaction?

A As the temperature increases to 25 °C, the reaction speeds up.

B Between 10 °C and 20 °C, the enzyme denatures.

C Between 35 °C and 45 °C, frequency of effective collisions increases.

D The optimum temperature for this reaction is 40 °C.

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Answer A

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8 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.

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..... [6]

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

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8	*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**	

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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.

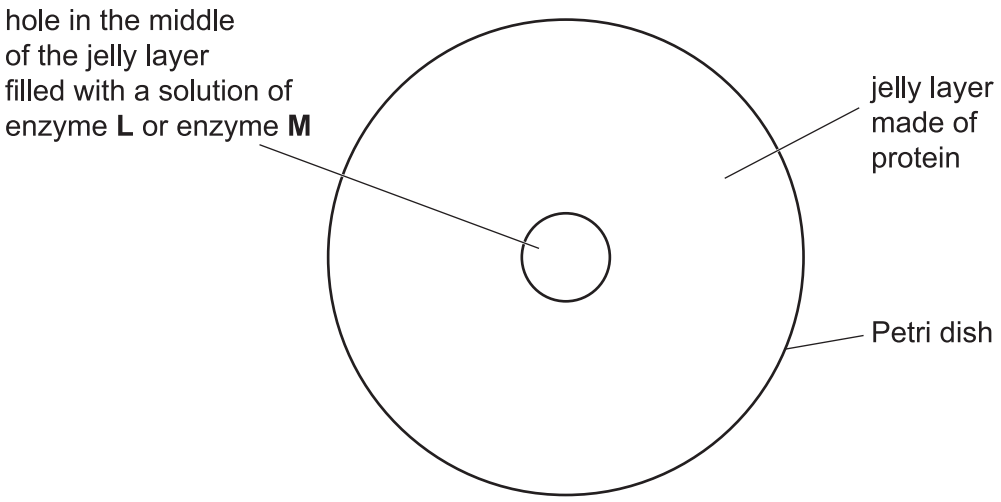


Fig. 6.1

Fig. 6.2 shows the results of the investigation.

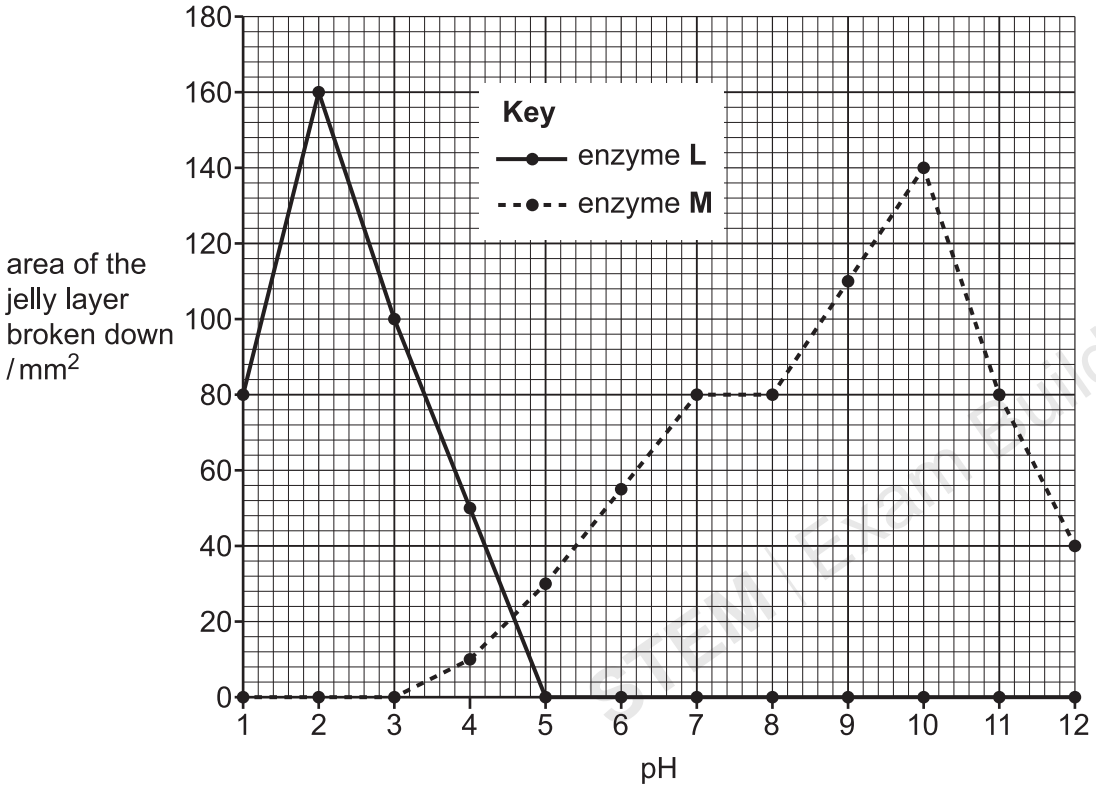


Fig. 6.2

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

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

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(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.

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(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.

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(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.

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..... [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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