Past-paper walk-through

Factors that affect enzyme action ▪ 3.2

eXercise

Questions in this set

- 9700/11 N25 Q12 ▪ 1 mark
- 9700/12 N25 Q14 ▪ 1 mark
- 9700/12 N25 Q15 ▪ 1 mark
- 9700/12 N25 Q16 ▪ 1 mark
- 9700/13 N25 Q16 ▪ 1 mark
- 9700/13 N25 Q17 ▪ 1 mark
- 9700/14 N25 Q15 ▪ 1 mark
- 9700/31 N25 Q1 ▪ 22 marks

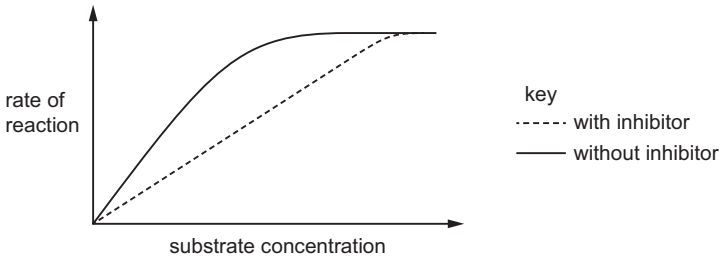
Reading the mark scheme

- **B1** a mark that stands on its own – the point is either made or not.
- **M1** a *method* mark: the right approach, even if the number is wrong.
- **A1** an *answer* mark, and it usually needs its M mark first.
- **C1** a working mark on the way to the answer.
- // separates answers the examiner accepts equally.
- **ecf** = error carried forward: a later part is marked on your own earlier answer.
- **owtte** = "or words to that effect" – the wording need not match.

Question 12

9700/11 N25 ▪ Q12 ▪ 1 mark

12 The graph shows the effect of substrate concentration on an enzyme-catalysed reaction with and without a competitive inhibitor.



What is the effect of the competitive inhibitor on V_{max} and K_m?

Question 12

A V_{max} decreases and K_m decreases.

B V_{max} stays the same and K_m decreases.

C V_{max} stays the same and K_m increases.

D V_{max} decreases and K_m stays the same.

Solution 12

Answer: **C**

Why

- A competitive inhibitor binds the active site itself, so more substrate can out-compete it.
- So the maximum rate can still be reached: V_{max} is unchanged.
- But more substrate is needed to get halfway there, so K_m increases.

Question 14

9700/12 N25 ▪ Q14 ▪ 1 mark

14 How is the Michaelis–Menten constant (K_m) used?

A to determine the number of collisions between the enzyme and substrate

B to compare the affinity of enzymes for their substrates

C to find the maximum velocity of an enzyme (V_{max})

D to find the optimum rate of reaction

Solution 14

Answer: **B**

Why

- K_m is the substrate concentration that gives half the maximum rate.
- A low K_m means the enzyme reaches half speed at low substrate – a high affinity.
- So it is used to compare how strongly different enzymes bind their substrates.

Question 15

9700/12 N25 ▪ Q15 ▪ 1 mark

15 Some students investigated the effect of pH on the rate of starch digestion by amylase at 20 °C.

- They added 2 cm^3 of a 1% amylase solution and 1 cm^3 of pH 4 buffer to a test-tube.
- They added 2 cm^3 of a starch solution, containing 0.02 g of starch, to the test-tube.
- They measured the time taken for the starch to be digested (to disappear).

The students then repeated these steps with pH 5, pH 6, pH 7 and pH 8 buffers.

The table shows the results.

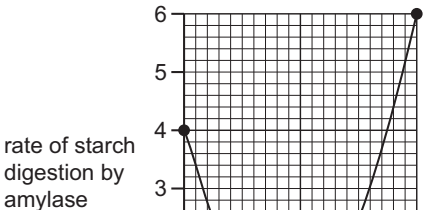
pH	time taken for starch to be digested / minutes
4	4.0
5	1.5

Question 15

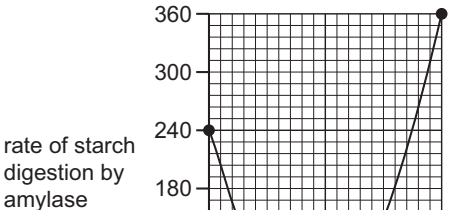
5	1.5
6	1.0
7	2.5
8	6.0

Which graph is correct for these data?

A

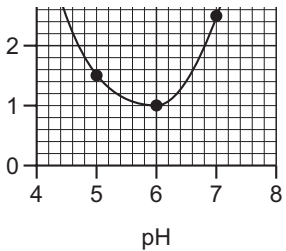


B



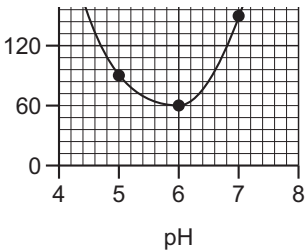
Question 15

/ minutes



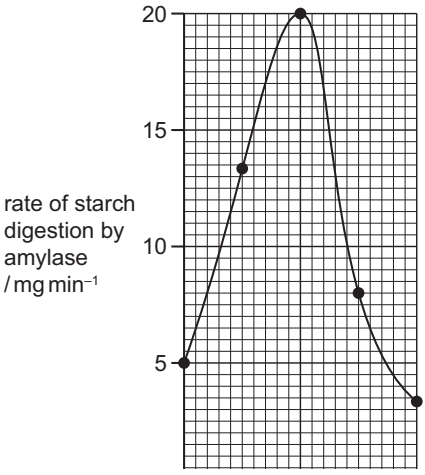
C

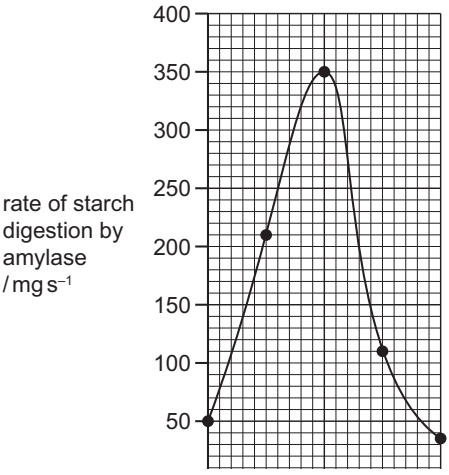
/ seconds



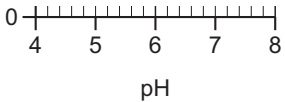
D

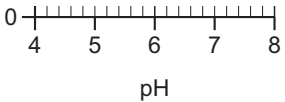
Question 15


rate of starch digestion by amylase / mg min⁻¹
20
15
10
5


rate of starch digestion by amylase / mg s⁻¹
400
350
300
250
200
150
100
50

Question 15





Solution 15

Answer: **C**

Why

- Work out the rate as amount of starch divided by the time taken.
- Keep the units consistent – the starch mass is given in grams and the time in seconds.
- Compare rates between pH values only when everything else was kept the same.

Question 16

9700/12 N25 ▪ Q16 ▪ 1 mark

16 Which statements are correct for a non-competitive inhibitor of enzyme action?

1 Increasing the concentration of the enzyme's substrate will reduce its effect.

2 It reduces the activation energy required for a reaction to take place.

3 It reduces the maximum rate of reaction.

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

Solution 16

Answer: **D**

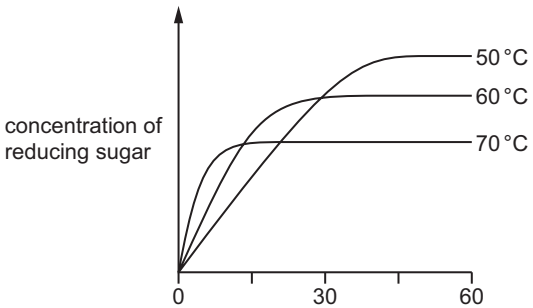
Why

- A non-competitive inhibitor binds away from the active site, so extra substrate cannot displace it – statement 1 is wrong.
- It has no effect on the activation energy – statement 2 is wrong.
- It does permanently take enzyme molecules out of action, so the maximum rate falls – statement 3 is right.

Question 16

9700/13 N25 ▪ Q16 ▪ 1 mark

16 The graph shows the results of an investigation into the effect of amylase on starch at three different temperatures.



Question 16

time / minutes

Which statements are correct conclusions using these results?

1 The optimum temperature is 50 °C.

2 The initial rate of reaction is highest at 70 °C.

3 The higher the temperature the more quickly the enzyme denatures.

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

Solution 16

Answer: **D**

Why

- Look at both the final amount of product and the initial gradient.
- The highest initial rate is not necessarily the best temperature – a higher temperature may denature the enzyme part-way.
- The optimum is the temperature that gives the most product overall, not just the fastest start.

Question 17

9700/13 N25 ▪ Q17 ▪ 1 mark

17 The rate of enzyme-catalysed reactions in human cells is regulated.

What may be involved in this regulation?

1 a change in enzyme concentration

2 a change in substrate concentration

3 inhibition by the final product of the reaction

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

Solution 17

Answer: **A**

Why

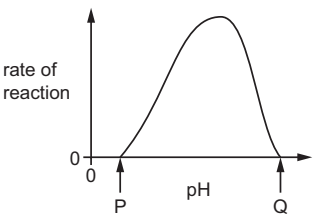
- More enzyme means more active sites, so the rate rises.
- More substrate raises the rate until the active sites are saturated.
- End-product inhibition is a standard control mechanism, so all three are involved.

Question 15

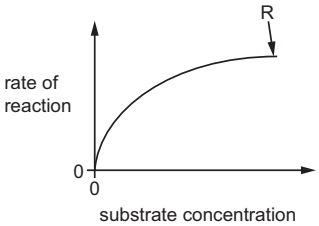
9700/14 N25 ▪ Q15 ▪ 1 mark

15 Graph J shows the effect of pH on the rate of an enzyme reaction. Graph K shows the effect of substrate concentration on the rate of an enzyme reaction.

graph J



graph K



A student wrote four statements about the graphs.

Question 15

1 In graph J, the enzyme is denatured at point Q.

2 In graph J, the enzyme is inactive at point P.

3 In graph K, the rate of reaction is directly proportional to the substrate concentration.

4 In graph K, V_{max} is reached at point R.

Which statements are correct?

A 1, 2 and 3 **B** 1, 2 and 4 **C** 1, 3 and 4 **D** 2, 3 and 4

Solution 15

Answer: **B**

Why

- Graph J peaks at the optimum pH, with the rate falling away on both sides as the enzyme denatures.
- Graph K rises then levels off, because at high substrate all active sites are occupied.
- The plateau on K is limited by enzyme concentration, not by substrate.

Question 1

9700/31 N25 ▪ Q1 ▪ 22 marks

1 The bacterium *Streptococcus pneumoniae* is commonly found in the throat. *S. pneumoniae* produces hydrogen peroxide as it grows. A sample can be taken from a patient's throat and tested to measure the concentration of hydrogen peroxide. This can be used as a measure of the growth of the bacteria.

You will determine the growth of bacteria by measuring the concentration of hydrogen peroxide in a solution that represents a sample taken from a patient. You will do this by measuring how long it takes for a sample of hydrogen peroxide to cause a colour change in a reaction mixture. The faster the mixture changes to a blue-black colour, the higher the concentration of hydrogen peroxide, and the greater the growth of bacteria.

You will use a range of known concentrations of hydrogen peroxide to estimate the concentration of hydrogen peroxide in a sample.

You are provided with the materials shown in Table 1.1.

Table 1.1

Question 1

labelled	contents	hazard	volume / cm^3
R1	dilute sulfuric acid	irritant	100
R2	starch solution	low	10
R3	potassium iodide solution	low	10
R4	sodium thiosulfate solution	low	10
H	2.0% hydrogen peroxide solution	irritant	25
U	solution representing patient sample	irritant	10
W	distilled water	low	100

If any solution comes into contact with your skin, wash off immediately with cold water.

It is recommended that you wear suitable eye protection.

You will need to carry out a **serial** dilution of the 2.0% hydrogen peroxide solution, **H**, to reduce the concentration by **half** between each successive dilution.

Question 1

You will need to prepare **four** concentrations of hydrogen peroxide solution in addition to the 2.0% hydrogen peroxide solution, **H**.

After the serial dilution is completed, you will need to have 10 cm^3 of each concentration available to use.

(a) (i) Complete Fig. 1.1 to show how you will prepare your serial dilution.

Each beaker should have:

- a labelled arrow to show the volume of hydrogen peroxide solution transferred
- a labelled arrow to show the volume of distilled water, **W**, added
- a label under the beaker to show the concentration of the hydrogen peroxide solution.

0 cm^3 of **W**

Question 1

Solution 1

(a)(i) Mark scheme

- 1
- states 1%, 0.5%, 0.25% and 0.125% under the appropriate beaker ;
- 2
- shows transfer of 10cm3 to each beaker from the previous beaker ;
- 3
- shows 10 cm3 of W added to each beaker ;
- 3

Solution 1

(a)(ii) Mark scheme

- 1
- (heading for independent variable)
- concentration of H2O2 and % and to the left of the dependent variable ;
- 2
- (heading for dependent variable)
- time / seconds ;
- 3
- result for each concentration ;

Solution 1

- 4
- expected pattern of results (the highest concentration has the shortest time) ;
- 5
- results recorded to the nearest whole second ;
- 5

Solution 1

(a)(iii)

Mark scheme

- the times for U1, U2 and U3 recorded and seconds ;
- 1

(a)(iv)

Mark scheme

- shows the three times added and divided by 3 ;
- 1

Solution 1

(a)(v)

Mark scheme

- estimates the concentration of hydrogen peroxide in sample U according to results ;
- 1

(a)(vi)

Mark scheme

- shows that there are no anomalies ;
- 1

Solution 1

(a)(vii)

Mark scheme

- states that using smaller intervals between concentrations of hydrogen peroxide around the estimate would allow a more
- accurate estimate ;
- 1

Solution 1

(b)(i) Mark scheme

- 1
- x-axis: time / hours
- and
- y-axis: percentage of bacterial cells able to produce hydrogen peroxide ;
- 2
- scale on x-axis: 40 to 2 cm, labelled at least every 2 cm
- and
- y-axis: 4 to 2 cm, labelled at least every 2 cm ;

Solution 1

- 3
- correct plotting of points using small dots in circles or crosses ;
- 4
- plots joined with thin line passing through all points ;
- 4

Solution 1

(b)(ii) Mark scheme

- 1
- percentage increases as time progresses (for both temperatures) ;
- 2
- greater increase at lower temperature ;
- 2
- 9700/31
- October/November 2025

Solution 1

(b)(iii)

Mark scheme

- 1
- value estimated from graph ;
- 2
- suitable line shown on the graph ;
- 2

Solution 1

(b)(iv)

Mark scheme

- states one of these variables – species of bacteria / pH / nutrient status / oxygen ;
- 1