Name	Date started	Target end date

GCE AS / A LEVEL — BIOLOGY UNIT 1 QUESTION PACK

1071-01 (Legacy BY1) · New spec Unit 1 Topic 3 · AS unit, first sat 2016, 80 marks, 1h 30min paper

REVISE
.wales

BIOLOGY — UNIT 1 · ENZYMES

BY1.4 Enzymes — active site, kinetics and inhibition

Lock-and-key and induced-fit models, factors affecting rate of reaction, competitive vs non-competitive inhibitors, immobilised enzymes and the Vmax / Km basics.

LEGACY 2008 SPECIFICATION

Estimated time for entire question pack: ~1 h 26 min

Derived from the legacy BY1 paper's pace of ~1.1 min/mark, padded for long-prose answers (54 marks over 5 questions).

*You are advised to **not** attempt to complete all of this in one sitting.*

ABOUT THIS QUESTION PACK

This is a **comprehensive practice question pack**, not a single mock paper. It contains every question from the legacy WJEC BY1 papers (2008 modular spec, 2011–2017) that maps onto new-spec AS Unit 1 Topic 3 (1.4).

Questions are ordered by source paper date.

INSTRUCTIONS

Use black ink or black ball-point pen. Show all working — quality of written communication will affect marks. A calculator is allowed. Diagrams included in answers must be fully annotated.

For Examiner's use only

Q	Source	Max	Mark
1	Jun 13 Q2	9	
2	Jan 14 Q4	12	
3	Jun 11 Q4	12	

Q	Source	Max	Mark
4	Jun 17 Q6	10	
5	Jan 12 Q4	11	
Total		**54**	

Enzymes — what the new spec asks

WJEC GCE AS / A Level Biology (from 2015) · Unit 1: Basic Biochemistry & Cell Organisation · Topic 1.4.

Active site & specificity

- Enzymes are globular proteins — tertiary structure determines shape.
- Active site complementary to substrate.
- Lock-and-key (rigid) vs induced-fit (flexible) models.

Factors affecting rate

- Temperature: rate rises until denaturation (~40°C in most human enzymes).
- pH: each enzyme has an optimum; extremes denature.
- Substrate & enzyme concentration: linear then plateau.

Inhibition

- Competitive: similar shape to substrate; binds active site; reversible by ↑ substrate.
- Non-competitive: binds elsewhere; alters active site; not reversed by more substrate.
- Examples: malonate (competitive); cyanide (non-competitive).

Immobilised enzymes & kinetics

- Immobilised on beads / fibres / gels — reusable, stable, easily separated.
- Industrial uses: lactose-free milk, biosensors, HFCS.
- V_{max} = maximum rate at saturating substrate; K_m = [S] at $\frac{1}{2}V_{max}$ (lower K_m = higher affinity).

Crib sheet »

Enzymes in one page

Quick-reference notes — revisit before each question.

Active site

Enzyme = globular protein; tertiary structure forms active site.

Substrate binds ⇒ E-S complex ⇒ products.

Specificity from complementary shape + charges.

Lock-and-key vs induced fit

Lock-and-key: rigid active site complementary to substrate.

Induced fit: active site moulds around substrate; explains broader specificity.

Temperature & pH

Q_{10} ~2 up to optimum.

Above optimum: H-bonds break ⇒ denaturation.

Extremes of pH alter R-group charges ⇒ active site distorts.

Substrate / enzyme conc.

Initial linear rise until saturation; plateau = V_{max}.

Enzyme conc.: linear if substrate in excess.

Inhibitors

Competitive: similar shape to substrate; reversed by ↑ [S]; shifts curve right.

Non-competitive: binds allosteric site; lowers V_{max}; not reversed.

Immobilised enzymes

Bound to beads/fibres/gels.

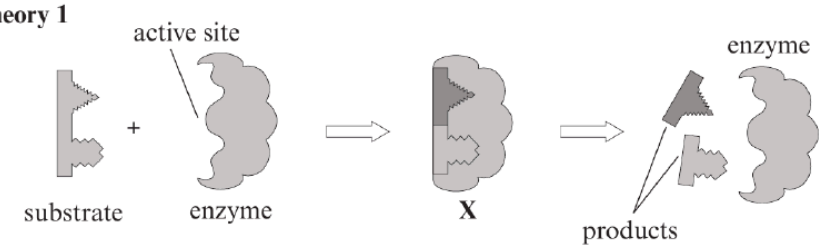
Reusable, easily separated, more thermostable, easy to control.

Examples: lactose-free milk (lactase), biosensors (glucose oxidase).

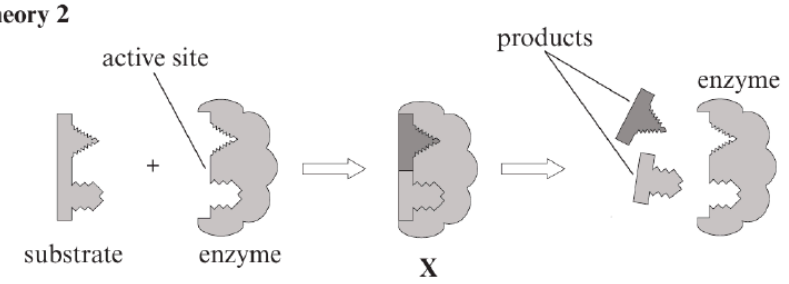
Examiner only

2. The diagram below shows two theories used to explain enzyme activity.

Theory 1



Theory 2



(a) (i) **Theory 1** shows the induced fit hypothesis. What name is given to **Theory 2**? [1]

.....

(ii) Which theory represents the activity of lysozyme? [1]

.....

(b) Name **X** as shown in both theories. [1]

.....

(c) Enzymes are biological catalysts. How do they bring about their effect of speeding up a reaction? [1]

.....

.....

Examiner only

(d) What characteristic of an enzyme at the **end of a reaction** is visible in both diagrams? [1]

.....

(e) State **three** factors which affect enzyme activity, excluding the presence of inhibitors. [3]

.....

.....

.....

(f) Distinguish between intracellular and extracellular enzymes. [1]

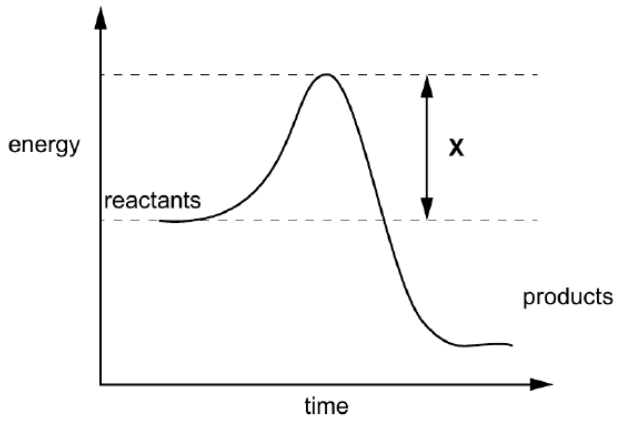
.....

.....

(Total 9 marks)

Examiner only

4. The graph below shows the energy changes that take place during a chemical reaction.



(a) (i) What is represented by **X** on the graph above? [1]

.....

(ii) Enzymes are biological catalysts.
Draw a line on the graph above to show the energy changes that would take place if an enzyme was present during the reaction.
[1]

(b) Succinate dehydrogenase is an enzyme found in mitochondria and is involved in respiration. The enzyme catalyses the conversion of succinate into fumarate. Using your knowledge of enzyme structure, explain why this is the **only** reaction succinate dehydrogenase can catalyse. [2]

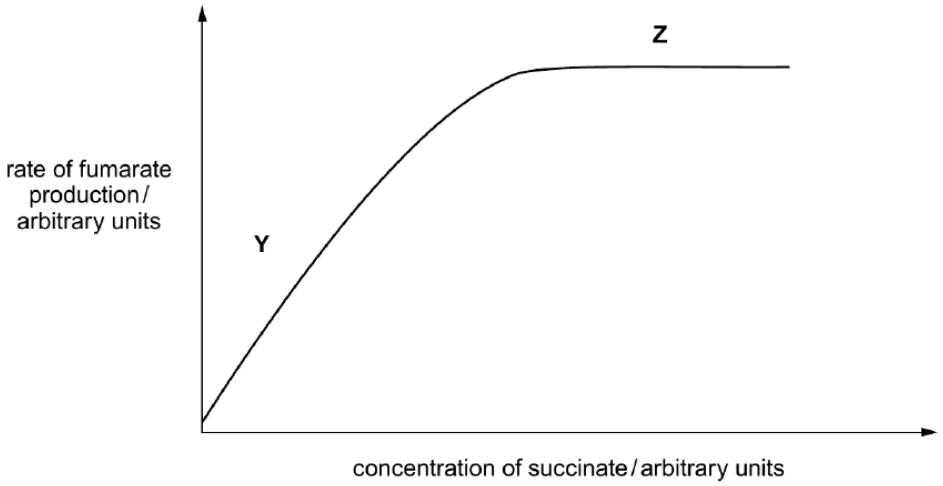
.....

.....

.....

Examiner only

(c) The graph below shows the rate of fumarate production at varying concentrations of succinate, at optimum temperature and pH with no inhibitors present.



(i) I State what factor is limiting the rate of reaction in the region marked **Y** on the graph. [1]

.....

II Use evidence from the graph to support your answer. [1]

.....

.....

.....

(ii) Explain what is limiting the rate of reaction in the region marked **Z** on the graph. [2]

.....

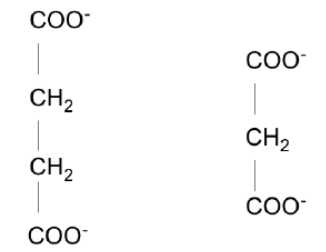
.....

.....

.....

Examiner only

(d) Malonate is a competitive inhibitor of succinate dehydrogenase. The diagrams below show the structural formulae of succinate and malonate.



succinate malonate

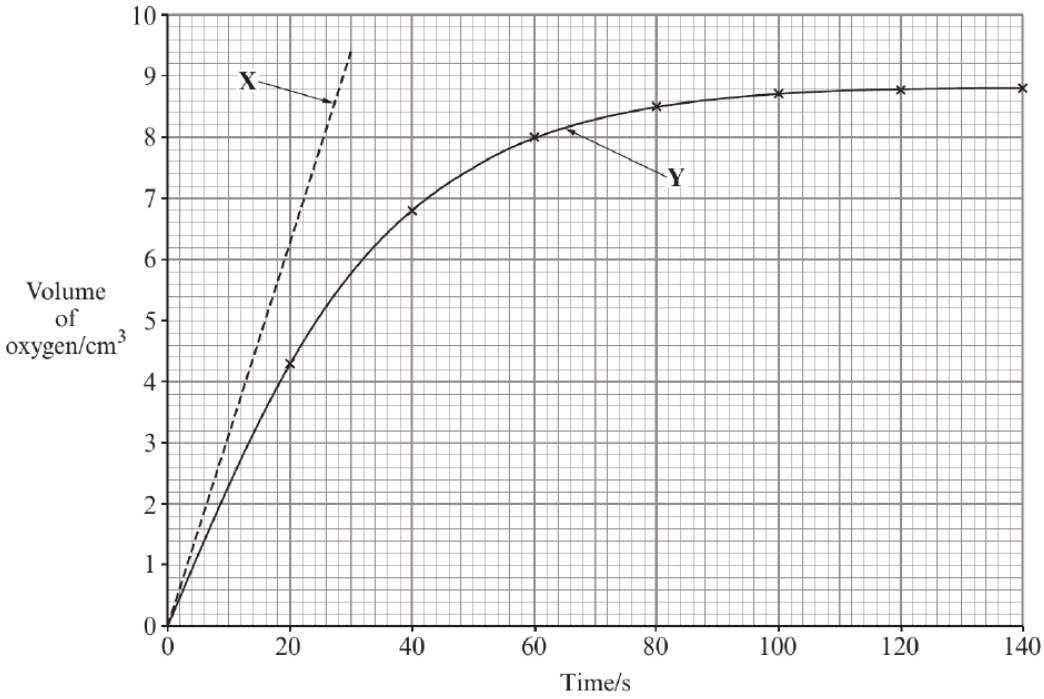
(i) Using the information in the diagram above and your own knowledge, explain how malonate inhibits succinate dehydrogenase. [3]

(ii) On the graph in part *(c)* opposite draw a curve to show the rate of reaction when malonate is present. [1]

12

Examiner only

4. A student investigated the action of the enzyme catalase. This enzyme catalyses the breakdown of hydrogen peroxide into oxygen and water.
The student collected the oxygen given off in a measuring cylinder. The volume of gas was recorded every 20 seconds as shown on the graph labelled **Y** below.



(a) The rate of reaction can be calculated using the formula:

$$\frac{\text{Volume of oxygen collected}}{\text{Time taken to collect}}$$

Use the formula to calculate the rate in $cm^3 min^{-1}$ for the first 30 seconds. [2]

.....

.....

(b) The initial rate is the rate of reaction at the beginning and is the maximum rate. It is shown by line **X**. The initial rate is $19\,cm^3 min^{-1}$.
Explain why the initial rate is greater than the rate calculated in *(a)*. [2]

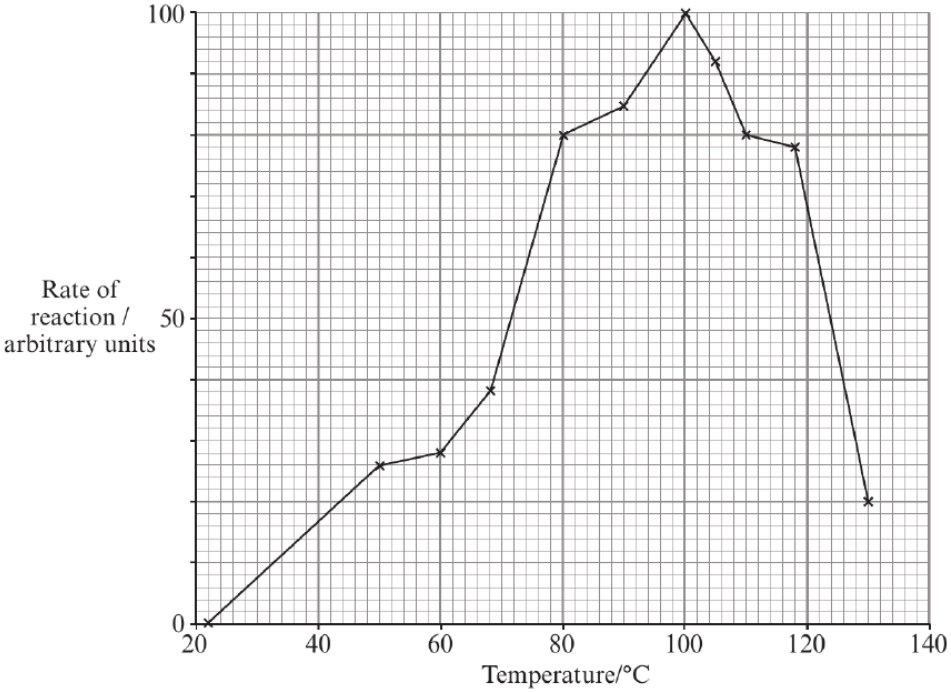
.....

.....

.....

Examiner only

(c) The graph below shows the effect of temperature on the activity of an amylase enzyme found in bacteria that live in hot water in volcanic regions.



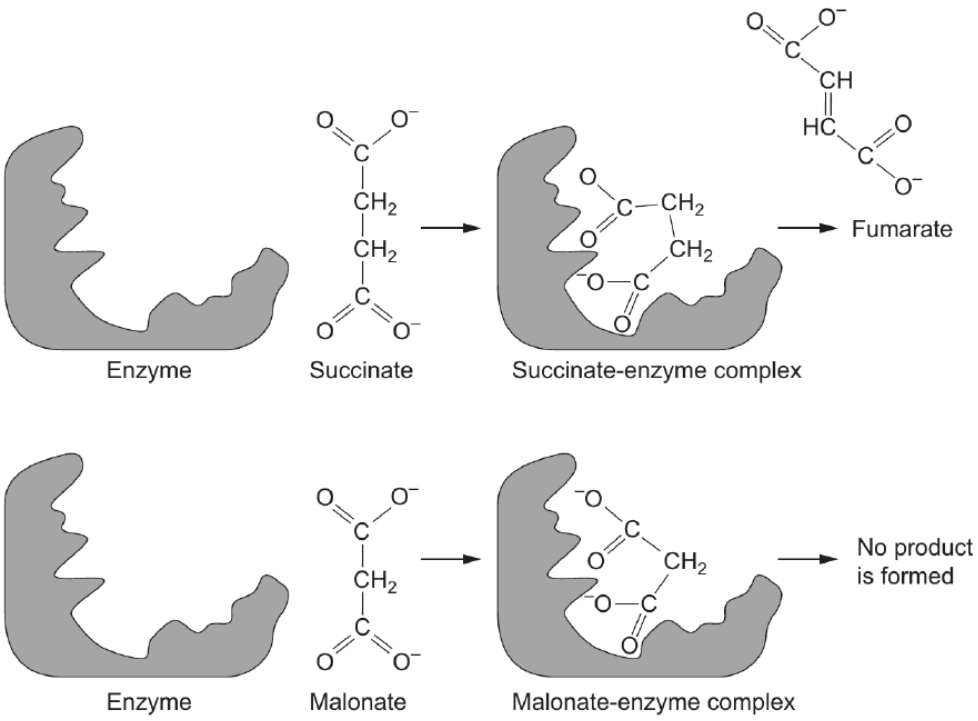
(i) Using the graph, describe and explain the effect of temperature on the rate of activity of the amylase. [6]

(ii) State the difference between bacterial amylase and an amylase found in humans. [2]

Examiner only

6. Succinate dehydrogenase is an enzyme which catalyses the breakdown of succinate. The molecule malonate acts as an inhibitor for the enzyme.

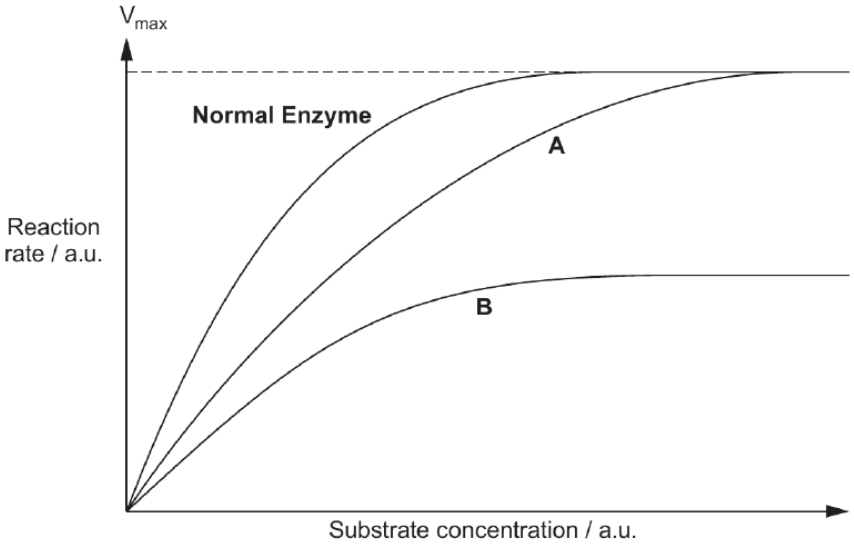
(a) State what is meant by the term inhibition. [1]



(b) (i) Use the diagram to explain why malonate is a competitive inhibitor. [2]

Examiner only

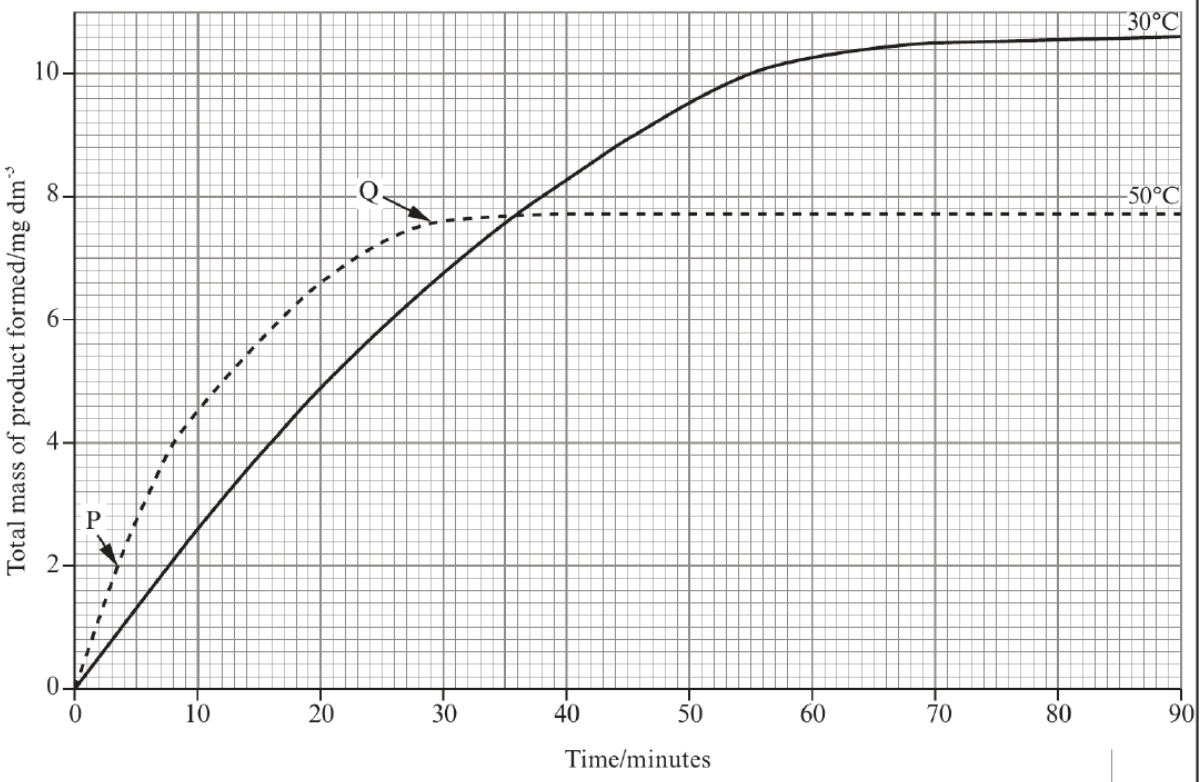
Enzyme catalysis can be affected by the presence of inhibitors as shown in the graph below.



(ii) From the graph, which line **A** or **B** would represent the action of malonate? Explain your answer. [3]

(iii) Many enzymes can also be inhibited by a non-competitive inhibitor, such as a heavy metal. Explain why the rate of reaction with a non-competitive inhibitor does not reach that of an uninhibited enzyme. [4]

4. An investigation was carried out to determine the mass of product formed in an enzyme-controlled reaction at two different temperatures, with an excess concentration of substrate. The results are shown in the graph.



Examiner only

(a) (i) Calculate the rate of reaction in the first 10 minutes at 30°C. [1]

Rate = ... mg dm^{-3} min^{-1}

(ii) State the factor which determines the rate of reaction between points **P** and **Q** on the graph. [1]

.....

(b) (i) Explain why the initial rate of reaction was slower at 30°C than at 50°C. [2]

.....

.....

.....

.....

(ii) Explain the shape of the curve between 30 minutes and 60 minutes at 50°C. [3]

.....

.....

.....

.....

.....

(c) The investigation was repeated at 30°C with the addition of a competitive inhibitor.

(i) Draw the expected curve on the graph. [1]

(ii) Explain how a competitive inhibitor would bring about this effect. [3]

.....

.....

.....

.....

.....

.....

(Total 11 marks)

END OF QUESTION PACK

5 questions · 54 marks · ~1 h 26 min
Source: WJEC BY1 (2008 modular spec, 2011–2017)
Curated for WJEC Biology 2015 spec AS Unit 1 — Topic 3 (1.4)