

6. Plant nutrition

6.1 Photosynthesis

Paper 3 and 4

Question Paper

Paper 3

Questions are applicable for both core and extended candidates

1 (a) (i) State the word equation for photosynthesis.

..... [2]

(ii) State the name of the green pigment that is needed for photosynthesis.

..... [1]

(b) A student investigated the rate of photosynthesis at different temperatures in potato plants.

Fig. 1.1 shows the results of the investigation.

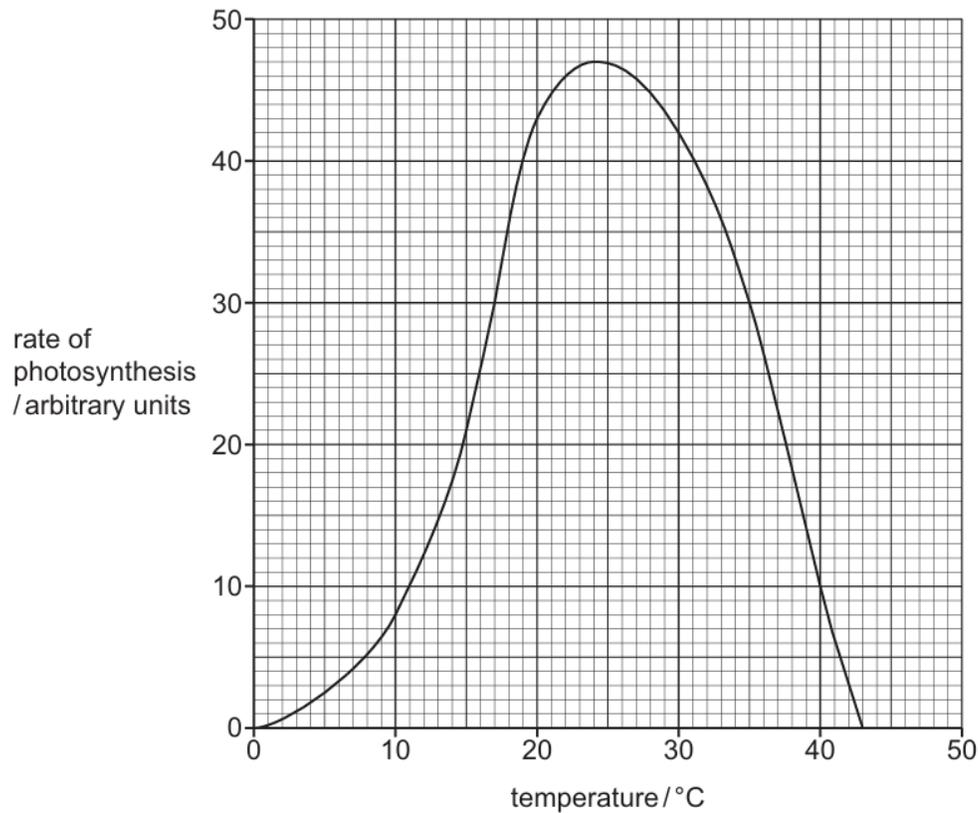


Fig. 1.1

Using the information in Fig. 1.1:

(i) State a temperature when the rate of photosynthesis is 30 arbitrary units.

..... °C [1]

(ii) State the rate of photosynthesis when the temperature is 15 °C.

..... arbitrary units [1]

- (iii) Describe the effect of increasing temperature on the rate of photosynthesis in potato plants.

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

- (c) (i) Potato cells contain starch.

State **one** use of starch in potato cells.

..... [1]

- (ii) Starch is a large molecule made from many glucose molecules.

State the name of **one** other carbohydrate that is found in plants and is made from glucose molecules.

..... [1]

- (iii) Glucose can be combined with ions to make amino acids in plants.

State the name of the ions needed to make amino acids.

..... [1]

- (d) Photosynthesis is one process of the carbon cycle.

State **two** other processes of the carbon cycle.

1

2

[2]

- 2 A student investigated photosynthesis in a variegated leaf.

A variegated leaf has a green part that contains a green pigment and a white part that does not contain the green pigment.

Fig. 2.1 is a photograph of some variegated leaves.

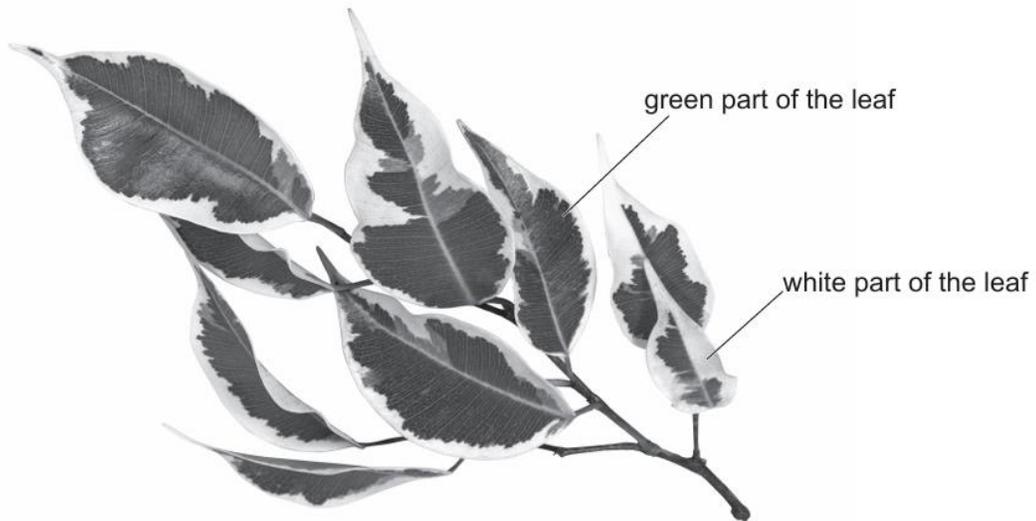


Fig. 2.1

- (a)** State where the green pigment is found in a plant cell.

..... [1]

- 3 Fig. 3.1 shows a photograph of some leaves on a tree.



Fig. 3.1

- (a) State **two** features of the leaves, **visible** in Fig. 3.1, that are adaptations for photosynthesis.

1

2

[2]

4 (b) A group of students investigated the effect of light intensity on the rate of photosynthesis.

They used this method:

- An aquatic plant was placed in a test-tube containing water.
- A lamp was placed 10 cm from the aquatic plant.
- The number of bubbles of gas produced in one minute was counted and recorded in Table 6.1.
- The investigation was repeated with the lamp at different distances from the aquatic plant.

Fig. 6.2 is a diagram of the equipment used.

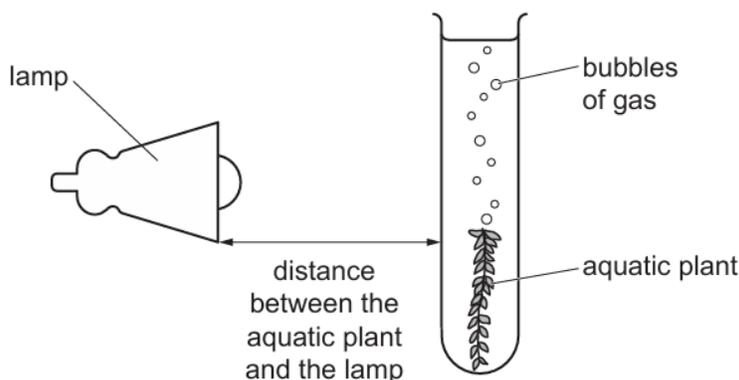


Fig. 6.2

The results are shown in Table 6.1.

Table 6.1

distance from the aquatic plant/cm	number of bubbles produced in one minute
10	90
15	85
20	75
40	50
50	30

(i) State the distance which gives the highest rate of photosynthesis.

..... cm [1]

(ii) Describe the effect of increasing light intensity on the rate of photosynthesis.

.....

 [1]

- (iii) The student repeated the investigation but added a source of carbon dioxide to the water in the test-tube.

Suggest how this would affect the rate of photosynthesis.

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

- 5 (b) Photosynthesis is the process occurring at **K** in Fig. 8.1.

State the **two** products of photosynthesis.

1

2

[2]

6 (c) Complete the sentences.

Seeds contain proteins for the of developing shoots and roots. Proteins contain the elements, oxygen, and nitrogen.

The new leaves of a seedling need the mineral ion to make the green pigment

This green pigment is needed to carry out the process of, in the presence of light.

[6]

7 (a) (i) State the word equation for photosynthesis.

..... [2]

(ii) State the source of energy for photosynthesis.

..... [1]

(iii) State the name of the structure in a cell where photosynthesis takes place.

..... [1]

(b) The effect of carbon dioxide concentration on the rate of photosynthesis in an aquatic plant was investigated.

- 10 test-tubes were prepared. Each contained water, an aquatic plant and a different concentration of carbon dioxide.
- Each test-tube was placed next to a lamp and the temperature in the test-tubes was maintained at 20 °C.
- The number of bubbles produced by each aquatic plant in one minute was counted.

Fig. 6.1 shows the apparatus that was used.

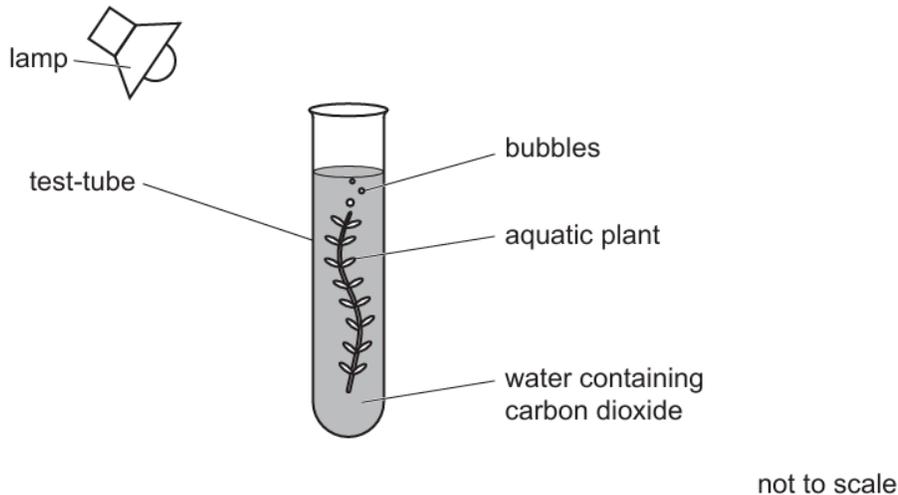


Fig. 6.1

The results of the investigation are shown in Fig. 6.2.

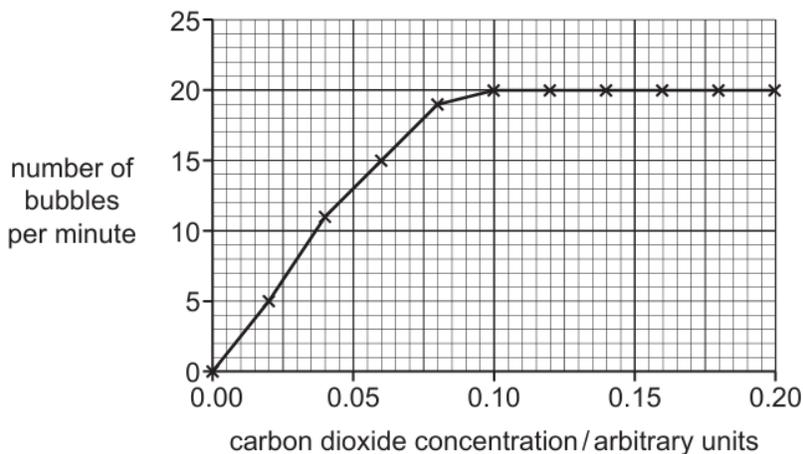


Fig. 6.2

(i) State the maximum number of bubbles produced in one minute.
 [1]

(ii) The investigator concluded that 0.10 arbitrary units was the optimum (best) concentration of carbon dioxide for photosynthesis in this investigation.

Describe the evidence shown in Fig. 6.2 that supports the investigator's conclusion.

.....

 [2]

(iii) The investigation described in **6(b)** was repeated but the temperature was reduced from 20°C to 10°C.

Predict the effect of reducing the temperature on the number of bubbles produced and explain your answer.

prediction

 explanation

[2]

(c) Carbon dioxide is a greenhouse gas.

State the name of **one** other greenhouse gas.

..... [1]

[Total: 10]

8 (b) Photosynthesis and germination have different requirements.

(i) State the word equation for photosynthesis.

..... [2]

(ii) State the name of **one** condition needed for both photosynthesis and germination.

..... [1]

- 9 (b) Fig. 2.1 shows a variegated leaf which uses photosynthesis to make carbohydrates.

A variegated leaf has green parts that contain chlorophyll and white parts that do **not** contain chlorophyll.



Fig. 2.1

- (i) State the word equation for photosynthesis.

..... [2]

- (ii) The carbohydrate produced by photosynthesis can be stored as starch in the leaf.

A plant with variegated leaves used up its store of starch because it was placed in the dark.

Explain why the plant used up its store of starch when it was placed in the dark.

.....

 [2]

- (iii) The plant with variegated leaves was then left in a warm, sunny place. After a few days, a leaf from this plant was removed and tested for starch.

Predict the results of the starch test by placing ticks (✓) in Table 2.1.

Table 2.1

part of leaf	starch present	starch absent
green		
white		

[1]

- (iv) State the name of the mineral ion that is needed to make chlorophyll.

..... [1]

10 Plants carry out photosynthesis.

(a) State the names of **two** substances produced by photosynthesis.

1

2

[2]

(b) A student investigated how temperature affects the rate of photosynthesis. The concentration of carbon dioxide was kept constant during the investigation.

The results are shown in Fig. 8.1.

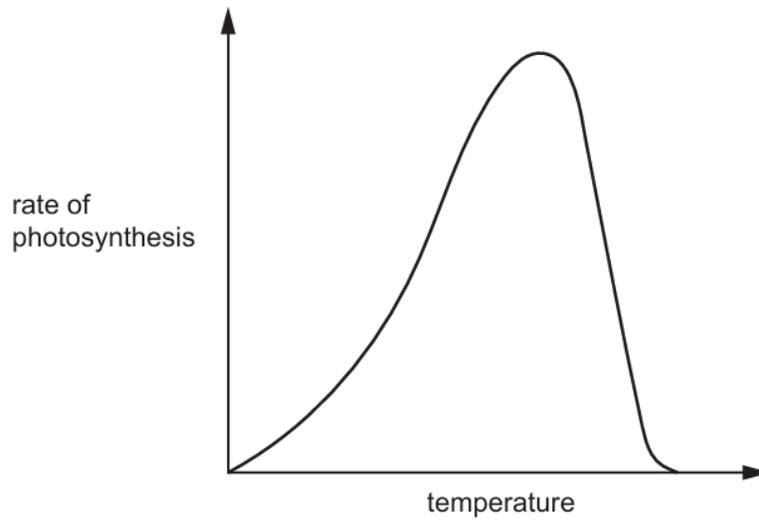


Fig. 8.1

(i) Predict how the rate of photosynthesis will change when carbon dioxide concentration increases and the temperature is kept constant at 20 °C.

.....

 [1]

(ii) State **one** factor other than temperature and carbon dioxide concentration that will affect the rate of photosynthesis.

..... [1]

(c) In another investigation students used a plant which had variegated leaves.

One of the leaves from this plant is shown in Fig. 8.2.



Fig. 8.2

Complete Table 8.1 to show where the processes of photosynthesis and respiration occurred in this variegated leaf when the plant was in the light.

Place a tick (✓) in each correct box.

Table 8.1

process	area A	area B
photosynthesis		
respiration		

[2]

(d) Cells in the mesophyll layers of a leaf carry out photosynthesis.

State the names of **two** leaf layers that light must pass through to reach the spongy mesophyll cells.

1

2

[2]

(e) Plants absorb mineral ions from the soil.

(i) State the name of the tissue that transports mineral ions in plants.

..... [1]

(ii) State the name of the mineral ion that is used to make chlorophyll.

..... [1]

(iii) State the name of the mineral ion that is used to make amino acids.

..... [1]

11 (b) A plant is in bright sunlight and has plenty of water.

Gases move into and out of its leaves.

Complete Table 4.1 to show the net direction of movement for the named gases.

Place a tick (✓) in each correct box.

Table 4.1

name of gas	moves into leaves	moves out of leaves
carbon dioxide		
oxygen		
water vapour		

[3]

(b) A student wrote a series of statements to explain why an increase in nitrate and magnesium ions increased the number of leaves. Not all of the statements are correct.

A – Magnesium is required for the synthesis of chlorophyll.

B – Nitrate ions are a component of carbohydrates.

C – Chlorophyll is required for photosynthesis.

D – Proteins are needed for growth.

E – Plants make their own food by the process of respiration.

F – Respiration produces glucose.

State the letters of the correct statements.

..... [3]

(c) State the principal source of energy for plants.

..... [1]

[Total: 7]

13 (c) Plants need mineral ions for healthy growth.

State why a plant needs magnesium ions and nitrate ions.

magnesium ions

.....

nitrate ions

.....

[2]

14 (b) (i) The leaves of a seedling photosynthesise.

State the word equation for photosynthesis.

..... [2]

(ii) Chlorophyll has to be present for photosynthesis to take place.

State the name of the mineral ion that plants need to make chlorophyll.

..... [1]

(iii) State the name of **one** type of cell that carries out photosynthesis.

..... [1]

(c) The rate of photosynthesis can be measured using the apparatus shown in Fig. 5.3.

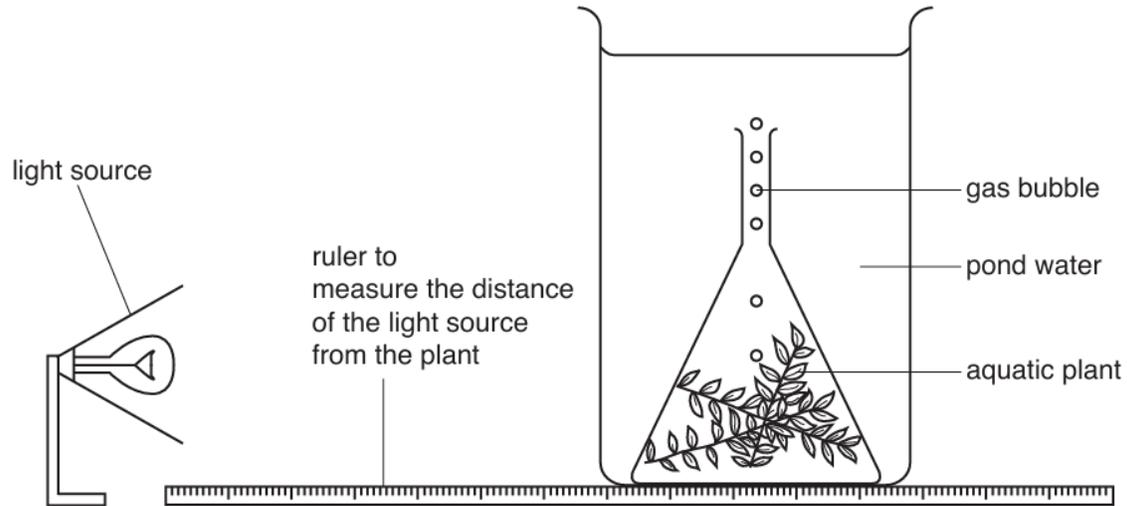


Fig. 5.3

The faster the rate of photosynthesis, the more gas bubbles are produced.

Table 5.1 shows the results from an investigation using this apparatus.

Table 5.1

distance of light source from plant/cm	number of bubbles produced in 5 minutes
5	74
10	75
20	35
30	15
40	5
50	1
60	0

(i) Describe the relationship between light and the rate of photosynthesis shown in Table 5.1.

.....

.....

.....

..... [2]

(ii) State **two** factors, other than light, that will affect the rate of photosynthesis in this investigation.

1

2

[2]

(d) Suggest **one** use of glucose in a plant.

.....

..... [1]

15 (b) State the name of **one** mineral ion and give a reason why it is important for plant growth.

ion

reason

..... [2]

- 16 The apparatus shown in Fig. 2.1 was used to investigate the effects of different conditions on the rate of photosynthesis in an aquatic plant.

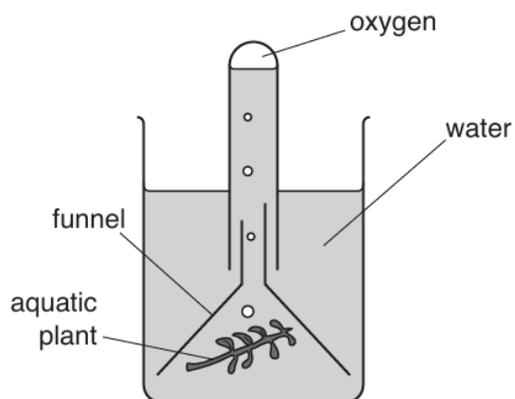


Fig. 2.1

A student investigated the effects of light and carbon dioxide on the rate of photosynthesis.

The number of bubbles of oxygen produced in one minute was counted in four different conditions.

Table 2.1 shows the results.

Table 2.1

test	conditions		number of bubbles of oxygen per minute
	light	carbon dioxide source added to the water	
1	present	no	2
2	absent	no	0
3	present	yes	20
4	absent	yes	0

- (a) State **two** conclusions about the conditions needed for photosynthesis using the information in Table 2.1.

1

.....

2

.....

[2]

(b) The investigation was carried out at 15°C. It was repeated at 25°C.

Suggest **and** explain the effect this had on the results of test 2 and test 3.

test 2

.....

.....

test 3

.....

.....

[4]

- 17 In an investigation, the carbon dioxide concentration in the air above a crop of maize plants was measured for 24 hours.

There was no wind blowing during the 24 hours of the investigation.

The results of this investigation are shown in Fig. 9.1.

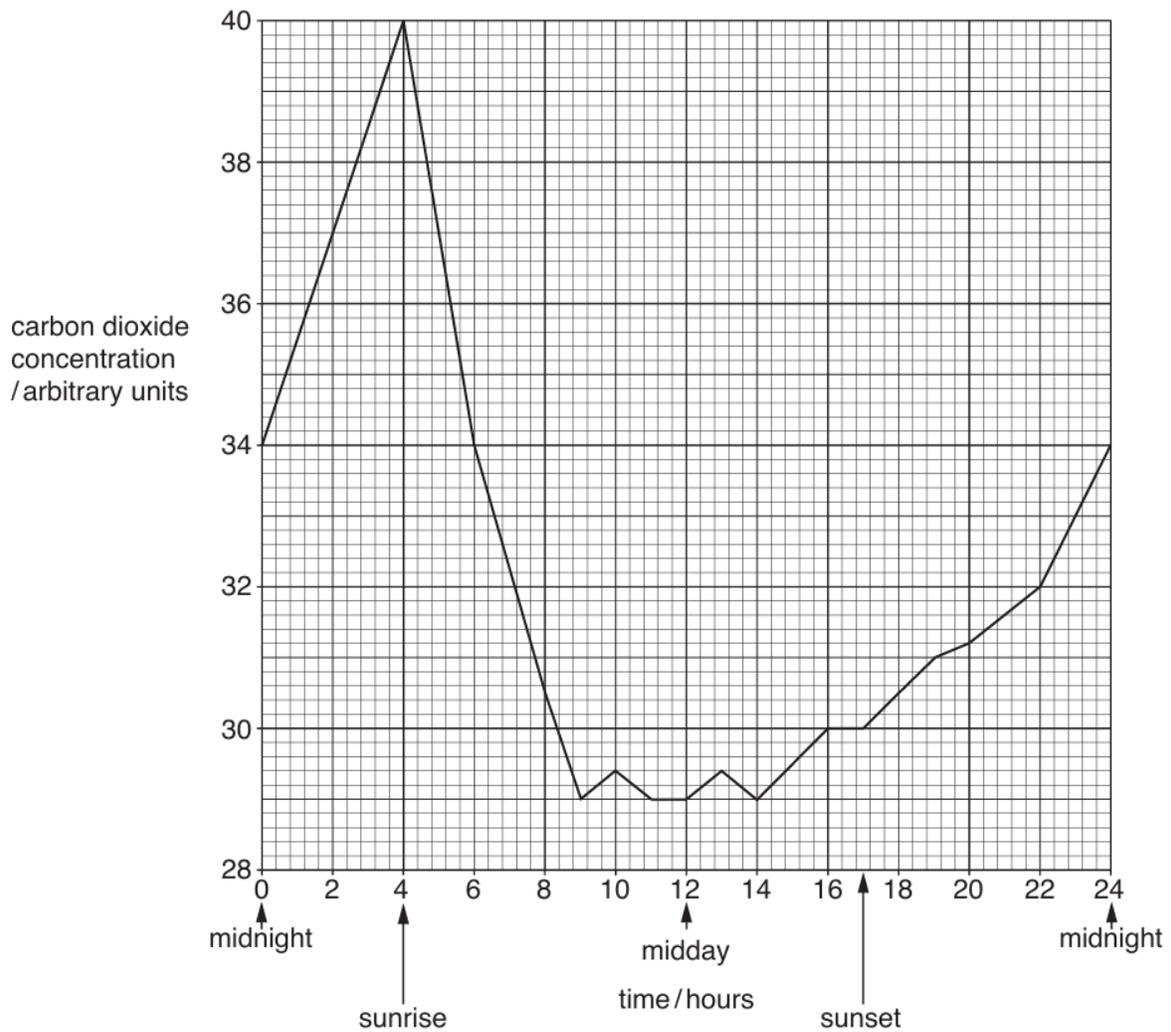


Fig. 9.1

(a) (i) State the **two** times, on Fig. 9.1, at which the carbon dioxide concentration in the air was 37 arbitrary units.

..... [1]

(ii) Calculate the difference in the carbon dioxide concentration in the air between 04:00 (sunrise) and 12:00 (midday) on Fig. 9.1.

Space for working.

..... arbitrary units [1]

(iii) Explain why the concentration of carbon dioxide decreases between 04:00 and 09:00.

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

(b) State **two** environmental factors that would affect the results of this investigation.

1

2

[2]

18 (a) Fig. 2.1 shows a diagram of a leaf.

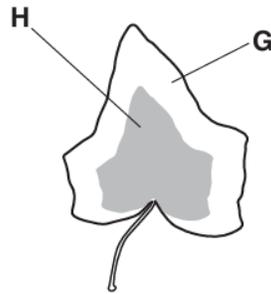


Fig. 2.1

- The part of the leaf labelled **G** contains no chlorophyll and is a white colour.
- The part of the leaf labelled **H** contains chlorophyll and is a green colour.

Glucose produced during photosynthesis is stored in the leaf as starch.

The leaf was boiled in ethanol to remove the chlorophyll. The leaf was then tested for the presence of starch with iodine solution.

(i) Predict the colour of the part of the leaf labelled **G** after iodine solution has been added.
[1]

(ii) Predict the colour of the part of the leaf labelled **H** after iodine solution has been added.
[1]

(iii) State a conclusion about chlorophyll from this investigation.

[1]

(b) A similar leaf was kept in the dark for 24 hours and then tested for the presence of starch.

The leaf contained no starch.

Explain why the leaf contained no starch.

.....

[1]

Paper 4

Questions are applicable for both core and extended candidates unless indicated in the question

(ii) Fig. 4.1 is a graph showing the effect of light intensity on the rate of photosynthesis.

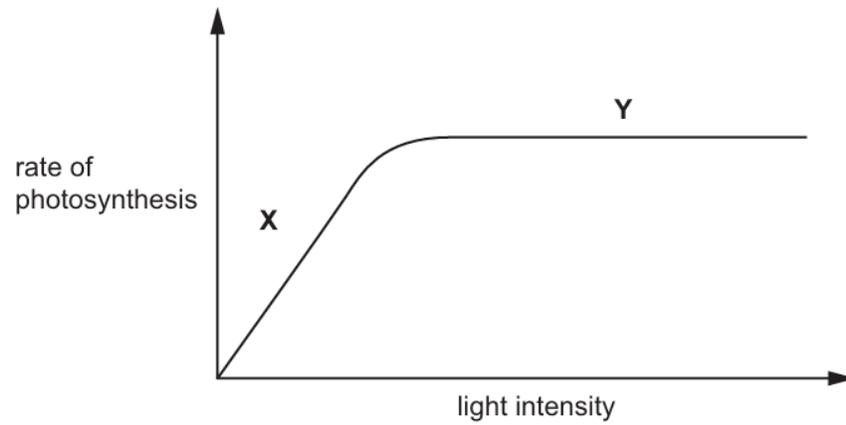


Fig. 4.1

(extended only)

State which factors could be limiting the rate of photosynthesis at **X** and at **Y** in Fig. 4.1.

.....

.....

..... [3]

20 (d) Explain why plants need nitrate ions.

.....

.....

.....

.....

..... [2]

21 (a) Fig. 6.1 is a diagram showing how glucose is used by different organisms.

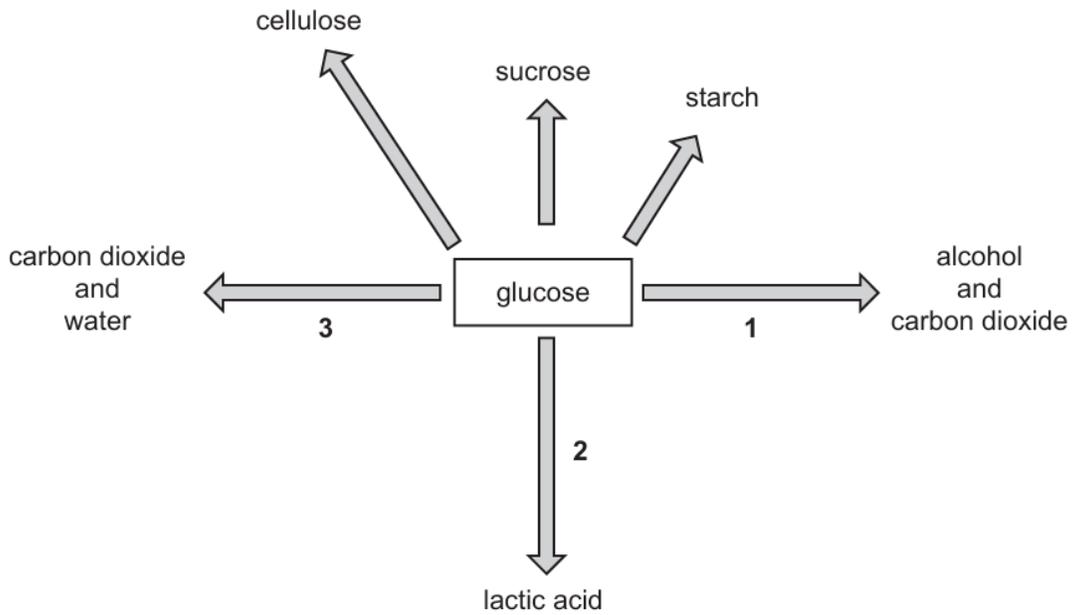


Fig. 6.1

(iv) State the main use of the molecule cellulose in a plant.

..... [1]

(v) Sucrose and amino acids are transported around a plant.

State the name of:

- the process by which sucrose is transported around a plant
- the tissue that transports sucrose and amino acids around a plant
- the mineral ion that is used to make amino acids.

process

tissue

mineral ion

[3]

- 22 A scientist investigated the effect of temperature on the rate of photosynthesis in one species of plant.

Photosynthesis involves enzyme-controlled reactions.

Discs were cut from a leaf and kept at different temperatures.

The total surface area of the discs was kept the same for each temperature.

The volume of oxygen that was produced by the leaf discs was measured and used to estimate the rate of photosynthesis.

The results are shown in Fig. 4.1.

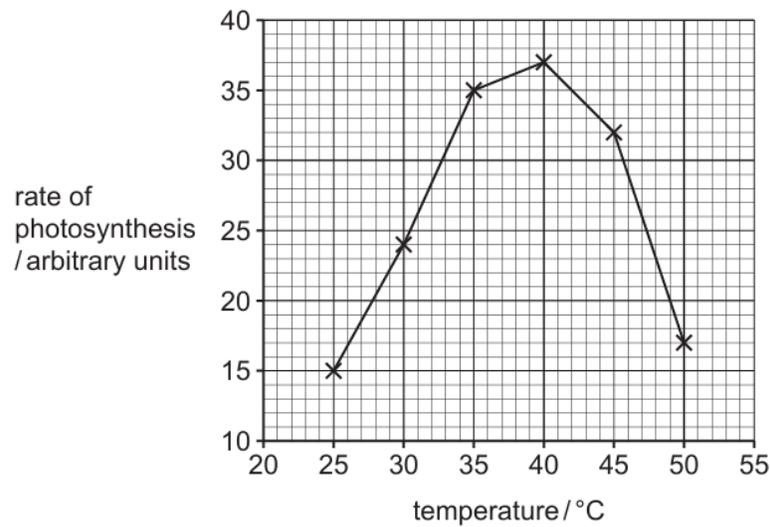


Fig. 4.1

- (a) Identify the optimum temperature for photosynthesis in Fig. 4.1.

..... °C [1]

(e) Describe the role of chlorophyll in photosynthesis.

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

23 (d) Explain the effect of a lack of magnesium ions on the colour of plant leaves.

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

(b) $C_6H_{12}O_6$ is one of the products of photosynthesis.

State the chemical formula of the **other** product. **(extended only)**

..... [1]

(c) Outline how the carbohydrates made during photosynthesis are used in plants.

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

25 (d) Low concentrations of carbon dioxide in the air may restrict the rate of photosynthesis in plants. **(extended only)**

(i) State the term given to something present in the environment in such short supply that it restricts life processes.

..... [1]

(ii) State **one** other feature of the environment that may also restrict the rate of photosynthesis.

..... [1]

26 (c) The researchers analysed two pigments, chlorophyll and lycopene, in homozygous red tomato fruit and homozygous yellow tomato fruit. Chlorophyll is found in unripe tomato fruit.

(i) Describe the function of chlorophyll.

.....

 [2]

(ii) State the name of **one** mineral required for the synthesis of chlorophyll.

..... [1]

(iii) The researchers analysed the concentration of the pigments in tomato fruits:

- before they were ready to eat (unripe)
- when they were ready to eat (ripe).

The results of the analysis are shown in Table 2.1.

Table 2.1

	chlorophyll concentration /mg per g of tomato fruit	lycopene concentration /mg per g of tomato fruit
unripe red fruit	10.0	0.0
ripe red fruit	1.2	105.7
unripe yellow fruit	6.2	0.0
ripe yellow fruit	0.4	0.7

Use the information in Table 2.1 to compare the changes in pigments in red fruit and yellow fruit as they ripen.

.....

 [3]

27 The rate of photosynthesis of terrestrial plants can be determined by measuring the uptake of carbon dioxide.

(a) Explain why plants take up carbon dioxide during photosynthesis.

.....

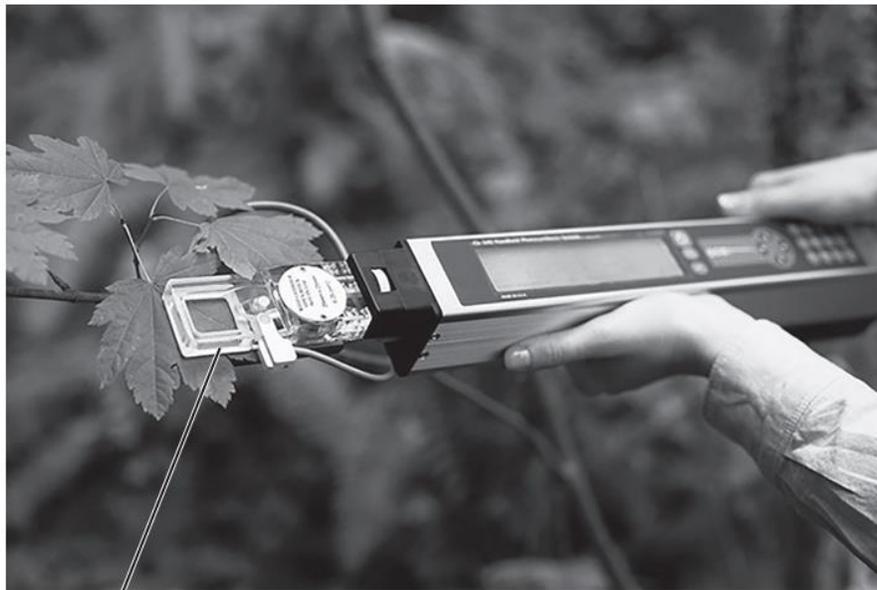
.....

.....

.....

..... [2]

(b) The rate of photosynthesis of parts of individual leaves can be measured using a hand-held device as shown in Fig. 2.1.



transparent chamber

Fig. 2.1

This apparatus allows air to flow through the transparent chamber that encloses part of the leaf. The apparatus measures the carbon dioxide concentration of the air entering and leaving the chamber.

Explain how the results from the apparatus can be used to calculate the rate of photosynthesis.

.....

.....

.....

..... [2]

- (c) A student used the apparatus shown in Fig. 2.1 to investigate the effect of temperature on the rate of photosynthesis of the leaves of Chinese plantain, *Plantago asiatica*, at two different concentrations of carbon dioxide, **A** and **B**.

Fig. 2.2 shows the results of the investigation.

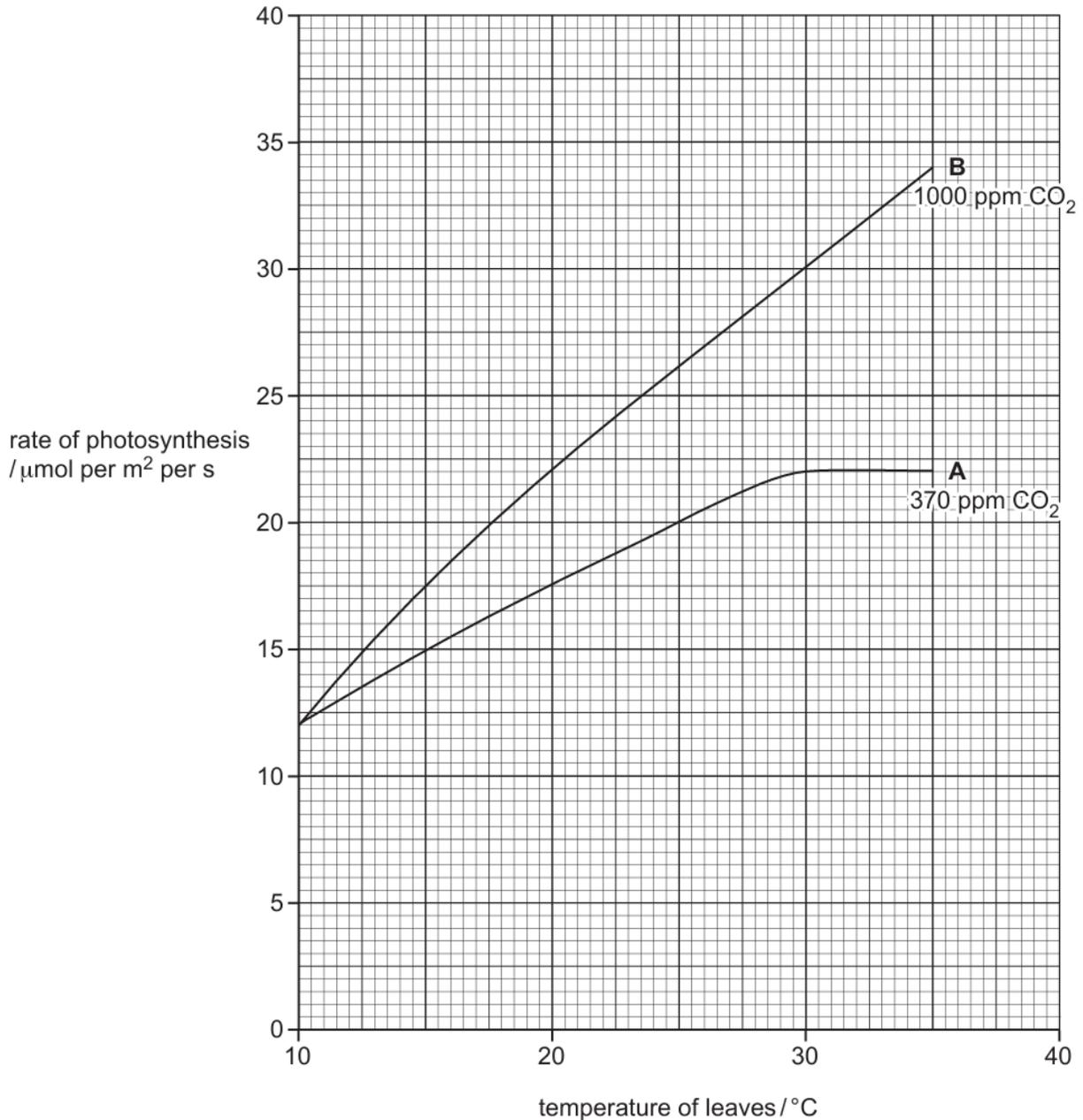


Fig. 2.2

- (i) State **one** environmental factor that should have been kept constant in this investigation.

..... [1]

- (ii) Describe the effect of temperature on the rate of photosynthesis when carbon dioxide concentration **A** was supplied.

Use the data from Fig. 2.2 in your answer.

.....

.....

.....

.....

.....

.....

.....

..... [3]

- (iii) Calculate the percentage increase in the rate of photosynthesis at 30 °C when the carbon dioxide concentration was increased from **A** to **B** as shown in Fig. 2.2.

Show your working and give your answer to the nearest whole number.

..... %

[2]

- (iv) Explain the effect of increasing temperature on the rate of photosynthesis for carbon dioxide concentration **B**.

Use the term *limiting factor* in your answer. **(extended only)**

.....

.....

.....

.....

.....

.....

.....

.....

..... [3]

- (v) The student concluded that carbon dioxide concentration is the factor limiting the rate of photosynthesis between 30 °C and 35 °C for the results shown for **A** in Fig. 2.2.

State the evidence for this conclusion. **(extended only)**

.....

.....

..... [1]

- (d) A similar investigation was carried out on Arizona honeysweet, *Tidestromia oblongifolia*, that grows in Death Valley in California where the highest temperatures may be greater than 45°C.

The results are shown in Fig. 2.3.

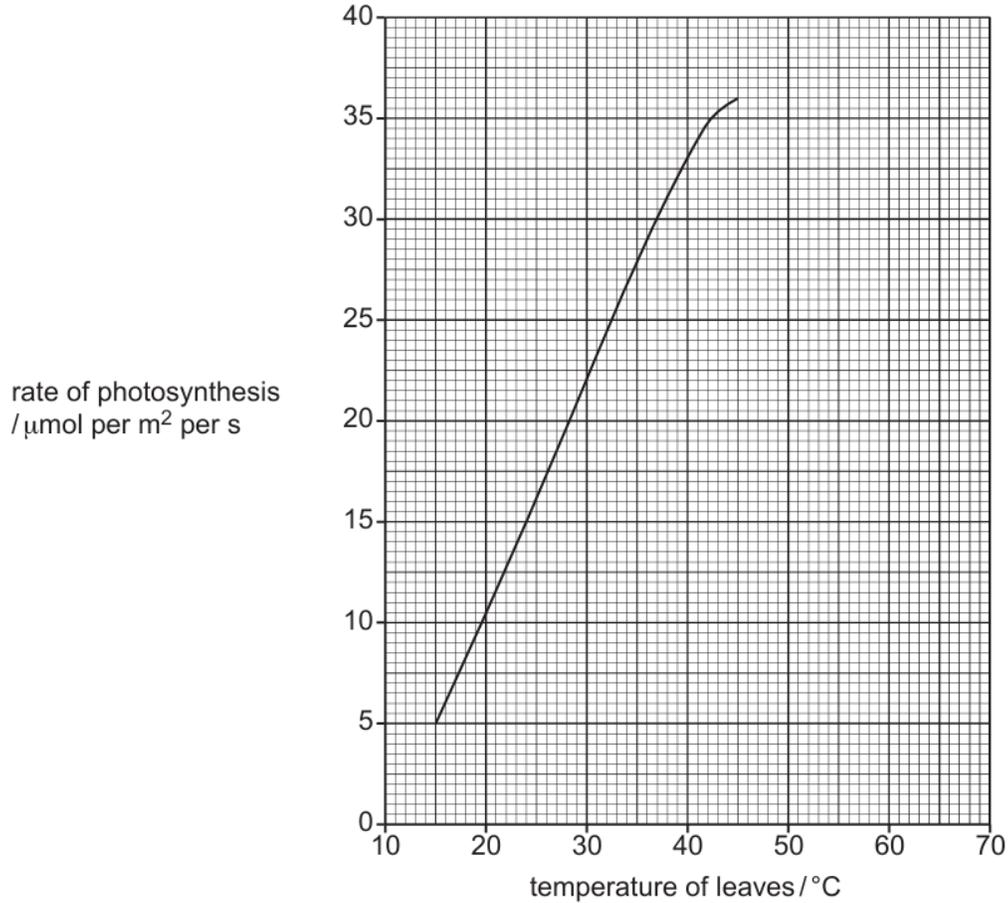


Fig. 2.3

Predict **and** explain what would happen to the rate of photosynthesis if the investigation is continued at temperatures higher than 45°C. **(extended only)**

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.....

.....

..... [2]

28 (c) Potato tubers store starch.

Explain why plants store starch.

.....

.....

.....

.....

.....

[2]