1 **(a)** Enzymes are biological catalysts.

Explain the term *biological catalyst*.

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..... **[2]**

(b) When the enzyme catalase is added to hydrogen peroxide, the following reaction occurs:

$$\underset{\text{hydrogen peroxide}}{H_2O_{2\,(l)}} \xrightarrow{\text{catalase}} 2\,H_2O_{(l)} + O_{2\,(g)}$$

In an investigation into the effect of temperature on the rate of this reaction, a student set up apparatus as shown in Fig. 2.1, using liquidised celery as a source of catalase.

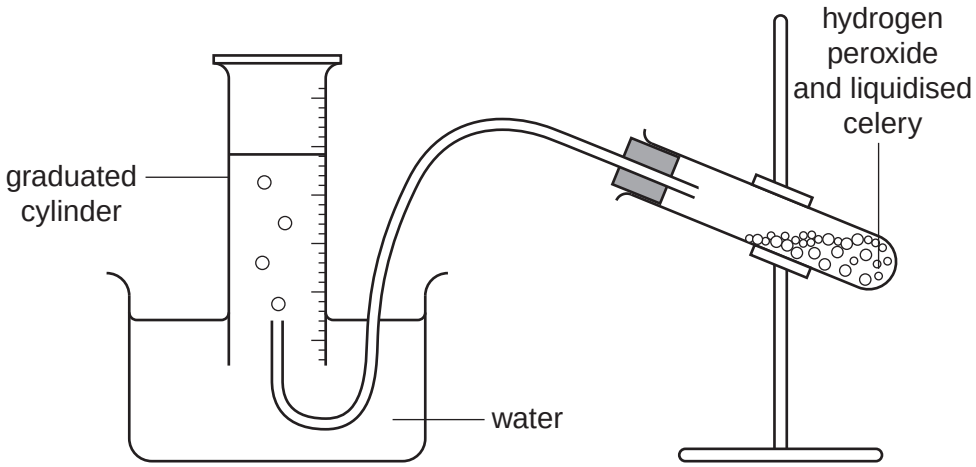

Fig. 2.1

The student measured the volume of oxygen produced at five different temperatures using samples of the liquidised celery.

(i) State the other variable that needs to be measured in order to calculate the **rate** of reaction.

..... **[1]**

(ii) Identify **one** potential problem with using samples of liquidised celery as a source of catalase in this investigation **and** suggest a way to minimise this problem.

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..... **[2]**

(iii) The student collected the data shown in Table 2.1.

Table 2.1

temperature (°C)	volume of oxygen (cm^3)
5	4
10	7
12	10
25	28
28	32

Suggest how the student could check the reliability of the data.

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..... **[2]**

(c) Another student carried out a similar procedure and presented his results as a graph. The graph that he drew is shown in Fig. 2.2.

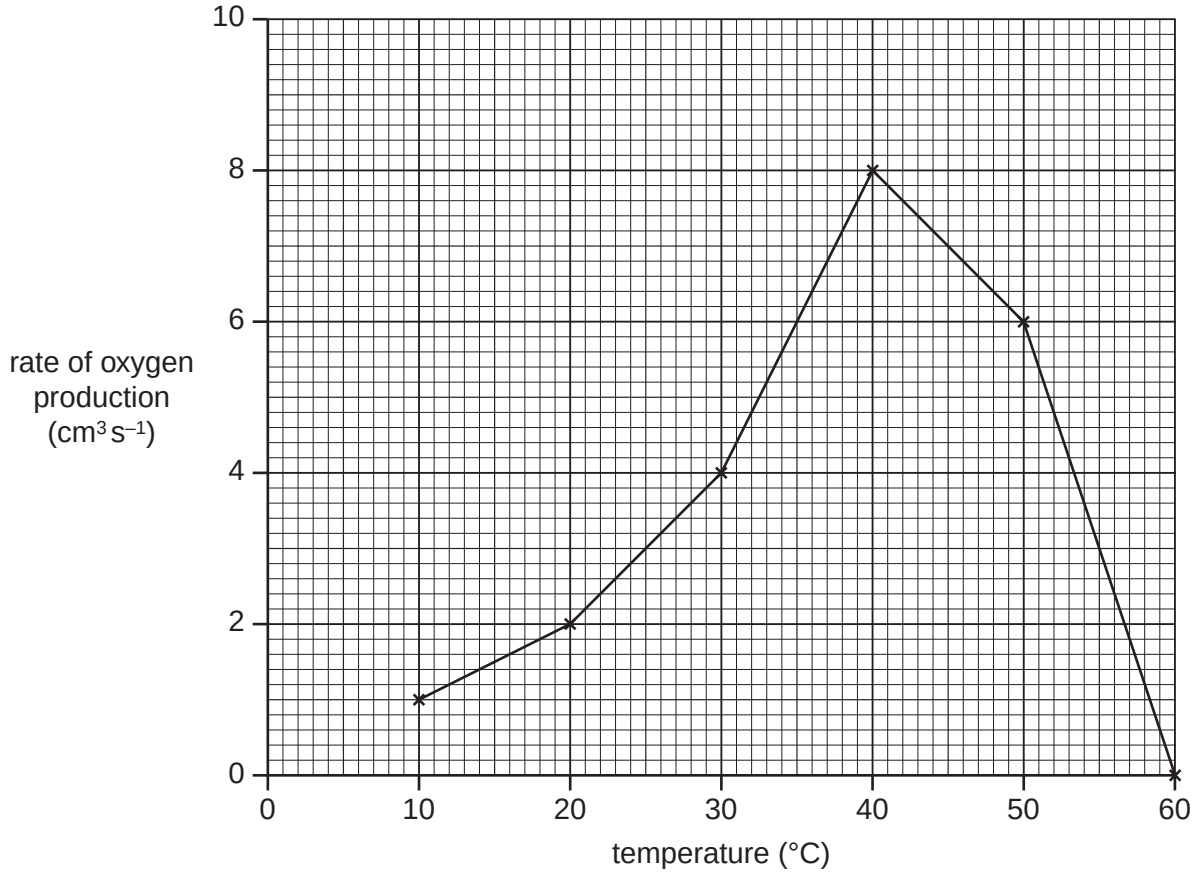

Fig. 2.2

(i) Describe the data shown in Fig. 2.2.

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..... **[4]**

(ii) Q_{10} is a measure of the increase in the rate of reaction for a 10 °C rise in temperature.

It is calculated using the following formula:

$$Q_{10} = \frac{\text{rate at } (t + 10\,°C)}{\text{rate at } t\,°C}$$

where $t + 10$ °C = rate at the higher temperature
t = rate at the lower temperature

Using the information in Fig. 2.2, calculate Q_{10} between 15 °C and 25 °C.

Show your working.

Answer = ... **[1]**

(iii) In the conclusion to this experiment, the student wrote the following:

> ***As the heat increased, the reaction went faster until it got to its highest. After this, the rate of reaction fell. This happened because the enzyme was killed and the hydrogen peroxide could not fit into the enzyme's key site.***

Suggest a more appropriate word to replace each of the underlined words.

heat should be replaced with .....

highest should be replaced with .....

killed should be replaced with .....

key should be replaced with ..... **[4]**

[Total: 16]

2 Fig. 2.1 shows part of an **amylose** molecule. This is an unbranched form of starch.

When iodine solution is added to starch, iodine fits into the helix of the amylose molecule, producing a colour change.

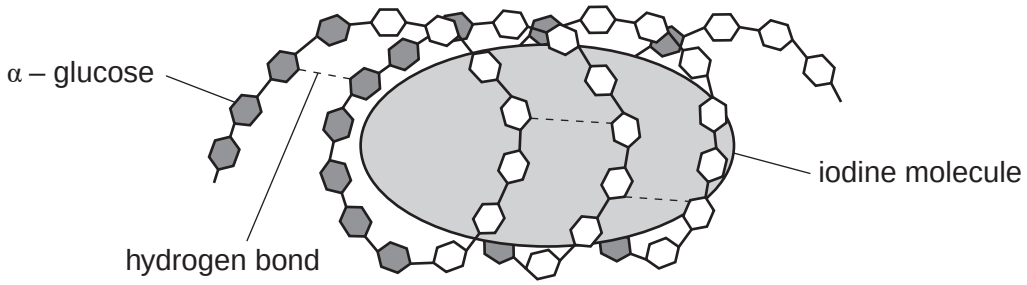

Fig. 2.1

(a) (i) State the colour of iodine solution in the presence of starch.

..... **[1]**

(ii) Hydrogen bonds hold the amylose molecule in its helical shape.

Describe how a hydrogen bond is formed.

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..... **[2]**

(iii) Using the information in Fig. 2.1, suggest what would happen to the iodine-amylose complex if the solution was heated to 60 °C.

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..... **[2]**

(b) **Amylase** is an enzyme that hydrolyses amylose to maltose. Maltose, like glucose, is a reducing sugar.

A student investigated the action of amylase on amylose. She mixed amylase with amylose and placed the mixture in a water bath.

Describe how she could measure the change in concentration of maltose (reducing sugar) as the reaction proceeds.

In your answer, you should ensure that the steps in the procedure are sequenced correctly.

[7]

(c) Fig. 2.2 shows the results that the student obtained from a practical procedure in which the rate of formation of maltose was measured in the presence and absence of chloride ions.

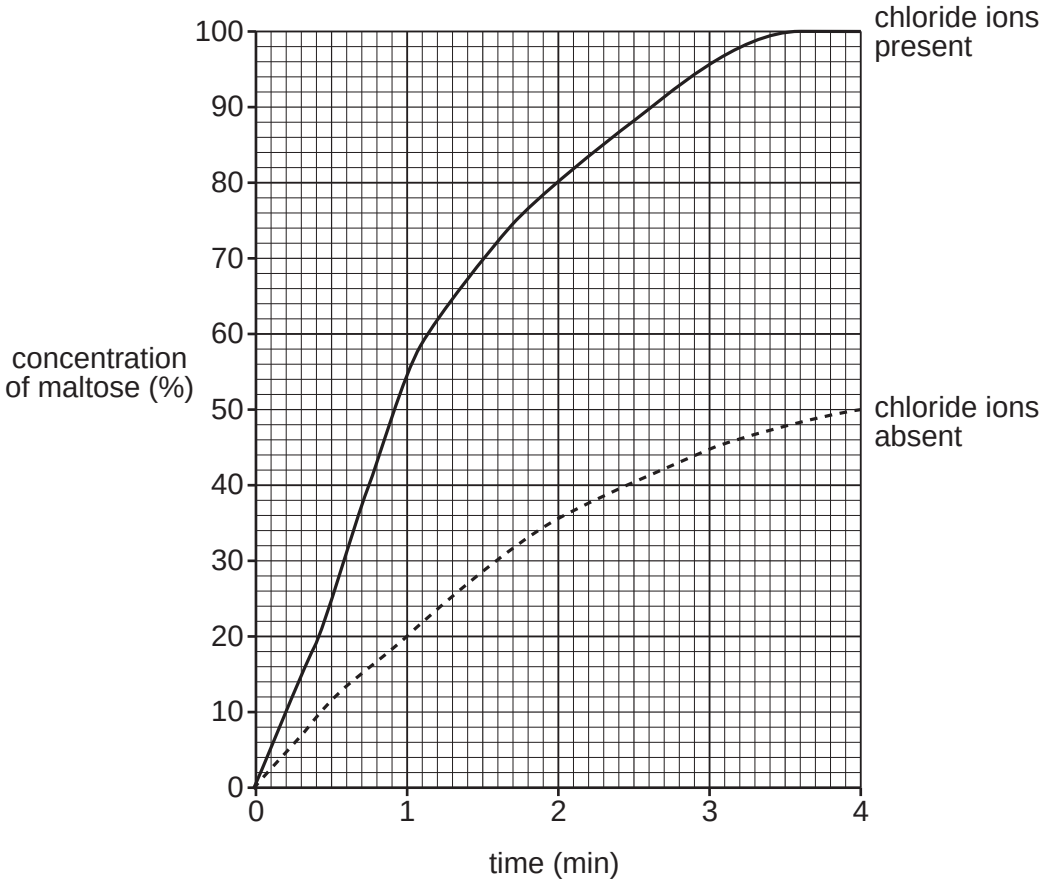

Fig. 2.2

(i) Describe the effect of chloride ions on the rate of reaction.

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..... **[2]**

(ii) Suggest how chloride ions have this effect on the rate of reaction.

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..... **[2]**

(iii) State **three** variables that need to be controlled in this practical procedure in order to produce valid results.

1 .....

2 .....

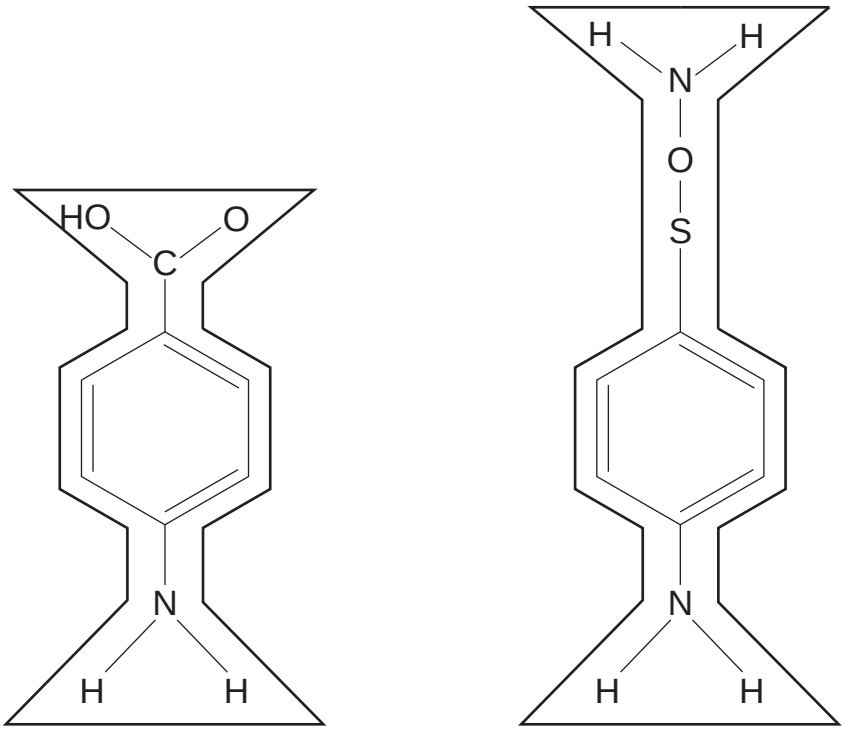
3 ..... **[3]**

[Total: 19]

3 **(a)** The enzyme DHPS is involved in the production of folic acid in bacteria.

- The substrate for DHPS is a molecule known as PABA.
- The enzyme DHPS is inhibited by the drug sulfonamide.

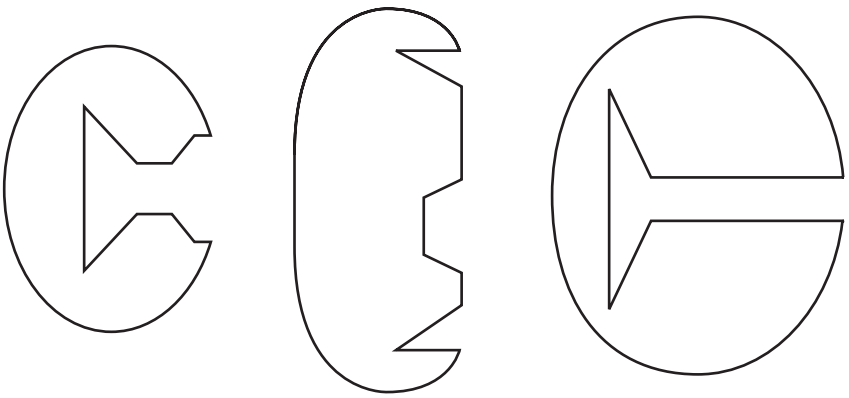
Fig. 3.1 shows the structure of PABA and that of sulfonamide.



PABA **sulfonamide**

Fig. 3.1

(i) Diagrams **X**, **Y** and **Z** represent these enzyme molecules and their active sites.



X **Y** **Z**

State the letter, **X**, **Y** or **Z**, that most accurately represents the enzyme DHPS.

..... **[1]**

(ii) Using the information in Fig. 3.1, explain why sulfonamide acts as a competitive inhibitor of DHPS.

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..... **[3]**

(b) Fig. 3.2 shows the effect of increasing the concentration of the substrate (PABA) on the rate of reaction.

- Curve **A** shows the rate of reaction without the presence of the competitive inhibitor sulfonamide.
- Curve **B** shows the rate of reaction in the presence of the competitive inhibitor sulfonamide.

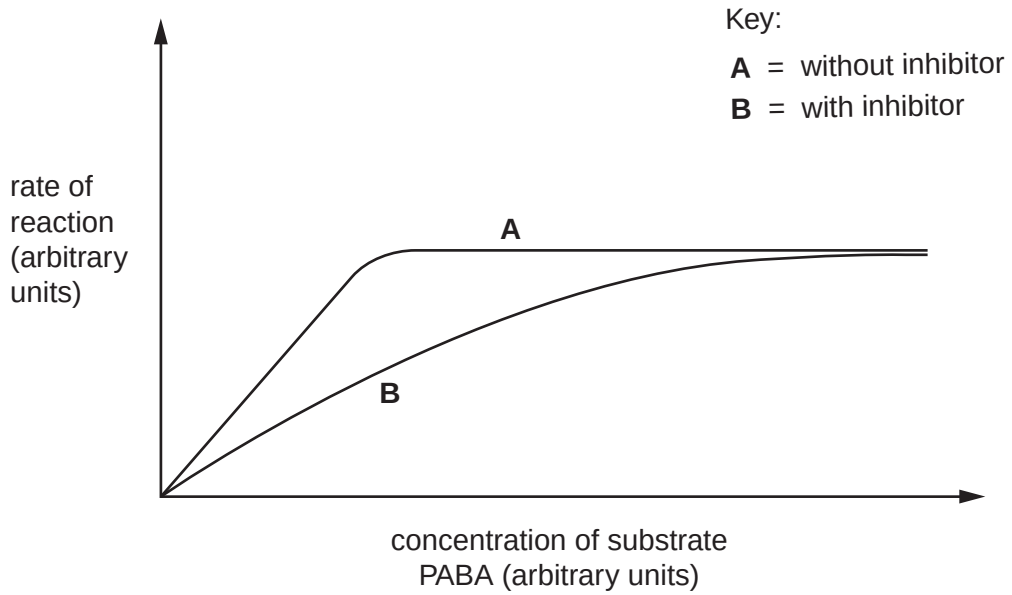

Fig. 3.2

Explain the effect of increasing the concentration of substrate on the rate of reaction;

(i) without inhibitor,

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..... **[3]**

(ii) with inhibitor.

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..... **[2]**

(c) Antibiotic resistance in bacteria is becoming an increasing problem.

Describe how a sulfonamide-resistant population of bacteria could develop.

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..... **[4]**

(d) Hospitals can check to see if a strain of bacteria causing an infection is resistant to a range of antibiotics by using a **multodisc**. A multodisc contains different antibiotics.

- The bacteria are isolated from a patient.
- The bacteria are spread on nutrient agar in a Petri dish.
- The multodisc is placed on the agar.

Fig. 3.3 shows a Petri dish with the bacteria, in which is placed a multodisc containing six different antibiotics.

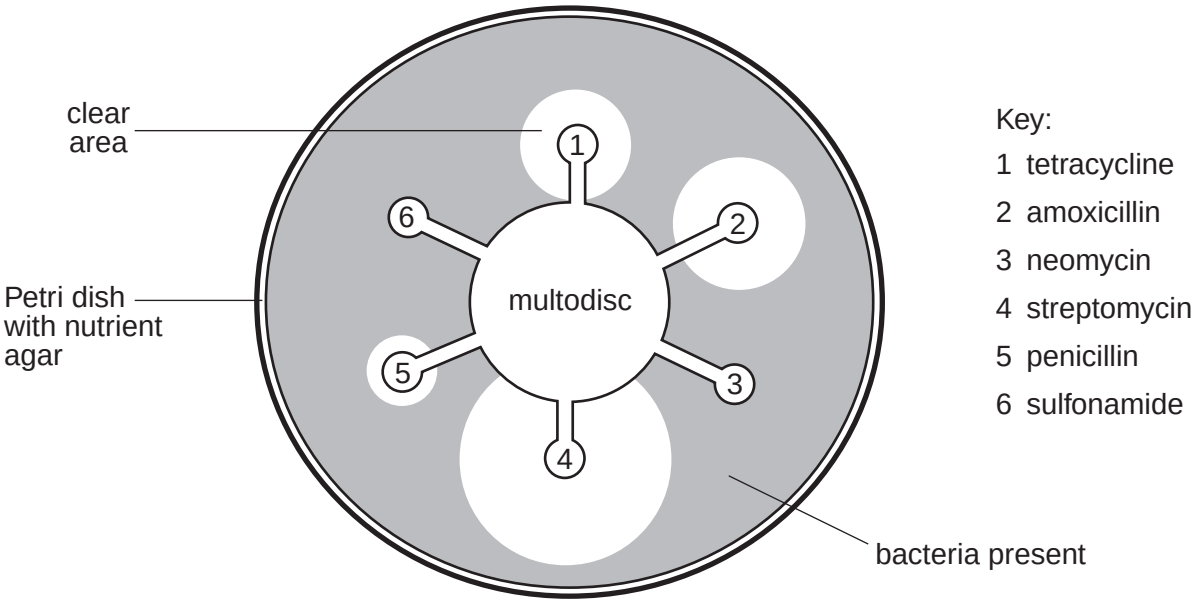

Fig. 3.3

(i) Explain why there are clear areas of agar in the Petri dish.

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.....

..... **[1]**

(ii) Using Fig. 3.3, name the antibiotic that is most effective against the bacteria causing the infection.

..... **[1]**

(iii) Suggest **three** reasons why a hospital might use a multodisc to select the most suitable antibiotic for treating a patient.

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..... **[3]**

(e) Drugs, such as antibiotics, are often first discovered in the natural environment.

Explain why it may become increasingly difficult to discover new drugs in the future.

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..... **[2]**

[Total: 20]