Required Practical 1, Enzyme Rates: AQA A Level Biology Exam Questio

17 questions · 36 marks · about 47 minutes. Answer in the spaces, then check the mark schemes at the end.

Question 1 · AS Paper 1 · June 2024 · Q08.2 · 2 marks

0 8 . 2 A scientist investigated the hydrolysis of the protein casein.

The scientist:

- mixed a solution of a protease enzyme with a solution of casein
- then measured the casein concentration in the mixture at intervals
- controlled all relevant variables appropriately.

For this investigation, identify:

[2 marks]

the independent variable _____

_____

_____

the dependent variable _____

_____

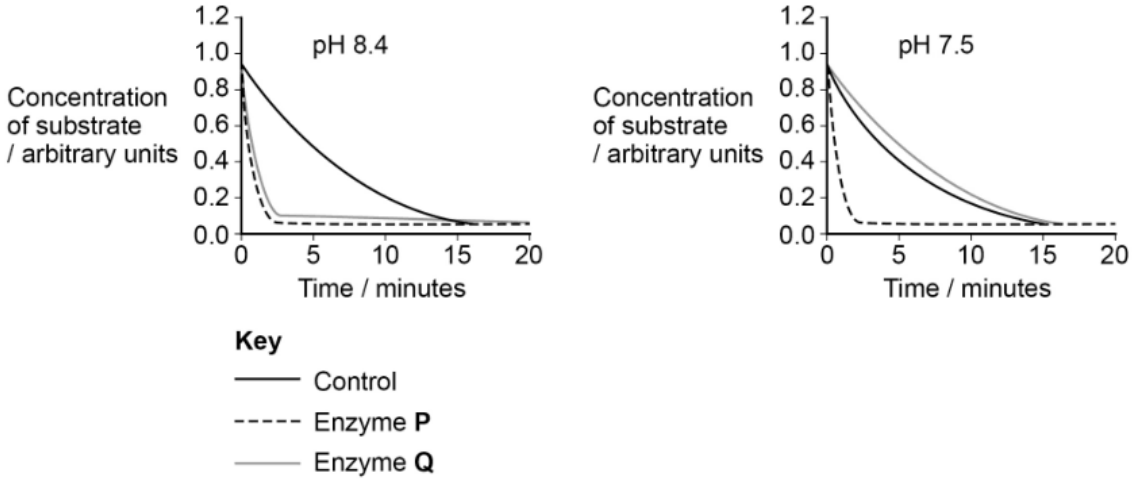
_____

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Scientists investigated the effect of pH 8.4 and pH 7.5 on the activity of enzymes **P** and **Q**.

Figure 8 shows their results.

Figure 8



0 5 . 3 Describe what the scientists should place in the control tubes in this investigation.

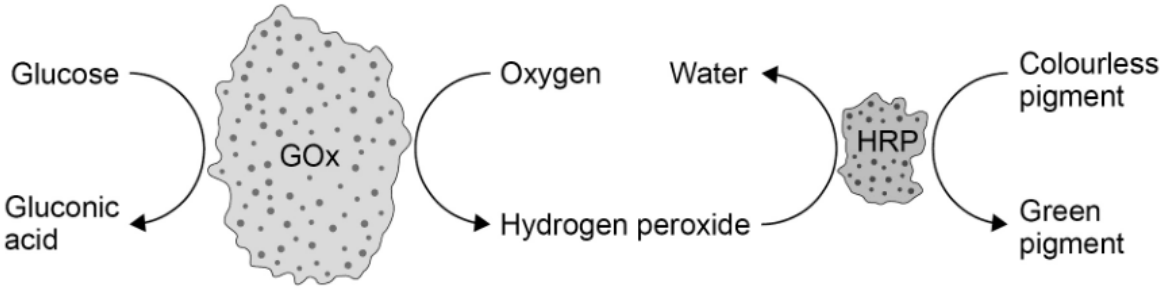
[3 marks]

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Question 3 · information from earlier in the question

0 8 A scientist investigated a sequence of reactions catalysed by **two** enzymes, GOx and HRP. **Figure 9** shows this sequence of reactions.

Figure 9



The scientist investigated the activity of GOx and HRP enzymes when they are:

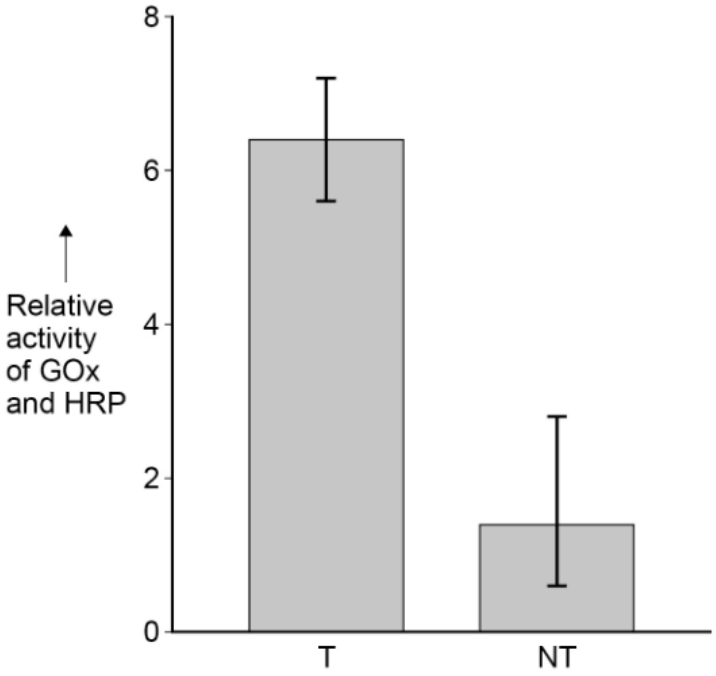
- trapped inside cages (**T**) and
- not trapped (**NT**), but free in solution with **no** cages.

Figure 10 shows his results.

The error bars show ± 2 standard deviations.

± 2 standard deviations include 95% of the data.

Figure 10



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Question 3 · AS Paper 2 · November 2021 · Q08.4 · 1 mark

0 8 . 4 The design of the scientist's investigation did **not** include a suitable control.

Suggest a suitable control.

[1 mark]

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The action of the enzyme catalase is shown below.

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

A student investigated the effect of hydrogen peroxide concentration on the rate of this reaction. He used catalase from potato tissue.

The student:

- put five potato chips in a flask
- added 20 cm^3 of 0.5 mol dm^{-3} hydrogen peroxide solution to the flask
- measured the time in seconds for production of 10 cm^3 of oxygen gas
- repeated this procedure with four different concentrations of hydrogen peroxide solution.

His results are shown in **Table 5**.

Table 5

Hydrogen peroxide concentration / mol dm^{-3}	Time for production of 10 cm^3 of oxygen gas / seconds	Rate of reaction / arbitrary units
0.5	18	
1.0	10	
1.5	7	
2.0	6	
2.5	6	

0 7 . 2 Other than those stated, give **one** factor the student would have controlled in his investigation.

[1 mark]

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Potato cells contain catalase.

A student investigates the effect of the surface area of potato pieces on the rate of the reaction of catalase.

0 6 . 2 Before starting the investigation, the student reads the following information.

Hydrogen peroxide:

- is a clear, colourless solution
- is harmful if swallowed
- causes serious eye damage
- may cause damage or irritation to the skin
- may cause respiratory irritation.

Use this information to suggest **two** safety precautions the student should take.

Give **one** reason for each safety precaution.

[2 marks]

Precaution 1 _____

Reason _____

_____

_____

Precaution 2 _____

Reason _____

_____

_____

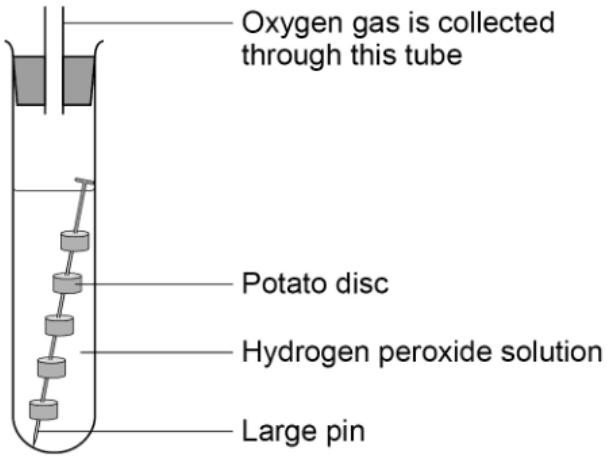
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The student uses the following method.

1. Cut a 75 mm long cylinder of potato into 5 discs of equal size.
2. Arrange the discs on a large pin in a boiling tube.
3. Add 40 cm^3 of 1.0 mol dm^{-3} hydrogen peroxide.
4. Record the volume of oxygen collected in 2 minutes.
5. Repeat steps 1 to 4 with an uncut cylinder of potato 75 mm long.

Figure 10 shows the equipment the student uses.

Figure 10



0 6 . 3 Suggest why the student arranges the potato discs on the pin as shown in **Figure 10**.
[1 mark]

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Question 7 · AS Paper 2 · June 2025 · Q06.4 · 3 marks

Table 3 gives measurements for one potato disc and the uncut potato cylinder used in the investigation.

Table 3

	Length (L) / mm	Diameter / mm
One potato disc	15	10
Uncut potato cylinder	75	10

0 6 . 4 Calculate how many times greater the total surface area of the five discs of potato is compared with the surface area of the uncut cylinder.

Use the information in **Table 3** and the formula below.

The formula for the surface area of a disc or cylinder = $2\pi r(r+L)$

where
r = radius
L = length
π = 3.14

[3 marks]

_____ times greater

Question 8 · AS Paper 2 · November 2020 · Q05.1 · 2 marks

0 5 . 1 A student investigated starch hydrolysis using the enzyme amylase.

During the procedure, the student:

- treated the starch to make it soluble
- prepared 10 cm^3 of different concentrations (mg dm^{-3}) of starch solution
- added an identical concentration of amylase to each starch solution
- measured the time in minutes to completely hydrolyse starch.

He repeated the procedure and calculated the mean time to completely hydrolyse starch in each concentration of starch solution.

Draw a table the student could use to record all of his results.

You only need to show completed column headings.

[2 marks]

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0 7 . 1 A student investigated the activity of the enzyme polyphenol oxidase (PPO) in apple tissue.

When apple tissue is exposed to air, PPO catalyses a reaction between colourless phenol compounds in apple tissue and oxygen.

Figure 7 shows the reaction.

Figure 7

$$\text{phenol compounds + oxygen} \xrightarrow{\text{PPO}} \text{brown pigment}$$

The student measured the time taken for the brown pigment to appear in two apple varieties (**D** and **E**).

Method

1. Cut a 1 cm cube of apple tissue from variety **D**.
2. Put the cube on a plate and leave the plate at 30 °C
3. Measure the time for the brown pigment to appear.
4. Repeat steps 1 to 3 two more times.
5. Repeat steps 1 to 4 with apple tissue from variety **E**.

The student obtained the results shown below, but did not record the data in a results table.

Variety **D** = 15 min 50 s, 18 min, 14 min 30 s

Variety **E** = 6 min 30 s, 8 min, 7 min

In the box labelled **Figure 8**, design a suitable results table.

- Enter the student's results into the table.
- Calculate the mean results and include these in the table.
- Use 1 decimal place for both mean results.

[3 marks]

Figure 8

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Question 10 · information from earlier in the question

The action of the enzyme catalase is shown below.

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

A student investigated the effect of hydrogen peroxide concentration on the rate of this reaction. He used catalase from potato tissue.

The student:

- put five potato chips in a flask
- added 20 cm^3 of 0.5 mol dm^{-3} hydrogen peroxide solution to the flask
- measured the time in seconds for production of 10 cm^3 of oxygen gas
- repeated this procedure with four different concentrations of hydrogen peroxide solution.

His results are shown in **Table 5**.

Table 5

Hydrogen peroxide concentration / mol dm^{-3}	Time for production of 10 cm^3 of oxygen gas / seconds	Rate of reaction / arbitrary units
0.5	18	
1.0	10	
1.5	7	
2.0	6	
2.5	6	

Question 10 · AS Paper 1 · June 2019 · Q07.3 · 2 marks

0 7 . 3 The student gave the maximum rate of reaction a value of 1.0 arbitrary units.

Complete **Table 5** by calculating the rate of reaction in arbitrary units at each hydrogen peroxide concentration. Record the rates using an appropriate number of significant figures.

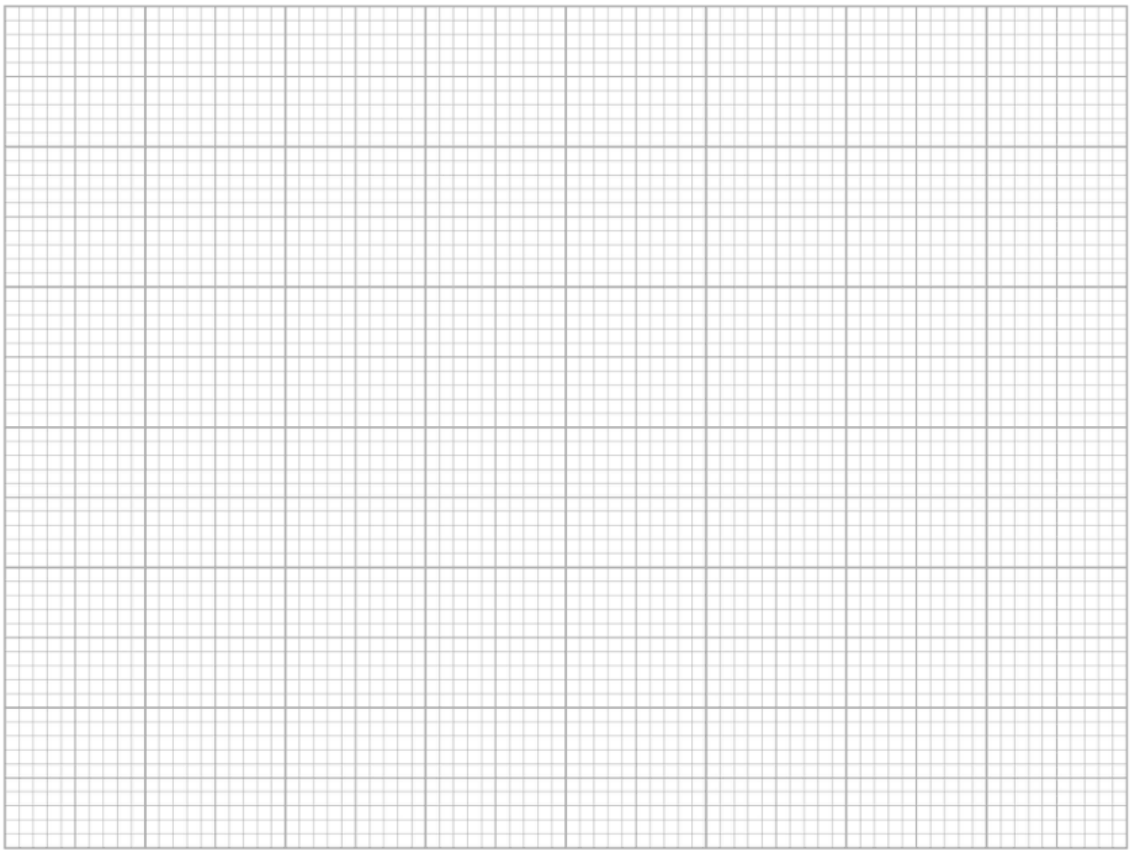
[2 marks]

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Question 11 · AS Paper 1 · June 2019 · Q07.4 · 3 marks

0 7 . 4 Plot a suitable graph of your processed data shown in **Table 5**.

[3 marks]



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0 5 . 2 The scientists grew plant cells in a culture for 12 days. At the start, there were only a few cells in the culture. Each day, they determined the mass of sucrose hydrolysed by SPS in the plant cells in **1 hour**.

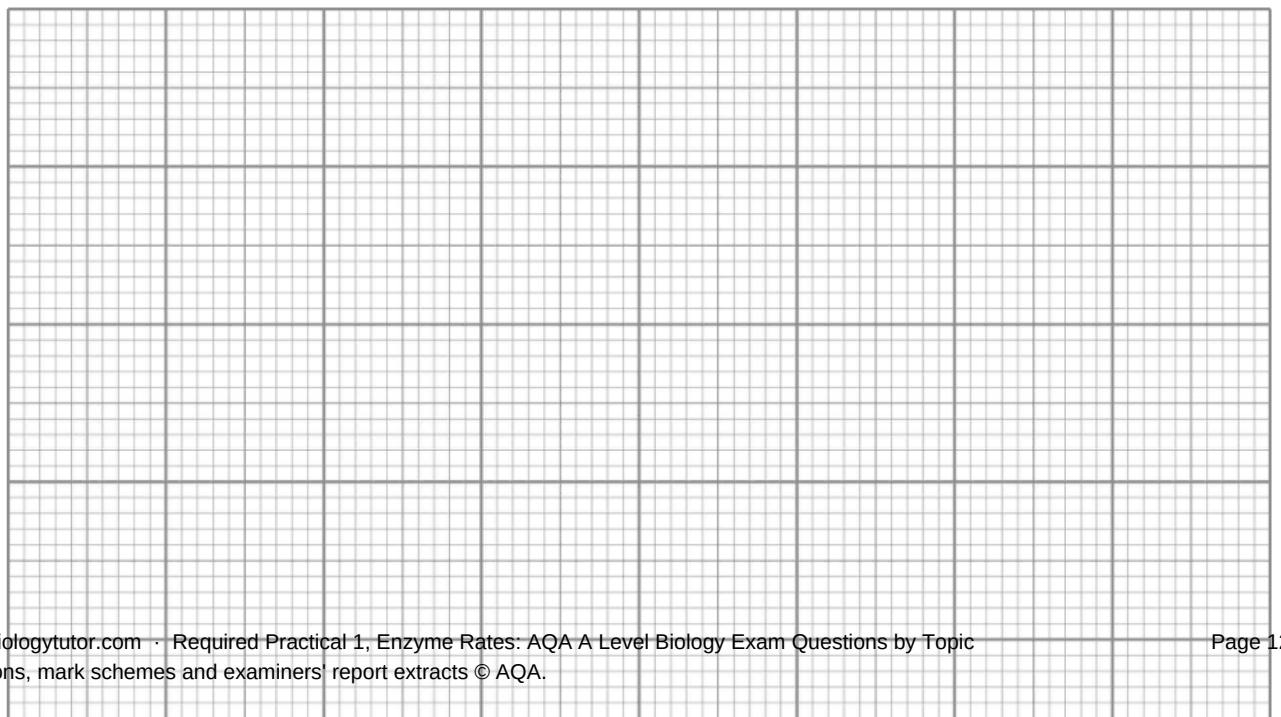
Table 2 shows their results.

Table 2

Day	Mass of sucrose hydrolysed by SPS in 1 hour / µg	Rate of hydrolysis of sucrose by SPS
0	0.07	
2	0.09	
4	0.11	
6	0.15	
8	0.20	
10	0.24	
12	0.24	

For each day, calculate the rate **per minute** of the reaction catalysed by SPS. Record the rates in standard form and plot a suitable graph of your processed data.

[3 marks]



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Question 13 · information from earlier in the question

The action of the enzyme catalase is shown below.

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

A student investigated the effect of hydrogen peroxide concentration on the rate of this reaction. He used catalase from potato tissue.

The student:

- put five potato chips in a flask
- added 20 cm^3 of 0.5 mol dm^{-3} hydrogen peroxide solution to the flask
- measured the time in seconds for production of 10 cm^3 of oxygen gas
- repeated this procedure with four different concentrations of hydrogen peroxide solution.

His results are shown in **Table 5**.

Table 5

Hydrogen peroxide concentration / mol dm^{-3}	Time for production of 10 cm^3 of oxygen gas / seconds	Rate of reaction / arbitrary units
0.5	18	
1.0	10	
1.5	7	
2.0	6	
2.5	6	

Question 13 · AS Paper 1 · June 2019 · Q07.5 · 1 mark

0 7 . 5 Suggest a change the student could make to his procedure so that 10 cm^3 of oxygen would be produced in less than 6 seconds.

[1 mark]

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Question 14 · information from earlier in the question

0 7 . 1 A student investigated the activity of the enzyme polyphenol oxidase (PPO) in apple tissue.

When apple tissue is exposed to air, PPO catalyses a reaction between colourless phenol compounds in apple tissue and oxygen.

Figure 7 shows the reaction.

Figure 7

$$\text{phenol compounds} + \text{oxygen} \xrightarrow{\text{PPO}} \text{brown pigment}$$

The student measured the time taken for the brown pigment to appear in two apple varieties (**D** and **E**).

Method

1. Cut a 1 cm cube of apple tissue from variety **D**.
2. Put the cube on a plate and leave the plate at 30 °C
3. Measure the time for the brown pigment to appear.
4. Repeat steps 1 to 3 two more times.
5. Repeat steps 1 to 4 with apple tissue from variety **E**.

The student obtained the results shown below, but did not record the data in a results table.

Variety **D** = 15 min 50 s, 18 min, 14 min 30 s

Variety **E** = 6 min 30 s, 8 min, 7 min

In the box labelled **Figure 8**, design a suitable results table.

- Enter the student's results into the table.
- Calculate the mean results and include these in the table.
- Use 1 decimal place for both mean results.

[3 marks]

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Question 14 · A level Paper 1 · June 2024 · Q07.2 · 2 marks

0 7 . 2 Suggest and explain why the results for variety **D** are different from the results for variety **E**.

[2 marks]

Question 15 · A level Paper 1 · June 2024 · Q07.3 · 3 marks

0 7 . 3 The student repeated the investigation but made **one** change to the method used to prepare the apple tissue.

The student then observed shorter times for the brown pigment to appear in both apple varieties.

Suggest the change the student made to the method of preparing the apple tissue.

Explain why the brown pigment appeared in a shorter time.

Do **not** suggest using a different volume or mass of apple.

[3 marks]

Change to method

Explanation

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Question 16 · information from earlier in the question

0 8 . 2 A scientist investigated the hydrolysis of the protein casein.

The scientist:

- mixed a solution of a protease enzyme with a solution of casein
- then measured the casein concentration in the mixture at intervals
- controlled all relevant variables appropriately.

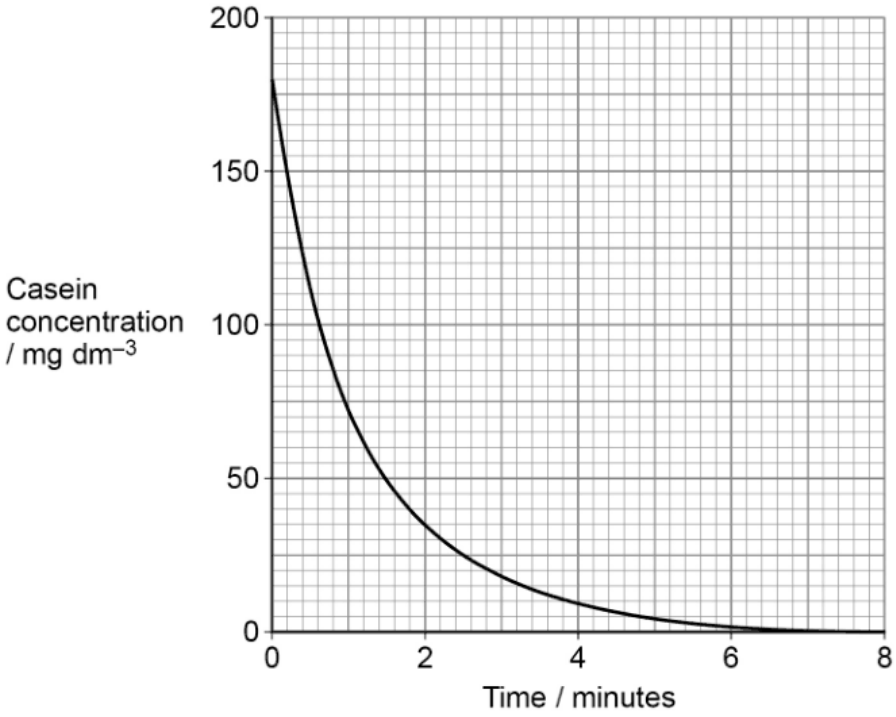
For this investigation, identify:

[2 marks]

Question 16 · AS Paper 1 · June 2024 · Q08.3 · 2 marks

0 8 . 3 **Figure 10** shows the scientist's results.

Figure 10



Use **Figure 10** to determine the rate of casein hydrolysis at 2 minutes.

Show how you obtained your answer.

[2 marks]

Answer _____ mg dm^{-3} minute^{-1}

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Question 17 · AS Paper 1 · June 2024 · Q08.4 · 2 marks

0 8 . 4 The scientist repeated the investigation but increased the temperature to the optimum temperature for this protease.

Sketch a line on **Figure 10** showing the results you predict if the investigation is repeated at the optimum temperature for the protease.

[2 marks]

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Mark schemes

Question 1 · AS Paper 1 · June 2024 · Q08.2 · 2 marks

08.2	1. (Independent) Time (of measurement/test /sample taken); 2. (Dependent) Casein concentration;	2 (2 x AO2)	

Question 2 · A level Paper 1 · June 2022 · Q05.3 · 3 marks

05.3	1. Same volume of (each) buffer/pH solution; 2. Same concentration/mass of substrate (at start); 3. Same concentration/mass of **denatured** enzyme; If no marks gained, accept for 1 mark, Buffer **and** substrate **and** denatured enzyme **OR** Buffer **and** substrate **and** no enzyme **OR** Buffer **and** substrate **and** water;	3 (3 x AO3)

Ignore temperature Ignore amount for volume, concentration OR mass Accept pH solution for buffer 3. Accept description of denatured, eg boiled

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Question 3 · AS Paper 2 · November 2021 · Q08.4 · 1 mark

08.4	Denatured enzymes **OR** Inactivated enzymes **OR** Empty cages (in water);	1	Accept any valid method of denaturing/inactivation
TOTAL		**8**	

Question 4 · AS Paper 1 · June 2019 · Q07.2 · 1 mark

07.2	Size/dimensions /mass/variety of potato **OR** Temperature (of solution/flask) **OR** pH (of solution);	1	Accept : weight of potato Ignore : amount of potato Ignore concentration/ volume of catalase

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06.2	1. Label glassware/beaker/flasks/boiling tubes/hydrogen peroxide because hydrogen peroxide could be mistaken for water; 2. Wear gloves to prevent hydrogen peroxide/solution making contact with skin/damaging skin; 3. (Work in) a well-ventilated room or fume cupboard to prevent inhaling hydrogen peroxide (fumes) **OR** to prevent respiratory damage; 4. Wear (safety) glasses/goggles to prevent hydrogen peroxide entering the eyes/damaging the eyes;

2 max (2 x AO2)	Each mark needs precaution and reason 2. Accept lab coat or mask/visor but only if idea of covering the skin is clear 3. Allow mask

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06.3	To expose all of the surface (to the hydrogen peroxide/substrate) **OR** To maximise the surface exposed (to the hydrogen peroxide);

1 (1 x AO2)	Ignore increasing the surface area

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06.4	Correct answer of 1.3/1.25 = **3 marks**;;; Incorrect answer but shows 3140 **and** 2512 = **2 marks** **OR** Incorrect answer but shows 3142 **and** 2513 = **2 marks** **OR** Incorrect answer of 1.5/1.47 = **2 marks**;; Incorrect answer but shows 628/628.3 = **1 mark**;	3 (3 x AO2)

Surface areas 3140 and 2512 if 3.14 used for π
Surface areas 3142 and 2513 if calculator used for π
0.8 if surface area of cylinder divided by surface area of discs
1.5/1.47 if diameter used instead of radius
628 for surface area of one disc

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Question 8 · AS Paper 2 · November 2020 · Q05.1 · 2 marks

05.1	1. Starch (solution) in first column; 2. Headings for starch concentration/solution **and** time for (starch) hydrolysis/digestion with mg dm-3 **and** minutes/mins/min/m/seconds/s;	2	Ignore columns with replicates/ mean Ignore lines 2. Accept brackets for solidus 2. Ignore reference to enzyme 2. Reject graph

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07.1

1. Variety **and** D **and** E in left column;
2. Time **and** '/ min' **and** Mean (time) '/ min' in column heading only;
3. Correctly calculated times **and** means calculated to one decimal place;

Examples achieving 3 marks

Variety	Time / minutes	Mean / minutes
D	15.8/15.83/16	16.1 **OR** 16.2 **OR** 16.3
	18	
	14.5/15	
E	6.5/7	7.2 **OR** 7.3
	8	
	7	

Apple	Time / s	Mean / s
D	950	
	1080	966.7
	870	
E	390	
	480	430.0
	420	

3 (3 x AO2)

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07.3	0.33, 0.60, 0.86, 1.0, 1.0 = 2 marks;; $\frac{6}{time}$ 2 significant figures If answer incorrect accept for 1 mark, Correct values but incorrect number of significant figures **OR** 1.0 written on row for hydrogen peroxide 2.0/2.5 in Table 5 **OR** Answers showing correct division, eg 0.3, 0.6, 0.9 **OR** Answers showing correct significant figures using incorrect calculation (÷18) 1.0, 0.56, 0.39, 0.33, 0.33	2

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Question 11 · AS Paper 1 · June 2019 · Q07.4 · 3 marks

07.4	1. Hydrogen peroxide concentration on x axis **and** rate of reaction on Y axis, linear number sequence **and** appropriate scale; 2. Correct units /mol dm^{-3} **and** /arbitrary units/au; 3. All co-ordinates plotted accurately **with** point-to-point or smooth curve;	3	1. Graph should cover half or more of the grid; eg reject if Y axis covers only three big squares 2. Accept brackets instead of solidus 3. Accept accurate plotting of co-ordinates given in 07.3 3. Reject: bar chart 3. Reject: if ruled straight line of best fit 3. Accept: if x axis starts at 0.5 3. Accept: if line is extended to (0,0) Plot coordinates must be processed data, hydrogen peroxide vs time = 0

Question 12 · AS Paper 1 · June 2016 · Q05.2 · 3 marks

05.2	1. Line graph with rate on y axis and days/time in days on x axis and linear scales; 2. Correct units of µg min^{-1}/per minute/$minute^{-1}$ $\times 10^{-3}$; 3. Rates correctly calculated and plotted, with line connecting points/line of best fit and no extrapolation;	3	Correct answers $\times 10^{-3}$ 1.17, 1.50, 1.83, 2.50, 3.33, 4.00, 4.00 (accept to 1DP) 2. Reject m^{-1} 2. Reject if put 10^{-3} on axis for each point 2. '/' means separating units from what goes before i.e. accept sucrose hydrolysis per min / µgx10^{-3} 3. Do not accept a ruled **straight line** of best fit Accept y axis starting at 1

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Question 13 · AS Paper 1 · June 2019 · Q07.5 · 1 mark

07.5	Cut up/use discs/homogenise/increase surface area (of potato chips) **OR** Use bigger chips **OR** Increase temperature **OR** Change pH;	1	Reject answer if the temperature is above 40°C Ignore: more/increase heat
TOTAL		**10**	

Question 14 · A level Paper 1 · June 2024 · Q07.2 · 2 marks

07.2	1. More phenol/substrate in E **OR** More PPO/enzyme in E **OR** Higher PPO/enzyme activity in E; 2. (So) more enzyme-substrate/E-S complexes (form);

2 (2 x AO2)	1. and 2. Accept the converse for D 1. Ignore oxygen 2. Ignore ESC

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07.3	1. Use (enzyme's) higher/optimum temperature; 2. More kinetic energy **OR** (So) more active enzyme; 3. (Causing) increased rate of reaction **OR** (Causing) more enzyme-substrate complexes/collisions; **OR** 4. Use (enzyme's) lower/optimum temperature **OR** Use (enzyme's) optimum pH; 5. Less denaturation; **OR** (So) more active enzyme; 6. (Causing) increased rate of reaction **OR** (Causing) more enzyme-substrate complexes/collisions; **OR** 7. Crush/grind/blend/chop the apple (tissue);	3 max (3 x AO3)
	8 (So) more PPO/phenol/substrate in contact with oxygen/air; 9. (Causing) increased rate of reaction **OR** (Causing) more enzyme-substrate complexes/collisions;	

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Mark in groups 1–2

Question 16 · AS Paper 1 · June 2024 · Q08.3 · 2 marks

08.3	1. and 2. Correct answer of 20–30 = **2 marks**;; Tangent drawn touching (2, 35) with incorrect calculation = **1 mark** **OR** 17.5 (for incorrect method with correct reading at 2 minutes (35) and division by correct time, (2)) = **1 mark**;	2 (2 x AO2)

Question 17 · AS Paper 1 · June 2024 · Q08.4 · 2 marks

08.4	1. Curve drawn entirely to the left of the curve given; 2. Similar shaped curve from (0, 180) to intersect x axis between (0, 0) and (6, 0);	2 (2 x AO3)

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