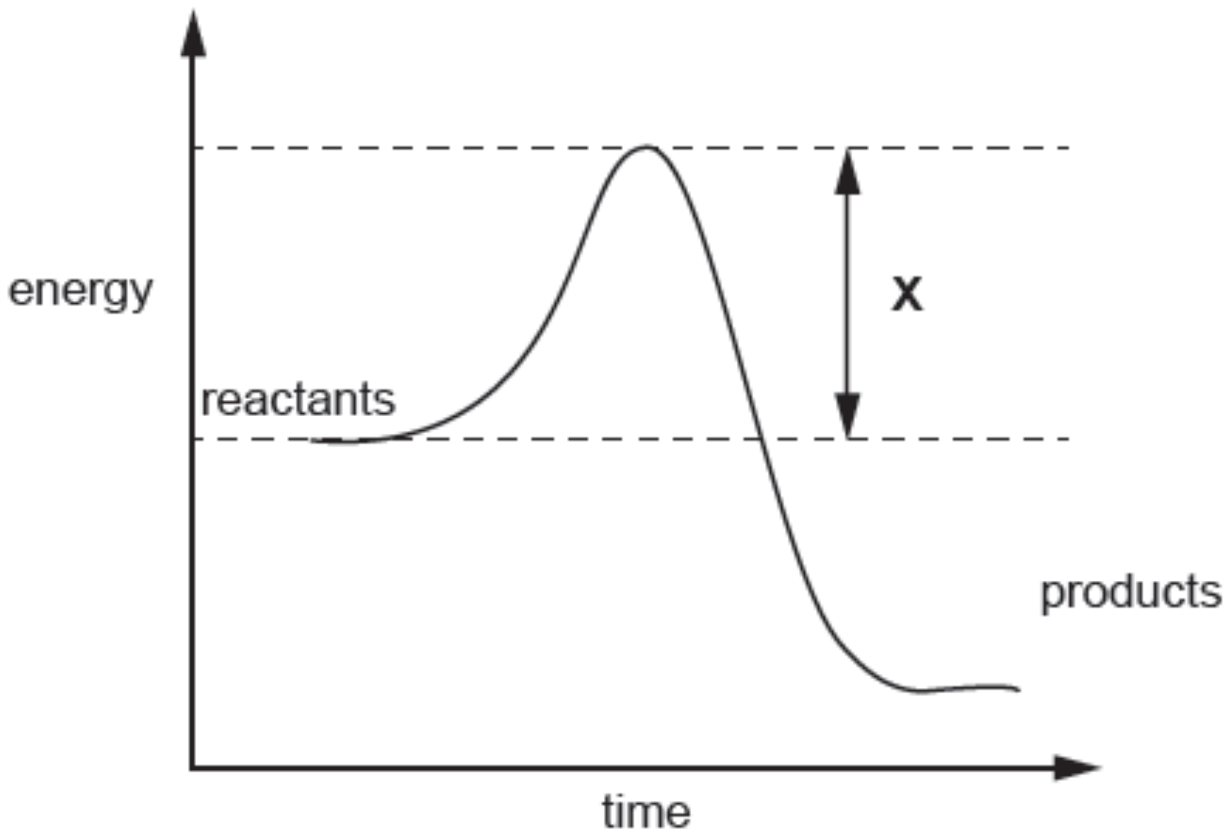
WJEC (Eduqas) Biology A-level
1.4: Enzymes
Questions by Topic

1. 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]

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(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]

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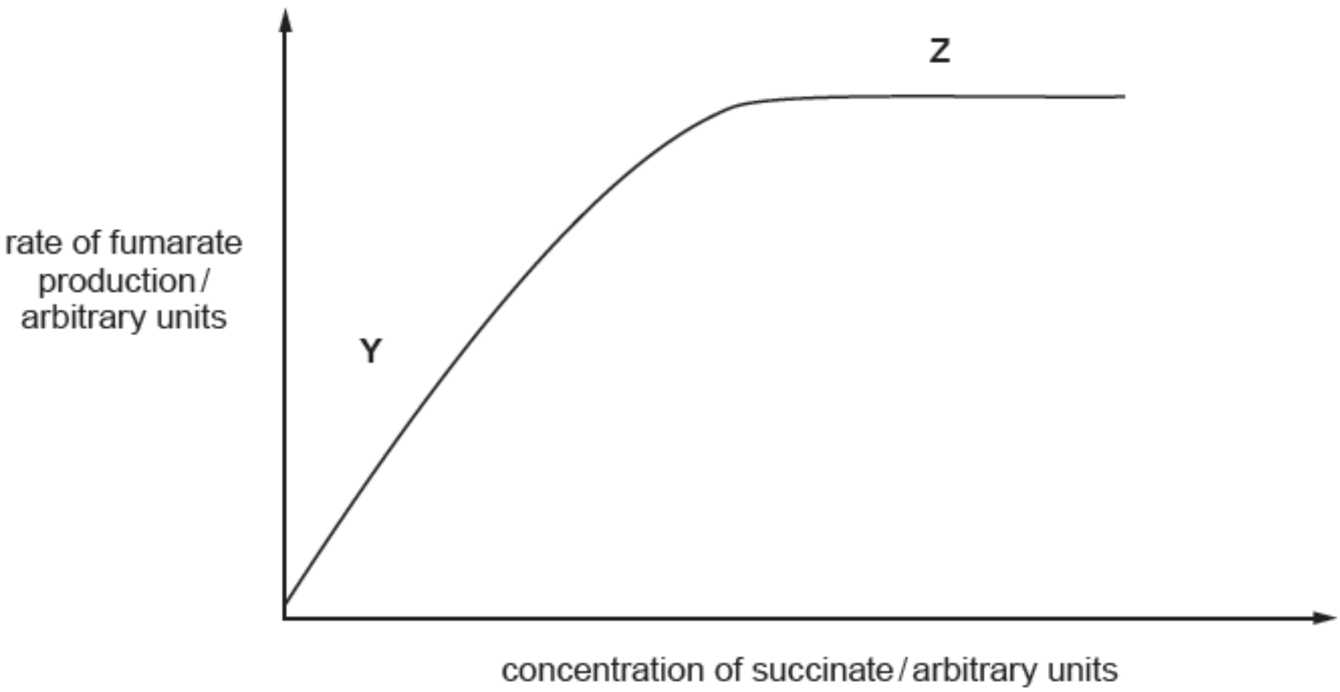
(c) The graph below shows the rate of fumarate production at varying concentrations of succinate, at optimum temperature and pH with no inhibitors present.



(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]

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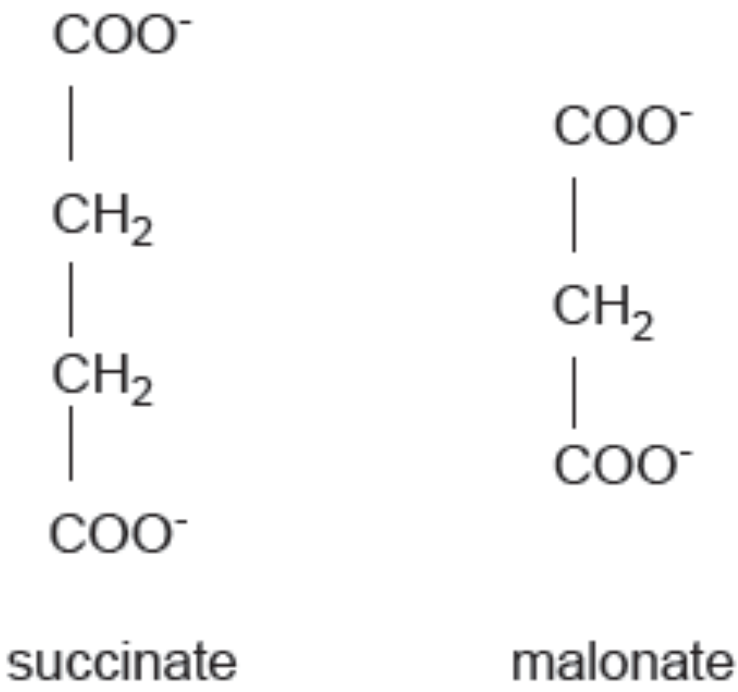
(d) Malonate is a competitive inhibitor of succinate dehydrogenase. The diagrams below show the structural formulae of succinate and malonate.



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

[3]

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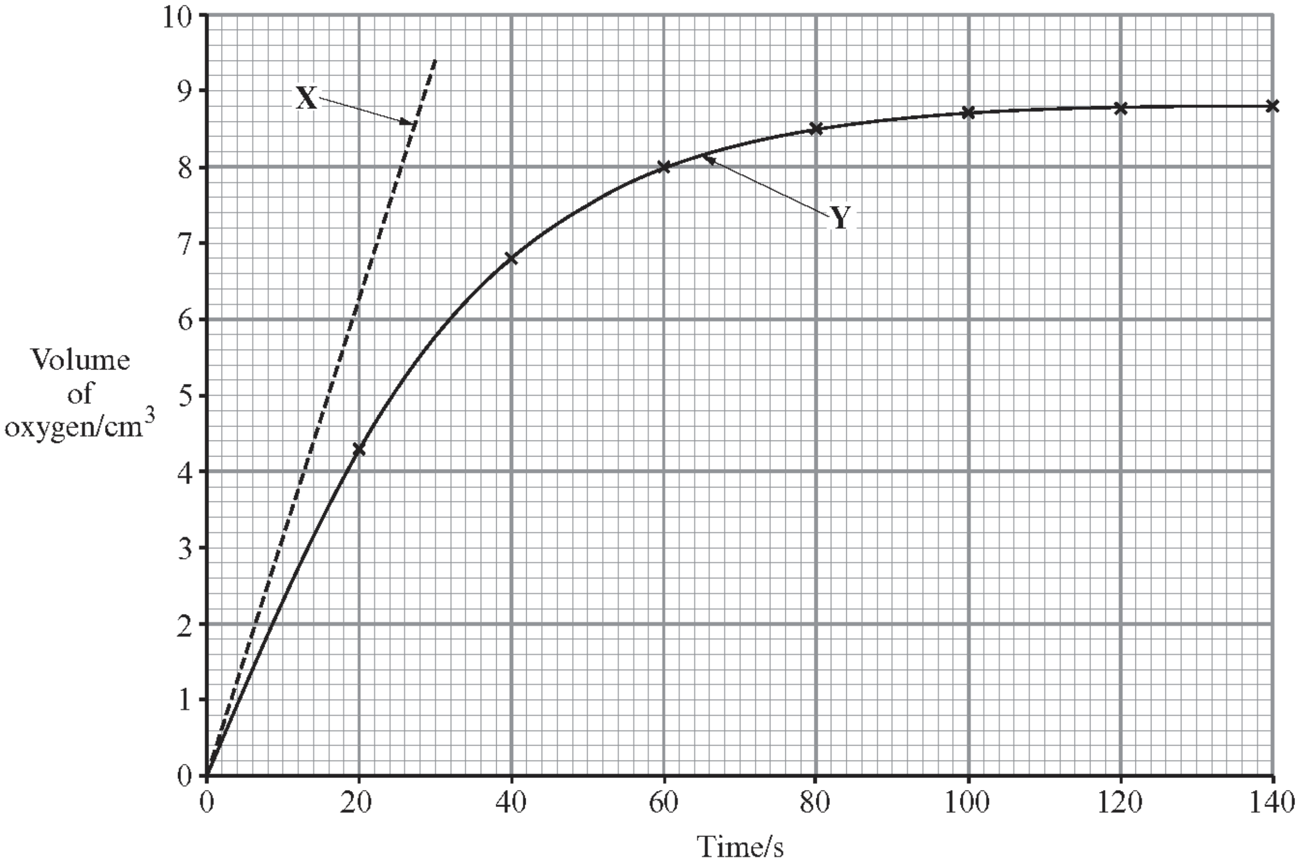
(ii) On the graph in part (c) opposite draw a curve to show the rate of reaction when malonate is present.

[1]

2.

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]

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(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]

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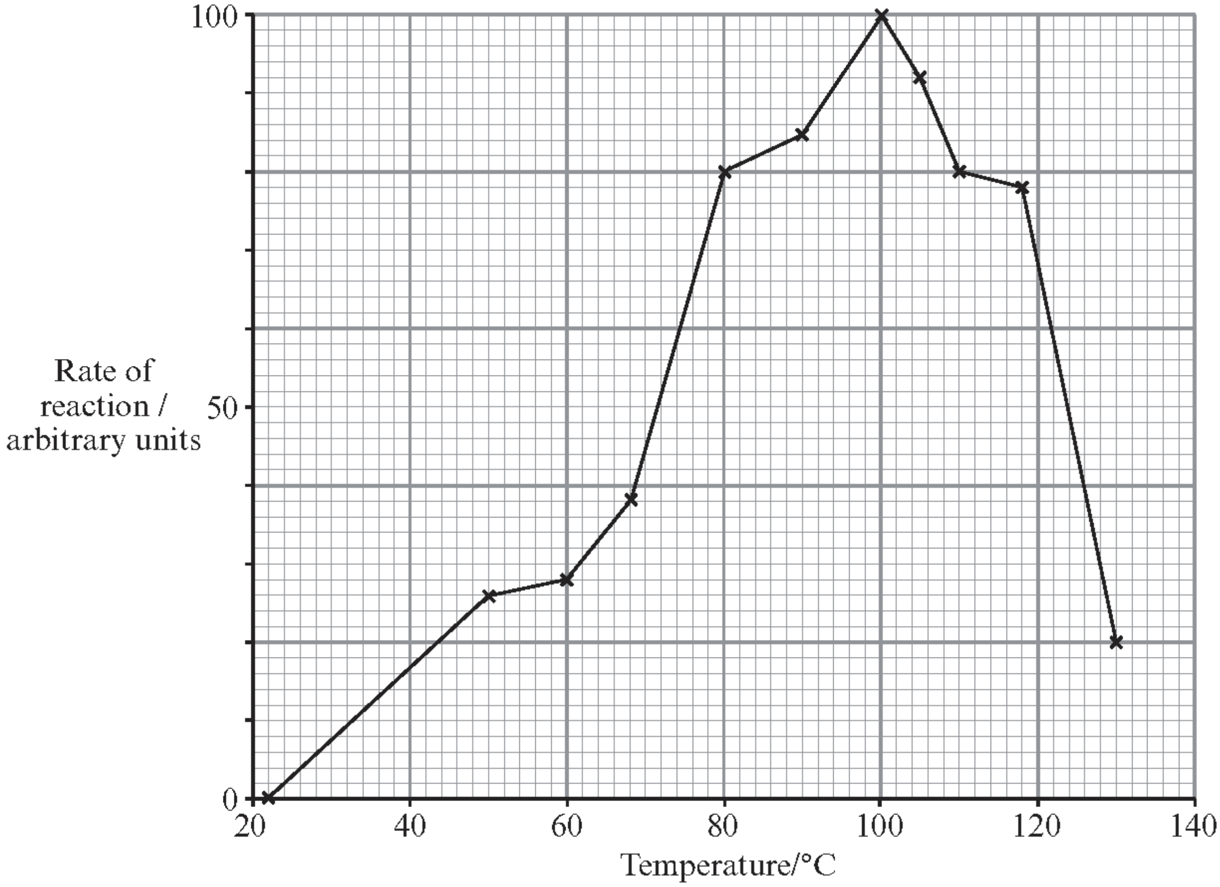
(c) The graph below shows the effect of temperature on the activity of an amylase enzyme found in bacteria that live in hot water in volcanic regions.



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

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

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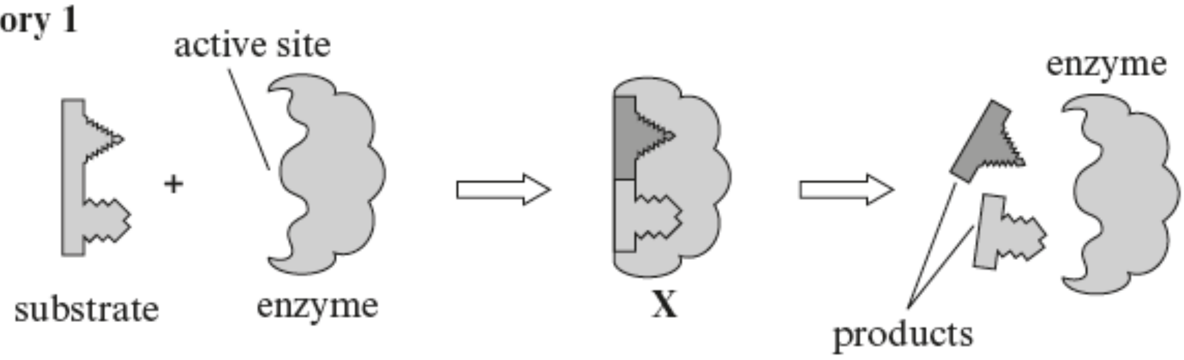
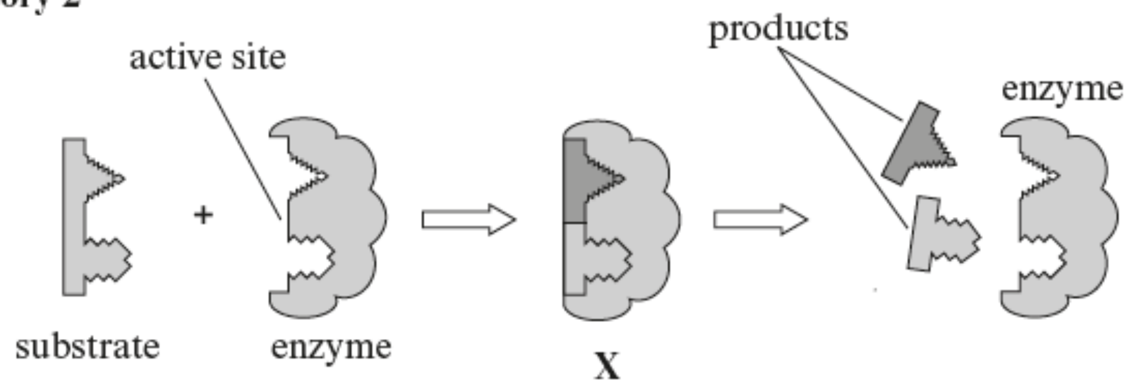
(Total 12 Marks)

4. 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]

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

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

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

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[1]

(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]

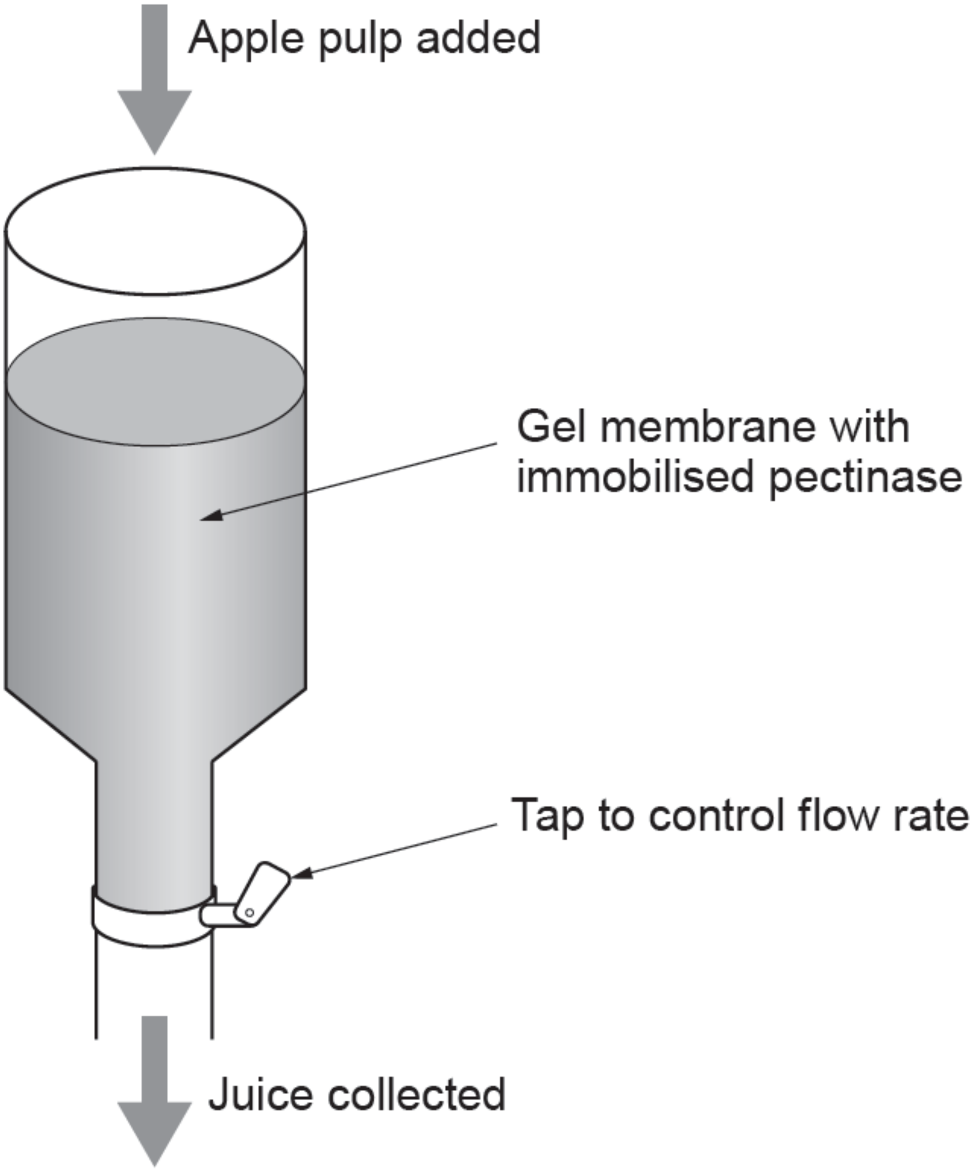
(f) Distinguish between intracellular and extracellular enzymes.

[1]

Total

[9]

4. Pectin is a structural polysaccharide found in the cell walls of plant cells and in the middle lamella between cells, where it helps to bind cells together. Pectinases are enzymes that are routinely used in industry to increase the volume and clarity of fruit juice extracted from apples. The enzyme is immobilised onto the surface of a gel membrane which is then placed inside a column. Apple pulp is added at the top, and juice is collected at the bottom. The process is shown in the diagram below.



(a) Immobilising enzymes can increase the temperature range over which they can be used.

Describe **two** other advantages of immobilising pectinases

[2]

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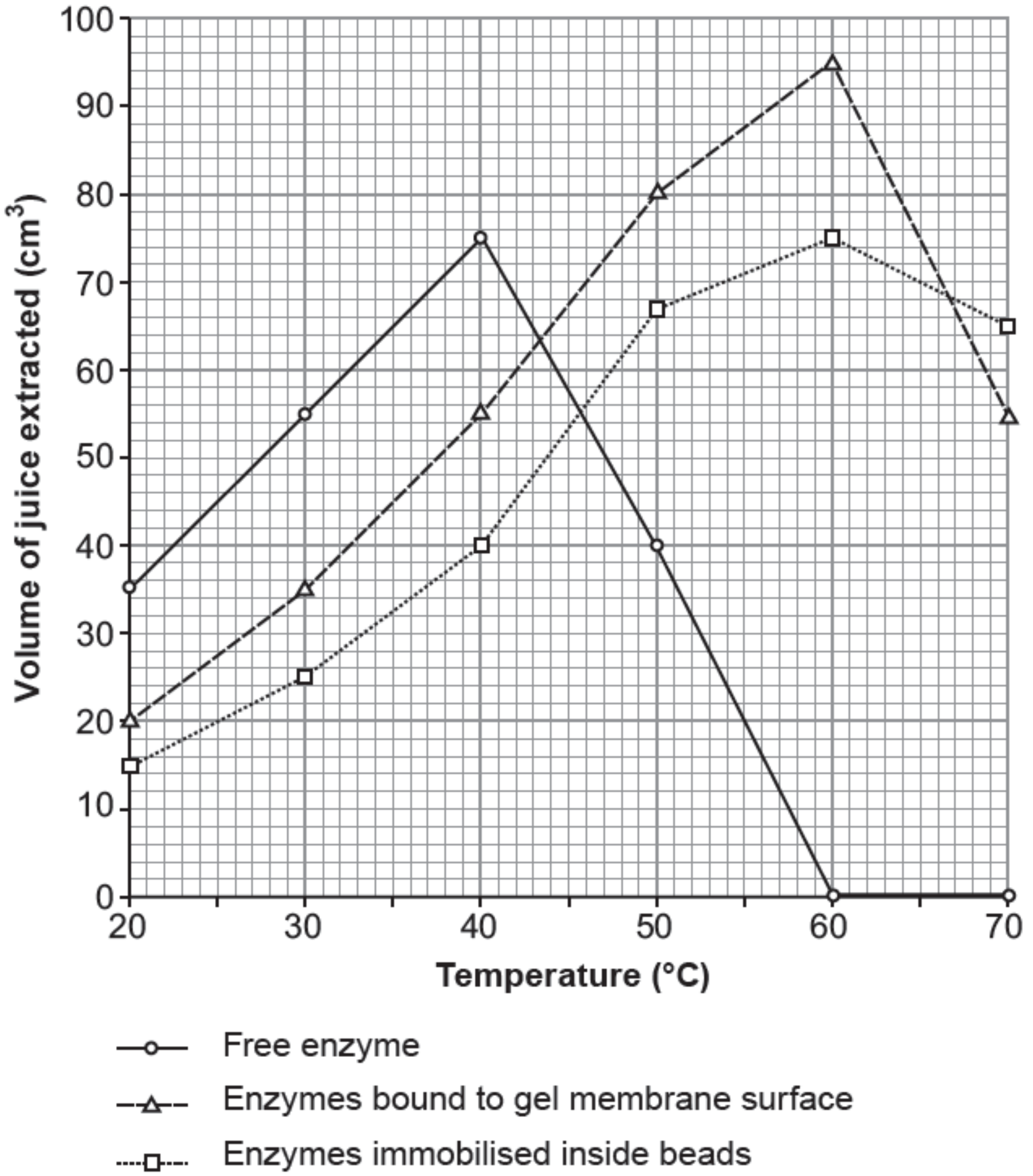
(b) Suggest why reducing the flow rate of material through the column would result in an increased volume of juice being collected.

[2]

(c) The extraction of juice using pectinase was compared using equal volumes and concentrations of free enzyme, enzymes bound to the surface of a gel membrane and enzymes immobilised inside alginate beads. The results are shown in the graph below.



Using the graph and your own knowledge of enzymes, answer the following questions.

(i) Describe and explain the results for the free enzyme at temperatures above 40°C.

[4]

(ii) Explain why a higher yield of juice was obtained when using free enzyme between temperatures of 20°C and 40°C than when using immobilised enzyme.

[2]

(iii) Suggest a reason for the differences seen in the results for the enzymes bound to the gel membrane surface with those immobilised inside the beads, between temperatures of 20°C and 60°C.

[2]

5. A new biological washing powder has been developed containing three protease enzymes (**A**, **B** and **C**), each removing different protein based stains. The manufacturer claims their revolutionary new washing powder works "best at 35°C, but offers superior removal of tough protein stains at higher temperatures".

(a) Enzymes are biological catalysts. Describe what is meant by the term *biological catalyst.* [2]

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Graph showing protease activity

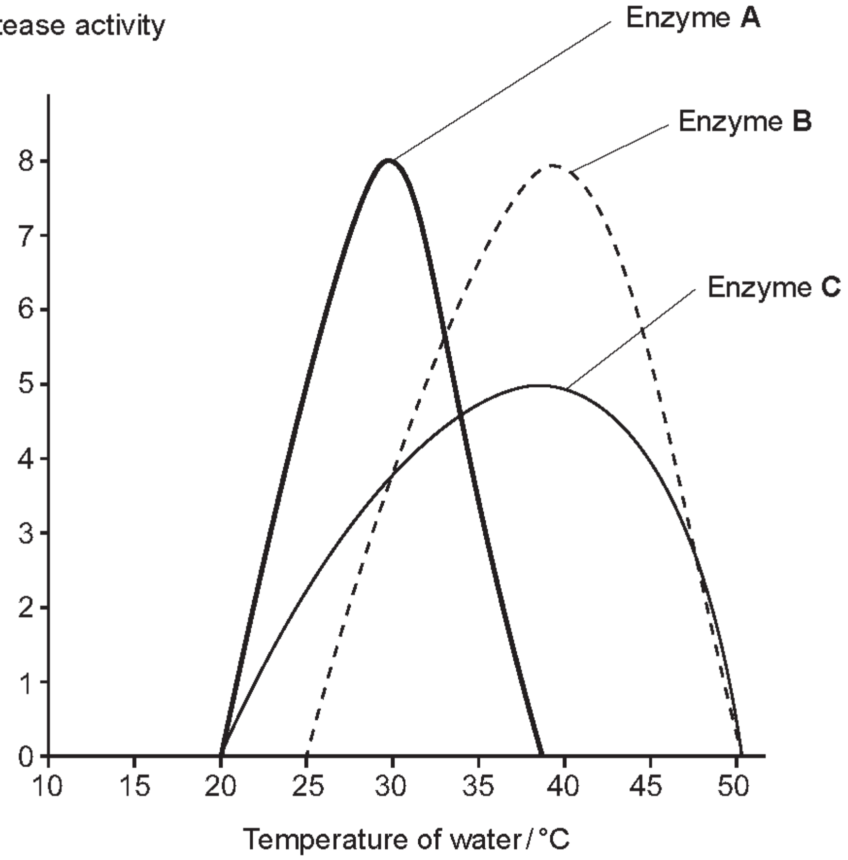

Table showing type of food stain removed

Protease enzyme	Food stain removed		
	Blood	Meat	Egg
A	Yes	No	No
B	No	Yes	No
C	No	No	Yes

(b) Using the graph and table, together with your knowledge of enzymes, answer the following questions.

(i) Explain why the washing powder works best at 35°C. [1]

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(ii) Which stain would not be removed when washing at 40°C? [1]

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(iii) Suggest why three different enzymes are needed to remove blood, meat and egg stains. [2]

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(iv) Explain fully why washing at 60°C would not be recommended for removing protein stains when using this washing powder. [4]

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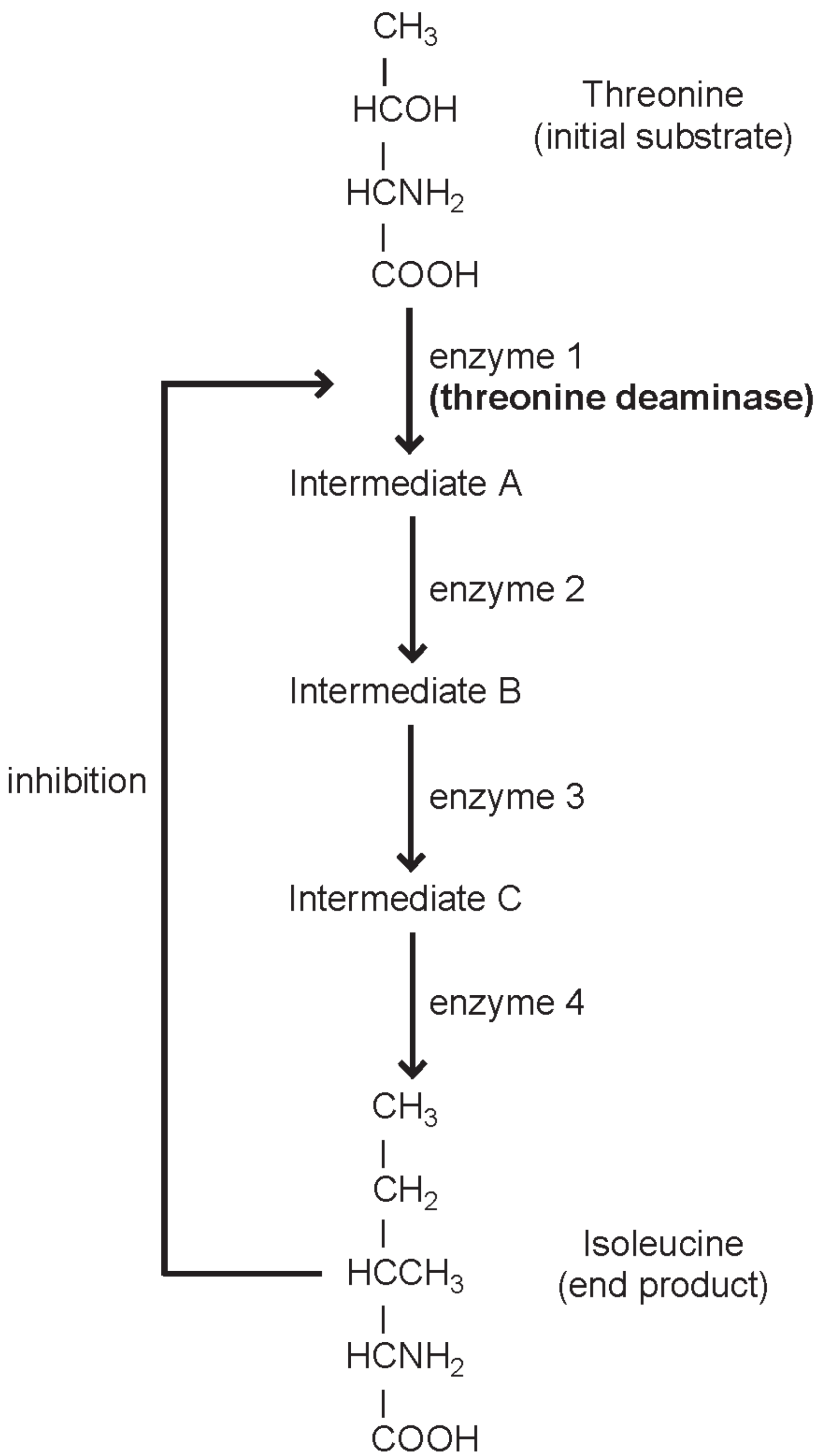
(c) Many metabolic pathways are switched off by their end products which act as competitive inhibitors of the first enzyme in the pathway. In the example below, the end product isoleucine inhibits threonine deaminase.



(i) Explain how isoleucine works as a **competitive inhibitor**. [4]

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(ii) Suggest a reason why this might be useful to the cell. [1]

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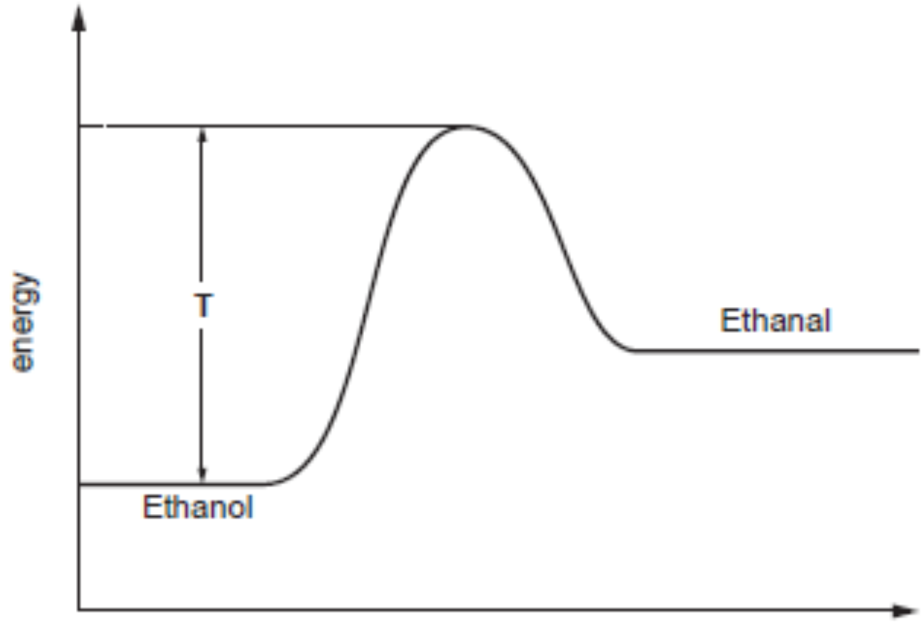
6. Alcohol dehydrogenase is an enzyme that catalyses the conversion of ethanol into ethanal.

The graph below shows the change in energy state when ethanol is converted to ethanal when no enzyme is present.



(a) (i) State what is represented by the region labelled **T**. [1]

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(ii) Draw a curve on the diagram to show the change in energy level when alcohol dehydrogenase is present. [1]

(b) Describe how alcohol dehydrogenase can catalyse the conversion of ethanol into ethanal. [3]

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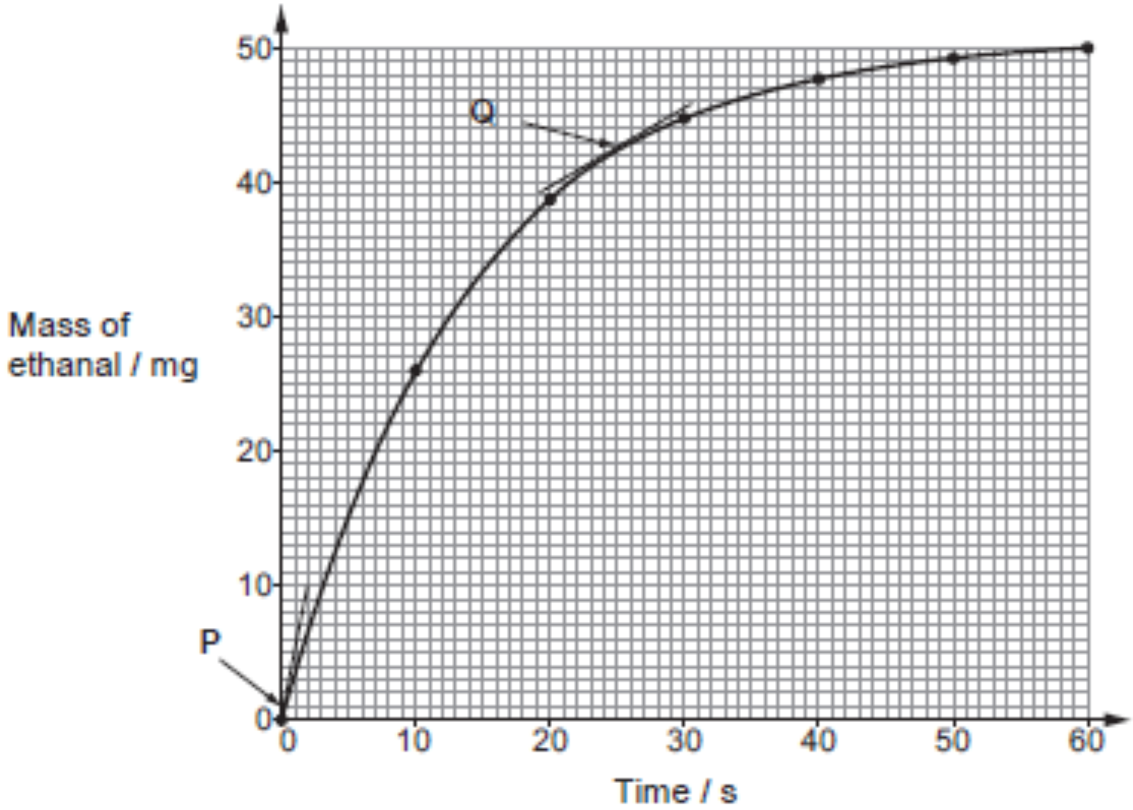
(c) A fixed mass of ethanol was added to a test tube containing alcohol dehydrogenase and a pH7 buffer solution. The test tube was incubated at 30°C and the mass of ethanal produced over time was recorded. The results are shown below.



(i) The rate of reaction at P was 5 mg s^{-1}.
Calculate the rate of reaction at Q. [2]

rate = ... mg s^{-1}

(ii) What conclusions can be drawn that would account for the difference in rate at P and at Q? [4]

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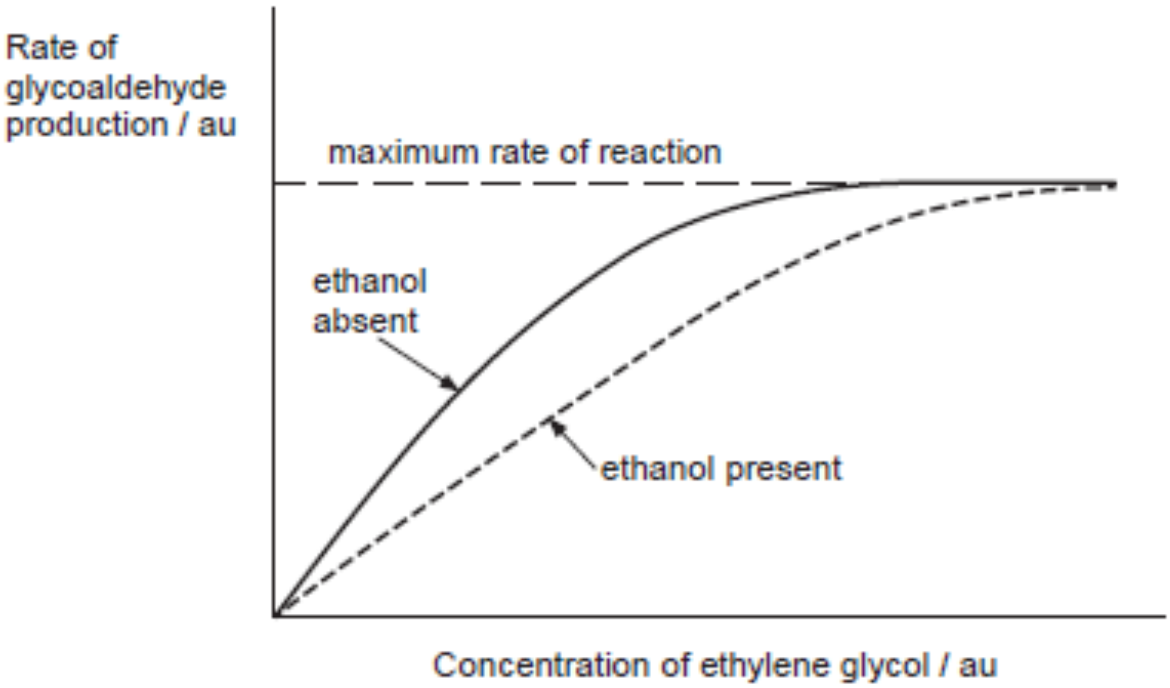
(d) Ethylene glycol is a colourless, odourless, sweet liquid, commonly found in antifreeze. It is highly toxic if ingested because once inside the body ethylene glycol is converted into glycoaldehyde. This reaction is also catalysed by alcohol dehydrogenase.

Treatment of ethylene glycol poisoning includes giving the patient ethanol, either intravenously or orally.

The graph below shows the rate of glycoaldehyde production in the presence, and absence of ethanol.



Use the information provided to explain why this treatment would reduce the effects of ethylene glycol poisoning. [5]

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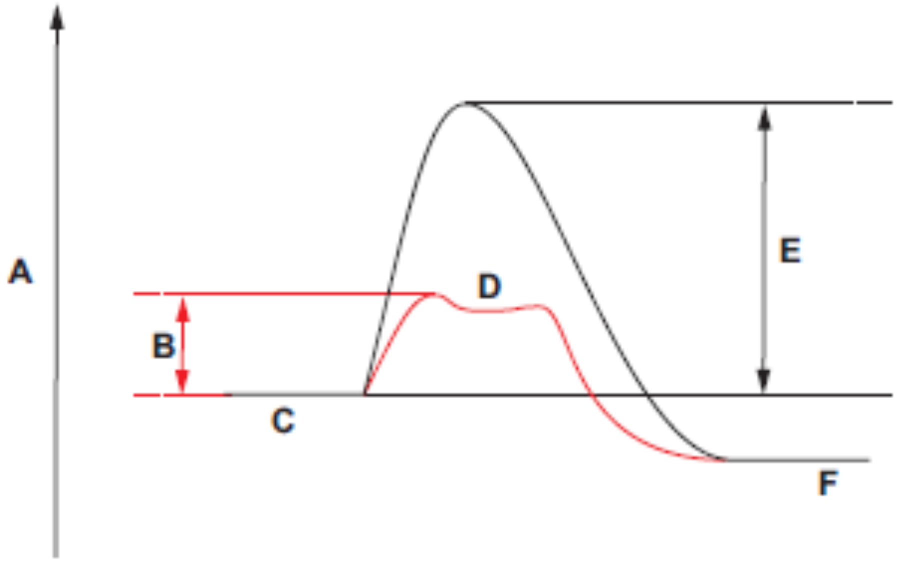
7. Enzymes catalyse reactions by lowering the activation energy of a reaction. This is shown in the graph below.



(a) Using letters from the graph, identify the following: [2]

- the energy level of the products of an enzyme catalysed reaction ....
- the activation energy of an enzyme catalysed reaction ....
- the energy level of an enzyme-substrate complex ....

(b) Adenylate kinase (ADK) is a globular protein that acts as an enzyme involved in the regeneration of ATP in muscle. There are several types of this enzyme. One form catalyses the following reaction:

$$2ADP \longrightarrow AMP + ATP$$

(AMP = adenosine monophosphate)

(i) Suggest why the activity of ADK would be an advantage to muscle. [1]

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(ii) The 'lock and key' model of enzyme action was first proposed in 1894 by Emil Fischer and provides a simple explanation of how enzymes and substrates interact. However, ADK interacts with its substrates by the induced fit mechanism proposed in 1958 by Daniel Koshland.

Explain how the induced fit mechanism differs from the lock and key model. [2]

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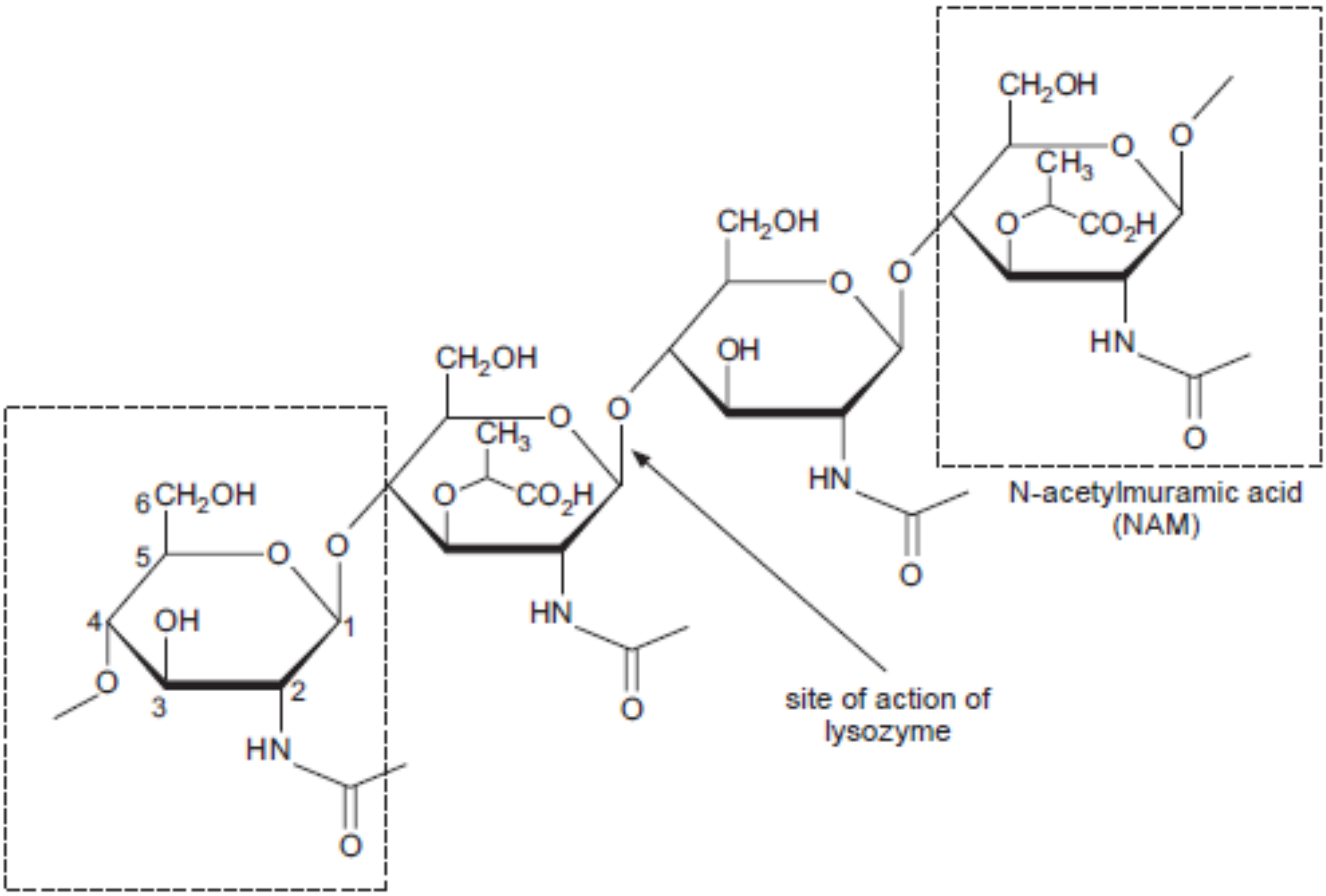
(c) Lysozyme is an enzyme which also forms enzyme-substrate complexes through the induced fit mechanism and can function both intra- and extra-cellularly. It catalyses the hydrolysis of a bond in the peptidoglycan component of the cell walls of some bacteria. This is shown in the diagram below. The carbon atoms have been numbered on one molecule of NAG (N-acetylglucosamine).



(i) State the difference between an intra- and an extra-cellular enzyme. [1]

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(i

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(ii

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