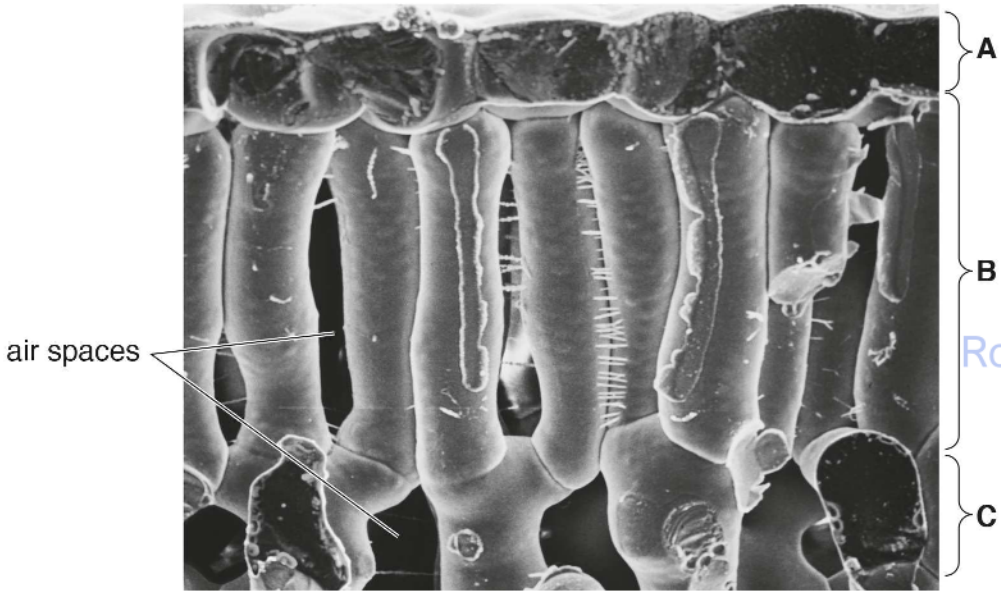
1 The photograph below is a scanning electron micrograph of a vertical section through part of the leaf of a broad bean plant, *Vicia faba*.



Explain why there are many interconnecting air spaces within the leaf.

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.....

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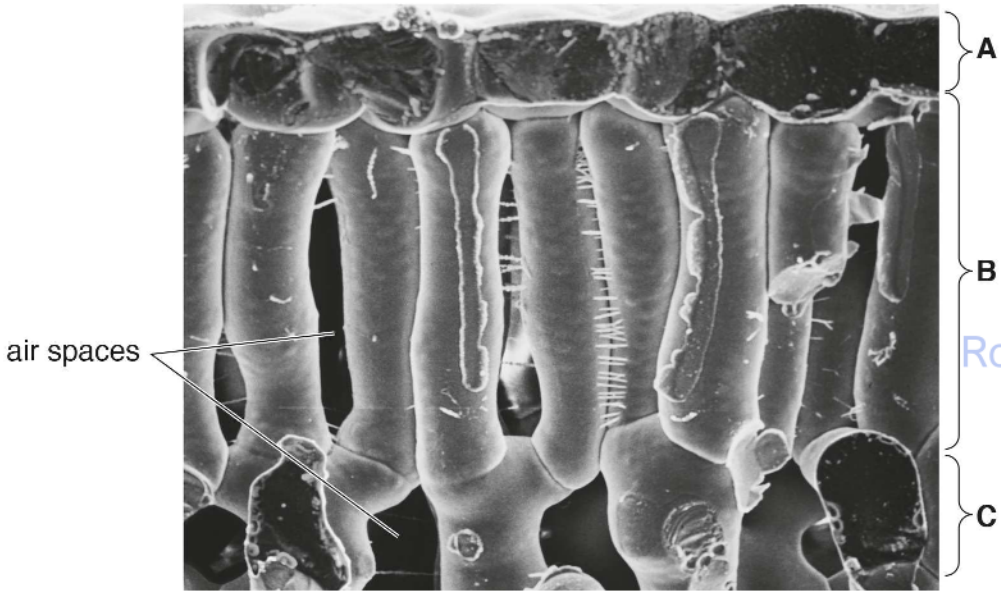
..... [2]

[Total: 2]

2 The photograph below is a scanning electron micrograph of a vertical section through part of the leaf of a broad bean plant, *Vicia faba*.



The cells in regions **B** and **C** in the photograph have a large surface area.

Explain why this is necessary for the functioning of the leaf cells.

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..... [3]

[Total: 3]

3 Stomata are found on the lower surface of broad bean leaves.

Describe the function of stomata.

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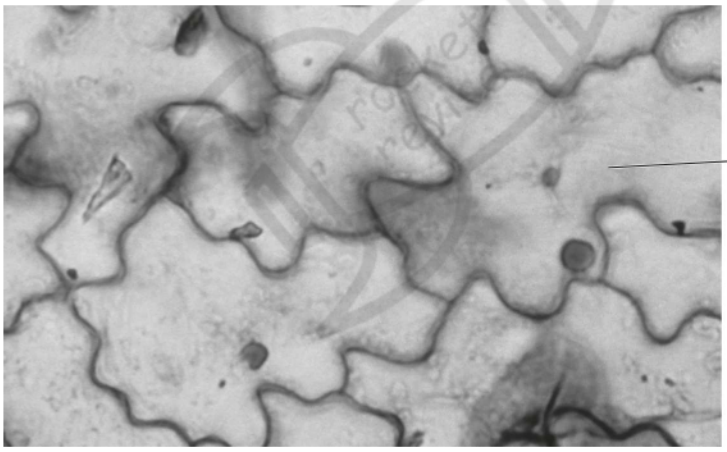
..... [3]

[Total: 3]

4 The image is a photomicrograph of part of the upper surface of a broad bean leaf, *Vicia faba*.

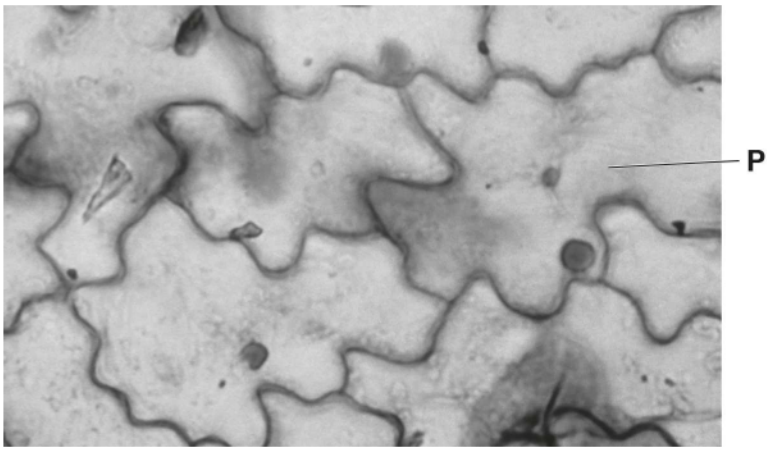


State the name of the tissue shown in the photomicrograph.

..... [1]

[Total: 1]

5 The image is a photomicrograph of part of the upper surface of a broad bean leaf, *Vicia faba*.



The tissue shown in the photomicrograph is transparent.

Explain why it is important to the plant that the tissue shown in the photomicrograph is transparent.

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..... [3]

[Total: 3]

6 State **three** ways a plant uses the sugars produced in photosynthesis.

1 .....

2 .....

3 ..... [3]

[Total: 3]

7 Water is one of the raw materials needed for the production of sugars in photosynthesis.

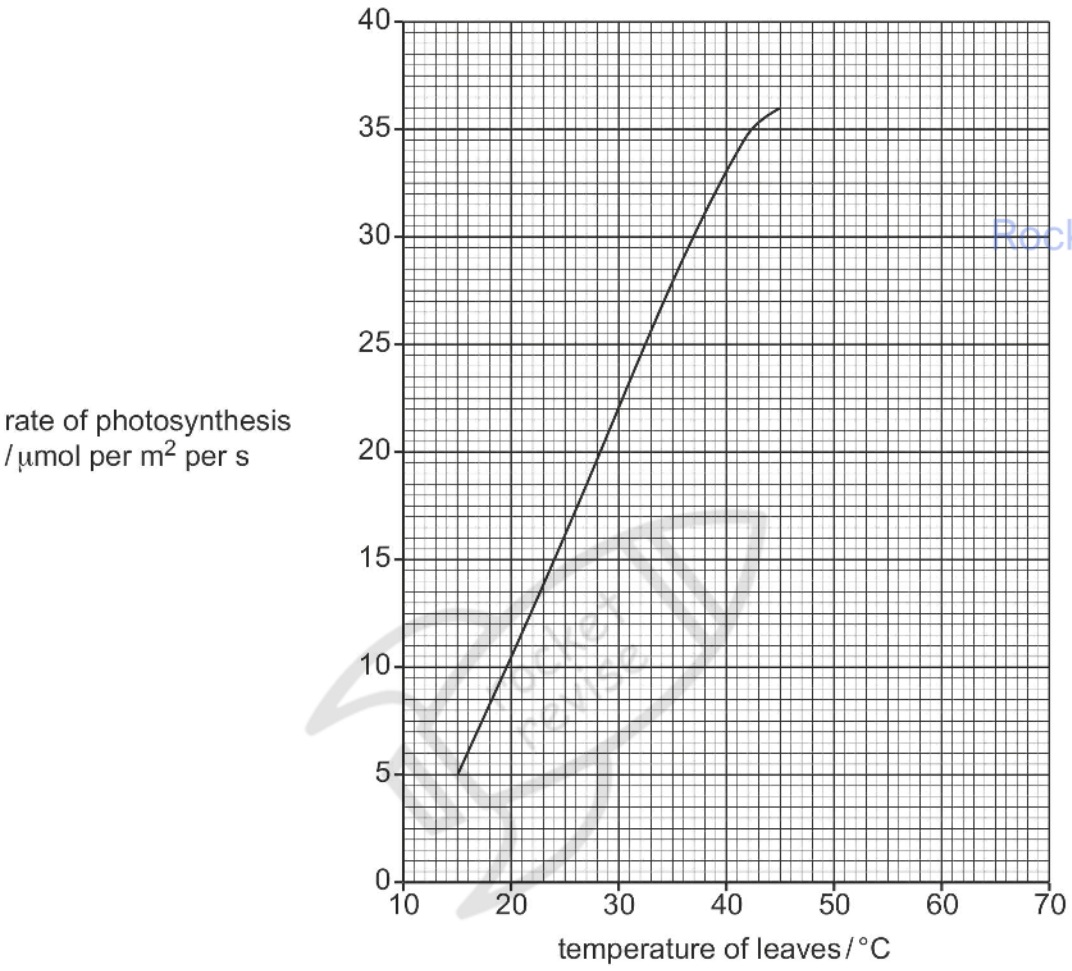
State the name of the other raw material needed for photosynthesis.

..... [1]

[Total: 1]

8 An investigation was carried out to measure the rate of photosynthesis of 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 the graph.



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

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..... [2]

[Total: 2]

9 Ammonium ions are an important part of the nitrogen cycle. They can be converted into nitrate ions, which are used by plants and protoctists such as diatoms.

Explain the effects of nitrate ion deficiency on plant growth.

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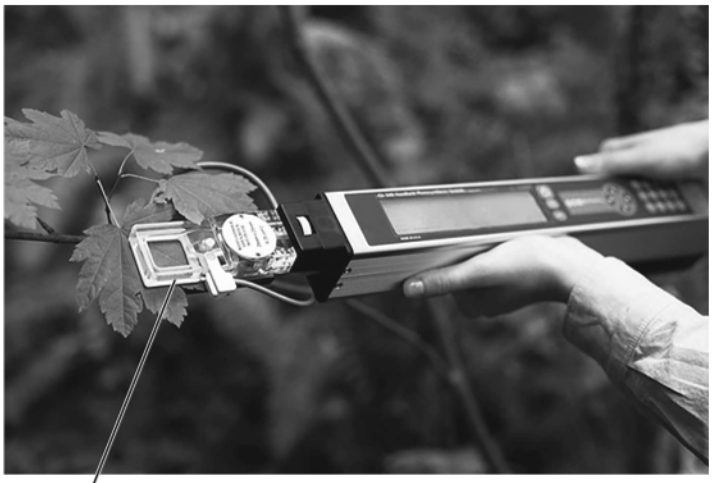
.... [3]

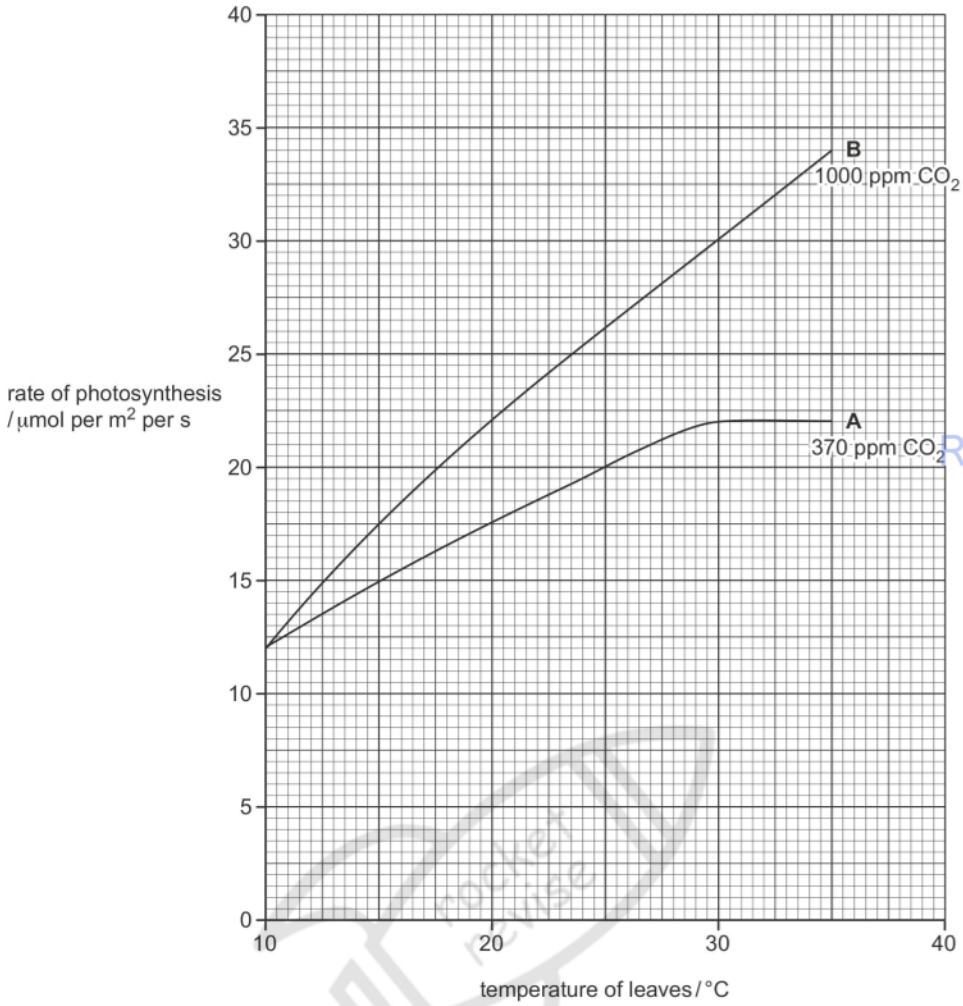
[Total: 3]

10 The rate of photosynthesis of parts of individual leaves can be measured using a hand-held device as shown in the photograph.



A student used the apparatus shown in the photograph 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**.

The graph shows the results of the investigation.



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 the graph.

State the evidence for this conclusion.

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.....

..... [1]

[Total: 1]

11 Scientists made some observations of the leaf structure of soybean plants.

Epidermis and mesophyll tissues are adapted for photosynthesis.

Complete the table by stating **two** structural features of each of these tissues and explain how each feature is an adaptation for photosynthesis.

tissue	feature	how the feature is an adaptation for photosynthesis
epidermis	1	....
	2	....
mesophyll	1	....
	2	....

[4]

[Total: 4]

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

Explain why plants take up carbon dioxide during photosynthesis.

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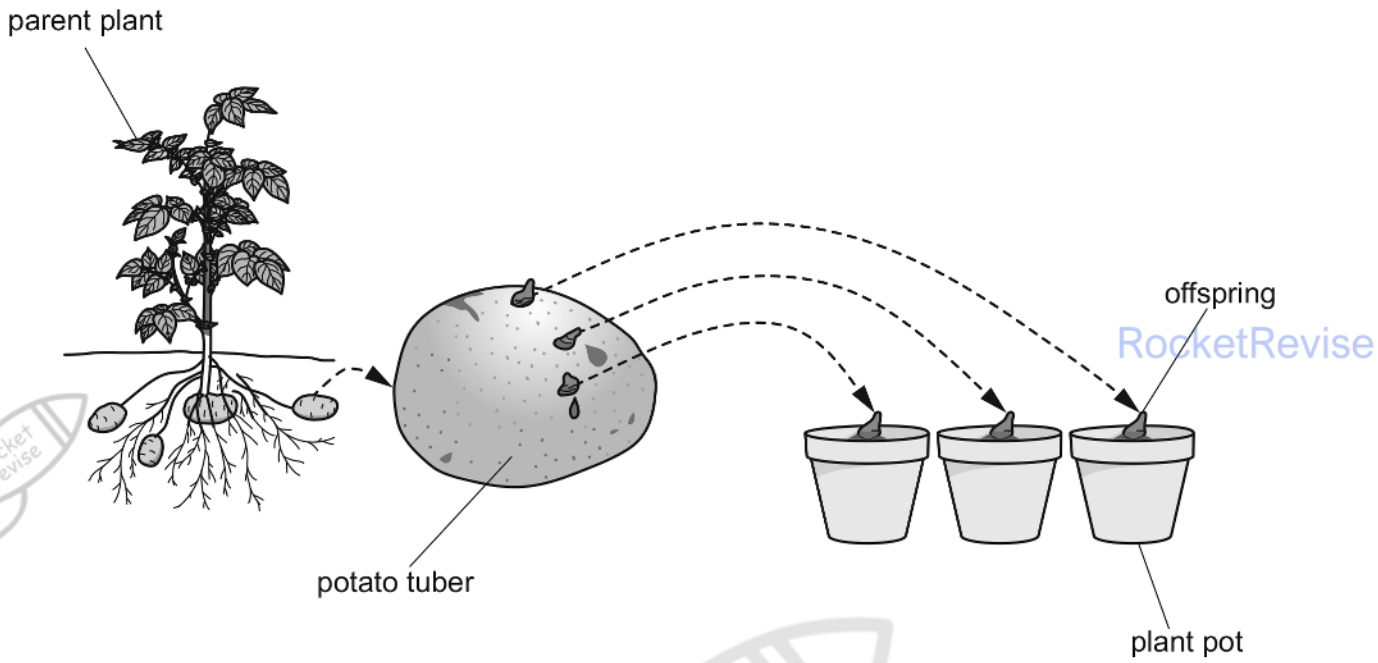
..... [2]

[Total: 2]

13 The diagram shows a method of reproduction that some potato farmers use to produce more potato plants.



Potato tubers store starch.

Explain why plants store starch.

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..... [2]

[Total: 2]

14 Soybean plants, *Glycine max*, were grown in two separate plots.

Each plot used a carbon dioxide enrichment system to control the atmospheric carbon dioxide concentration.

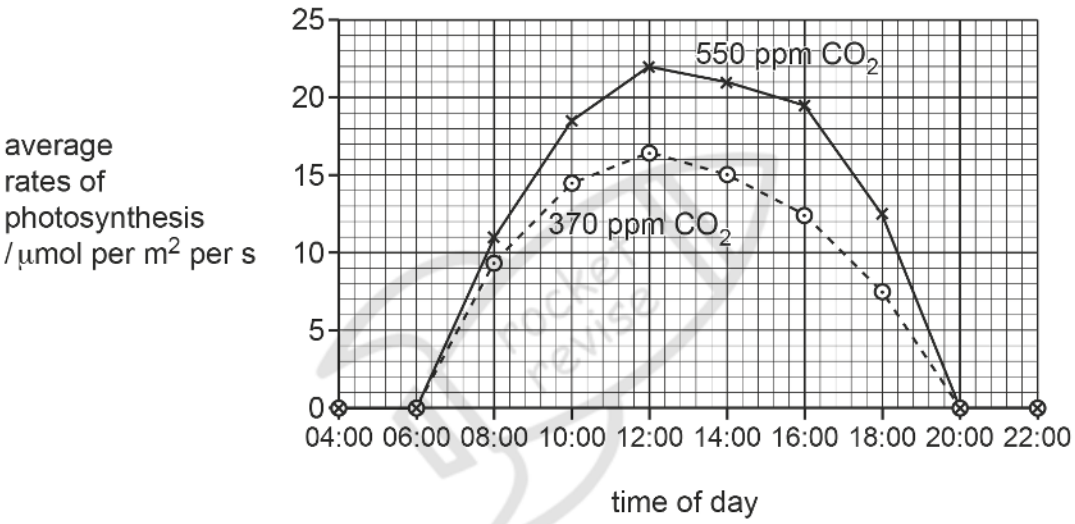
The atmospheric carbon dioxide concentrations in the two plots were kept at:

• 370 ppm, which is similar to the current atmospheric carbon dioxide concentration

• 550 ppm, which is a possible future atmospheric carbon dioxide concentration.

When the soybean plants were fully grown, scientists calculated the average rates of photosynthesis at regular intervals from 04:00 to 22:00 for both plots.

The results are shown in the graph.



Describe **and** explain the effect of carbon dioxide concentration on the average rates of photosynthesis of the soybean plants from 04:00 to 22:00.

Use the data from the graph in your answer.

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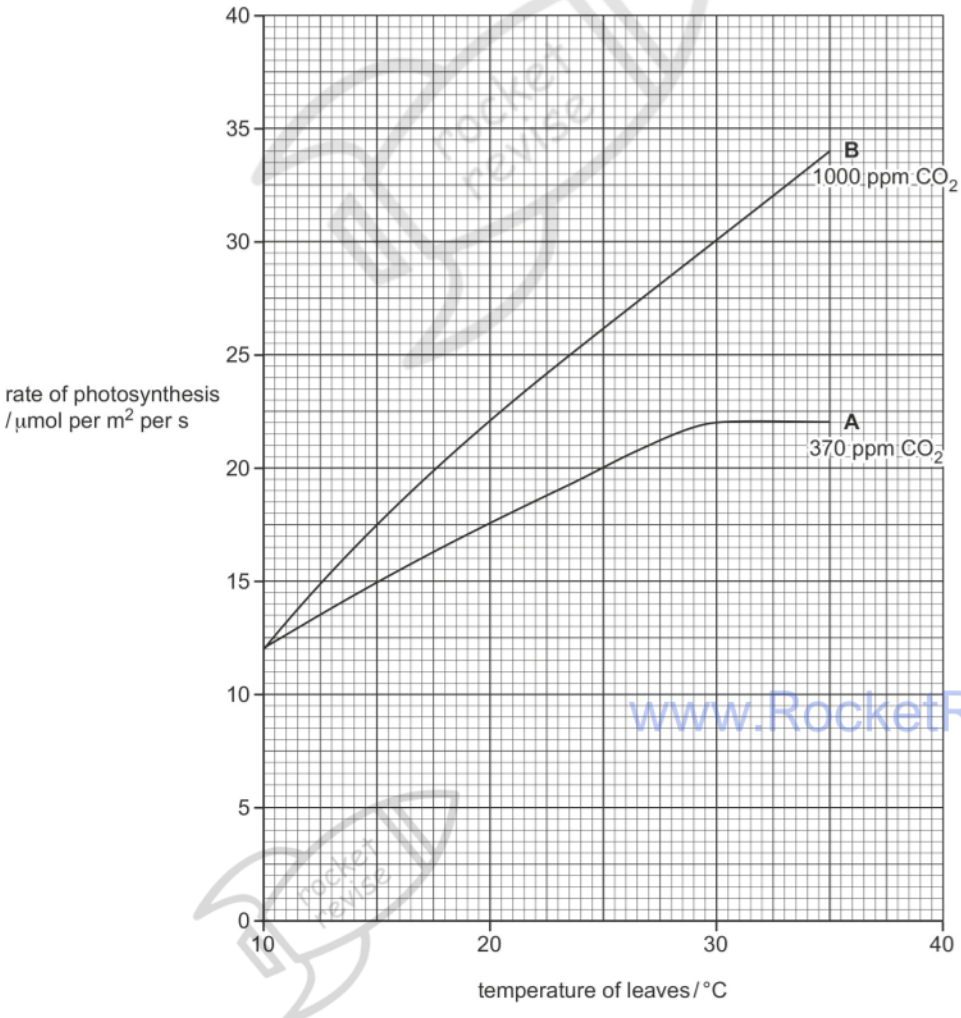
.... [6]

[Total: 6]

15 The rate of photosynthesis of parts of individual leaves can be measured using a hand-held device as shown in the photograph.

A student used the apparatus shown in the photograph 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**.

The graph shows the results of the investigation.



Explain the effect of increasing temperature on the rate of photosynthesis for carbon dioxide

concentration **B**.

Use the term *limiting factor* in your answer.

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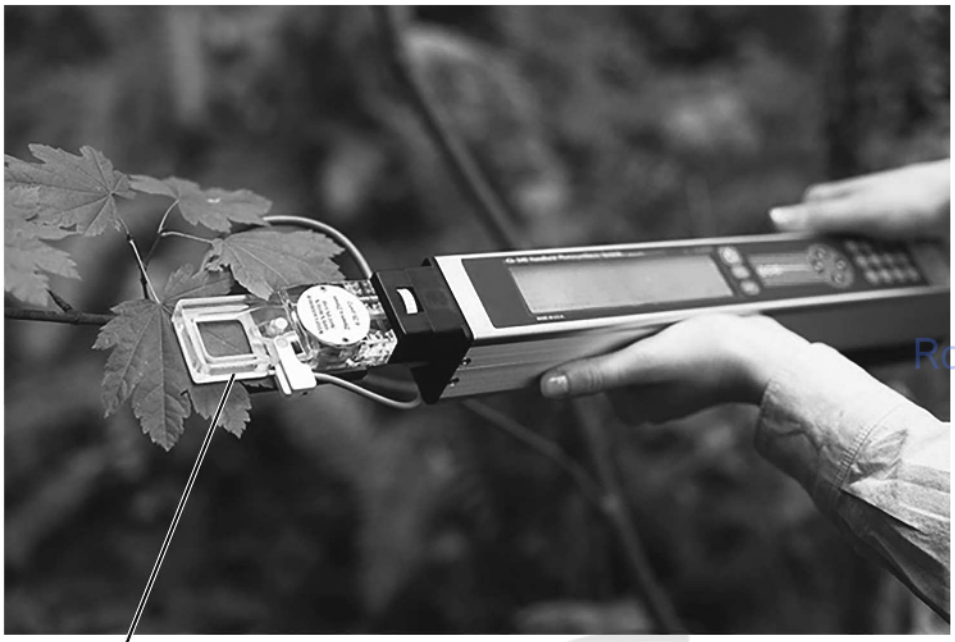
..... [3]

[Total: 3]

16 The rate of photosynthesis of parts of individual leaves can be measured using a hand-held device as shown in the photograph.



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.

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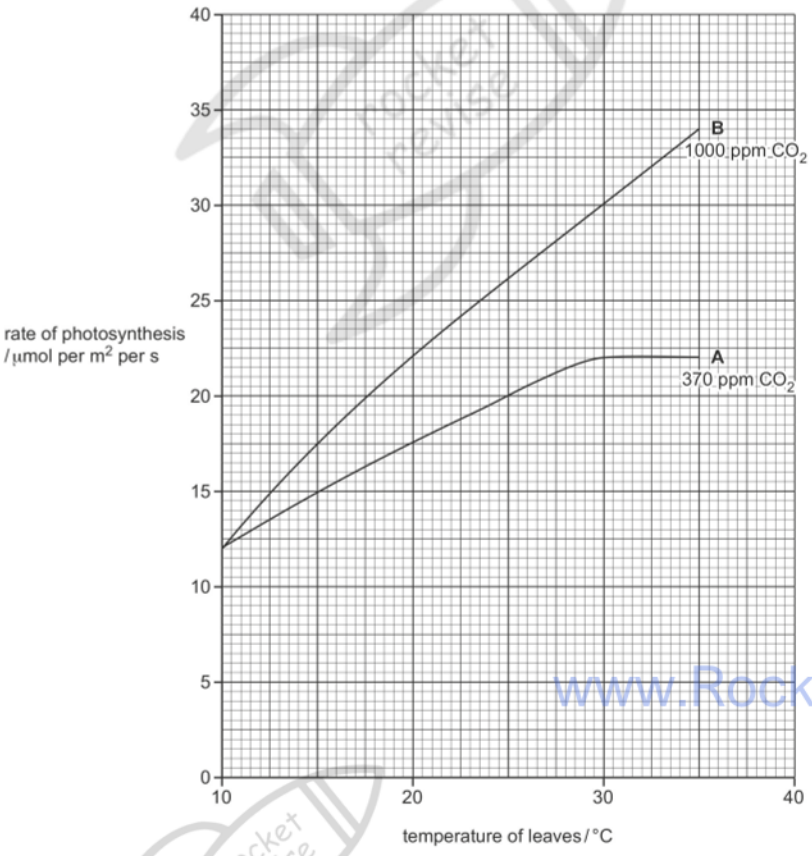
..... [2]

[Total: 2]

17 The rate of photosynthesis of parts of individual leaves can be measured using a hand-held device as shown in the photograph.

A student used the apparatus shown in the photograph 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**.

The graph shows the results of the investigation.



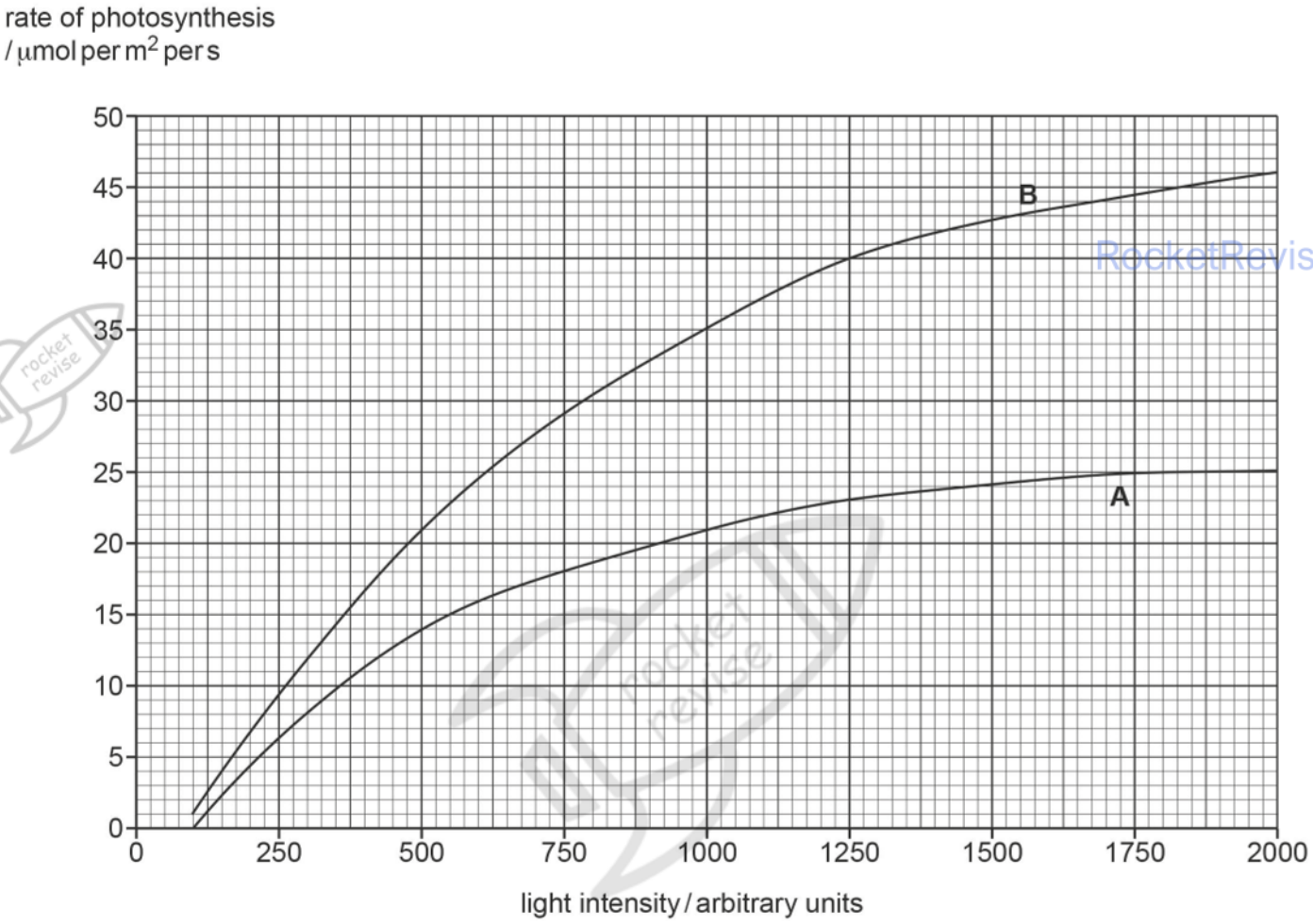
State **one** environmental factor that should have been kept constant in this investigation.

..... [1]

[Total: 1]

18 Scientists investigated the effect of light intensity on the rate of photosynthesis in the leaves of eucalyptus trees at two different concentrations of carbon dioxide, **A** and **B**.

The results are shown in the graph.



Key:

A carbon dioxide concentration 140 ppm

B carbon dioxide concentration 1000 ppm

Explain the effect of increasing light intensity on the rate of photosynthesis when the concentration of carbon dioxide was 1000 ppm.

Use the term *limiting factor* in your answer.

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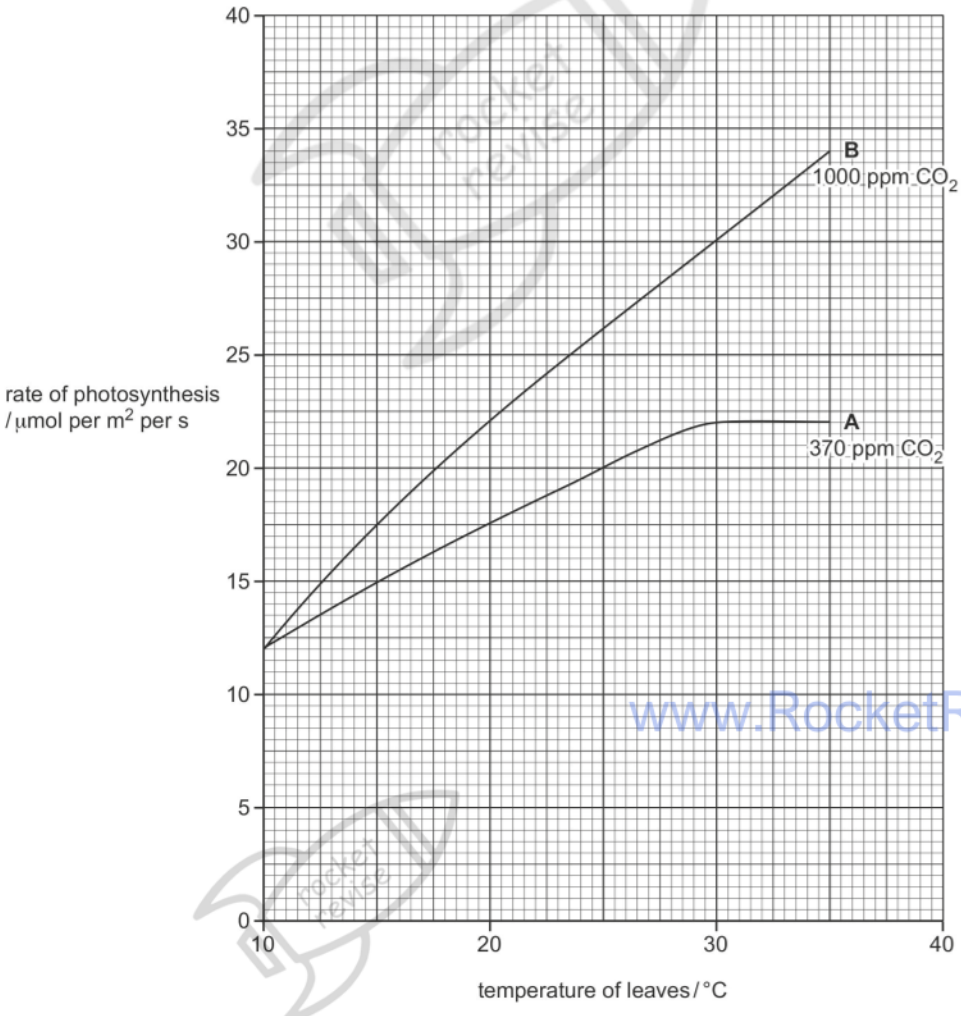
..... [4]

[Total: 4]

19 The rate of photosynthesis of parts of individual leaves can be measured using a hand-held device as shown in the photograph.

A student used the apparatus shown in the photograph 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**.

The graph shows the results of the investigation.



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 the graph.

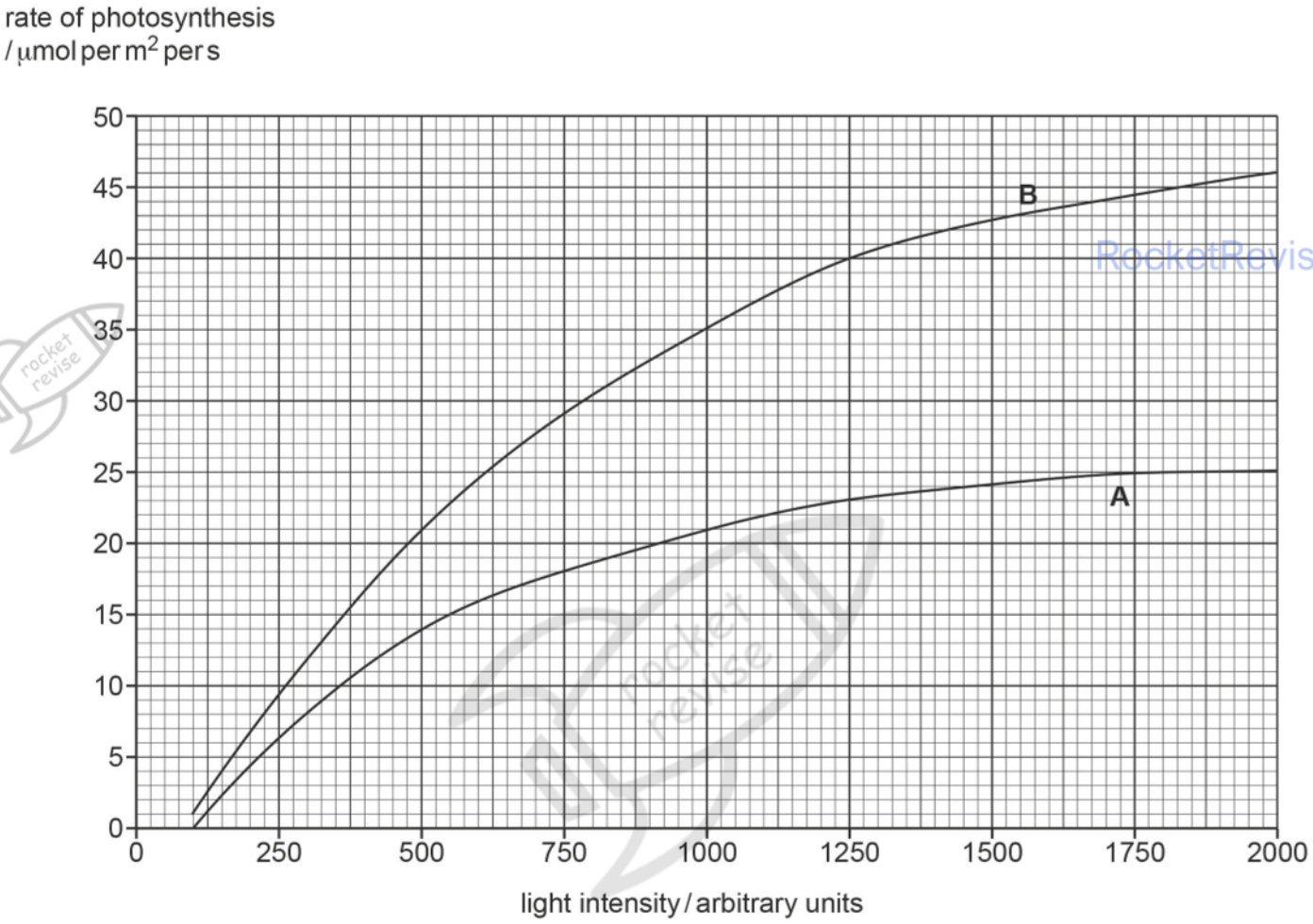
Show your working and give your answer to the nearest whole number.

..... % [2]

[Total: 2]

20 Scientists investigated the effect of light intensity on the rate of photosynthesis in the leaves of eucalyptus trees at two different concentrations of carbon dioxide, **A** and **B**.

The results are shown in the graph.



Key:

A carbon dioxide concentration 140 ppm

B carbon dioxide concentration 1000 ppm

Describe the effect of increasing light intensity on the rate of photosynthesis when the concentration of carbon dioxide was 140 ppm.

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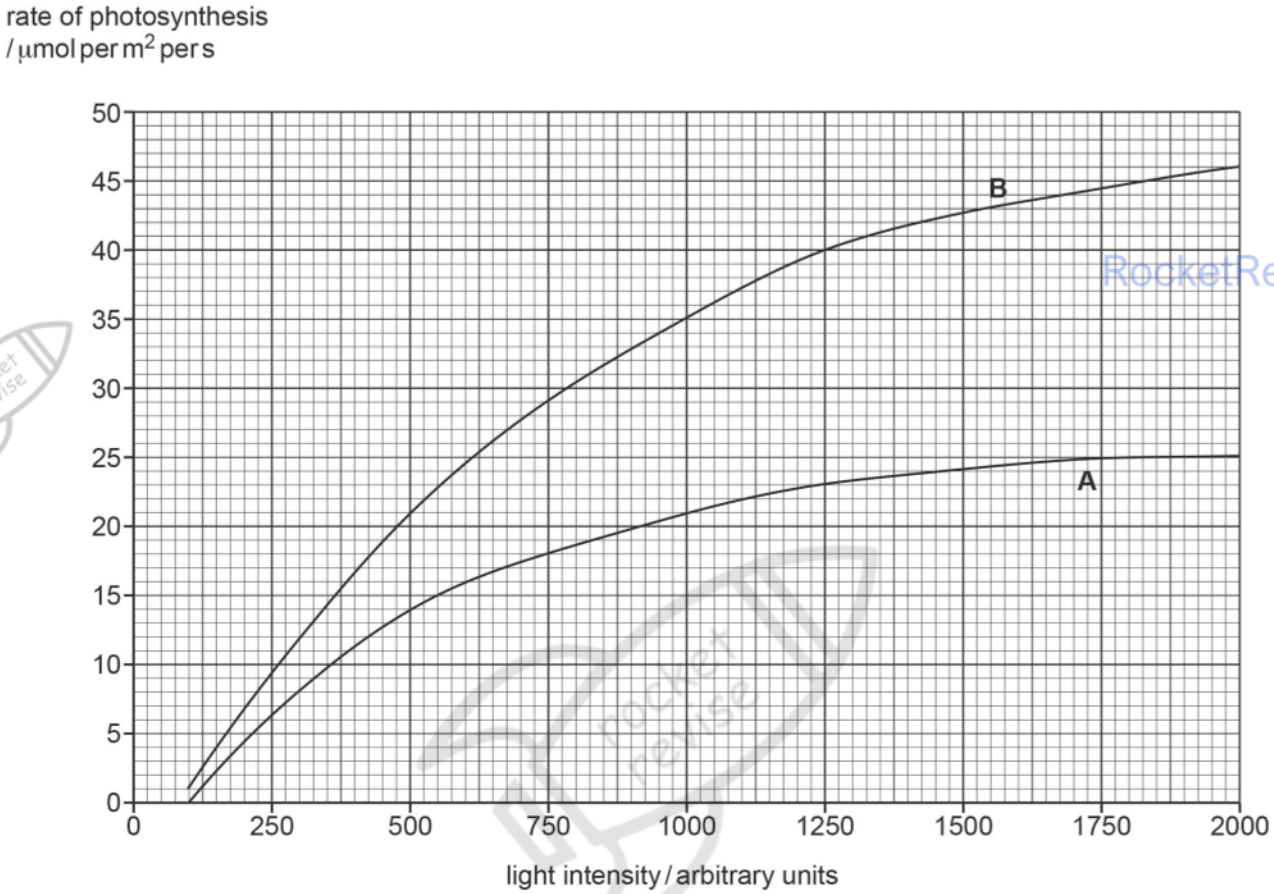
[3]

[Total: 3]

21 Scientists investigated the effect of light intensity on the rate of photosynthesis in the leaves of eucalyptus trees at two different concentrations of carbon dioxide, **A** and **B**.

The results are shown in the graph.



Key:

A carbon dioxide concentration 140 ppm

B carbon dioxide concentration 1000 ppm

Calculate the percentage increase in the rate of photosynthesis at a light intensity of 1250 arbitrary units when the carbon dioxide concentration was increased from 140 ppm to 1000 ppm.

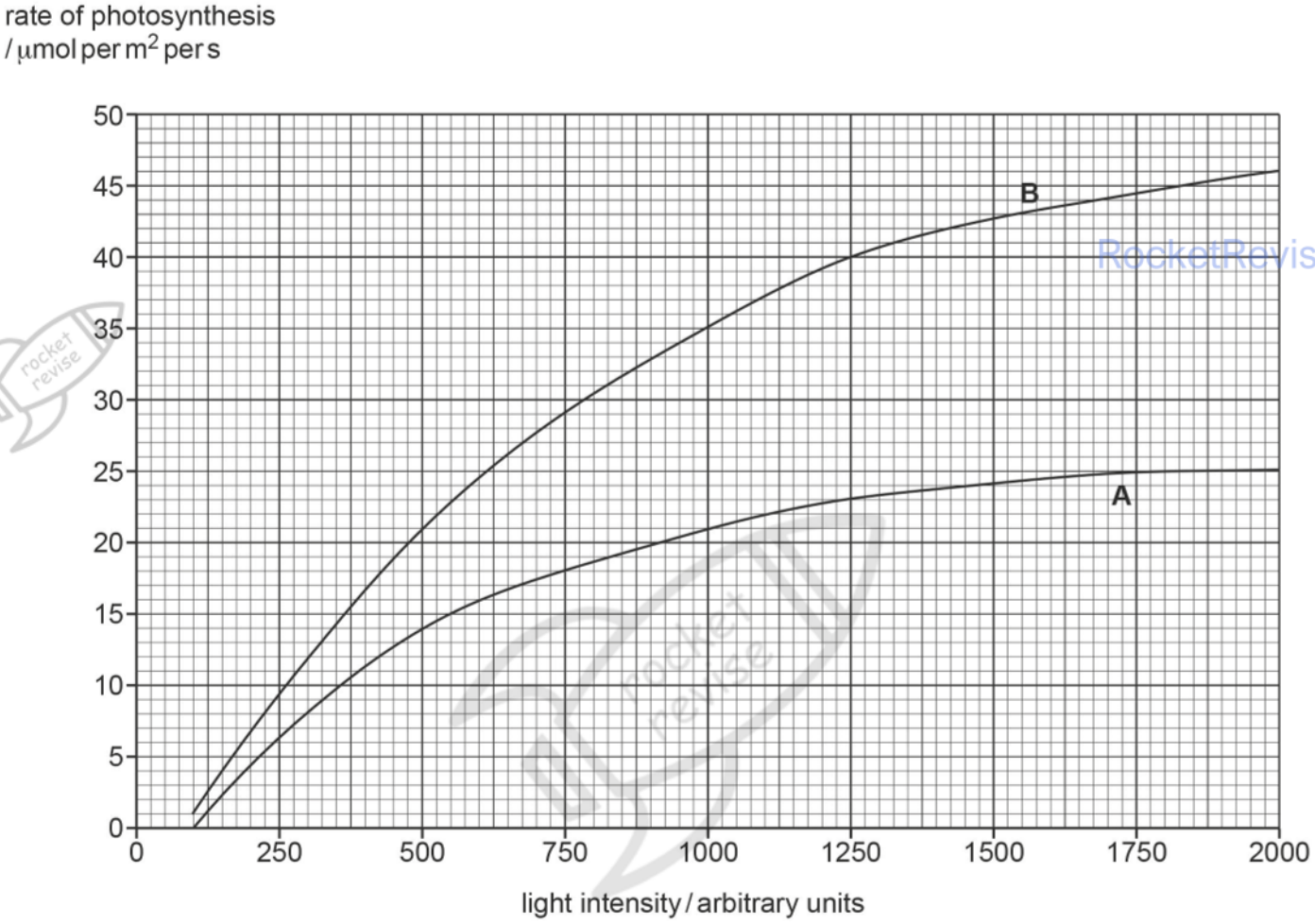
Show your working and give your answer to the nearest whole number.

..... % [3]

[Total: 3]

22 Scientists investigated the effect of light intensity on the rate of photosynthesis in the leaves of eucalyptus trees at two different concentrations of carbon dioxide, **A** and **B**.

The results are shown in the graph.



Key:

A carbon dioxide concentration 140 ppm

B carbon dioxide concentration 1000 ppm

Suggest **and** explain why the scientists kept the temperature of the leaves at 20°C while they recorded results.

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..... [2]

[Total: 2]

23 Phloem is used to transport sucrose and amino acids in plants. Sucrose is a carbohydrate.

Describe the uses of carbohydrates **and** amino acids in plants.

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..... [4]

[Total: 4]

24 Plants produce glucose in leaves and convert some of it to sucrose.

Explain how glucose is produced in leaves.

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..... [3]

[Total: 3]

25 One type of herbicide is a chemical that prevents the uptake of magnesium ions.

Suggest how this herbicide kills plants.

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..... [3]

[Total: 3]

26 Sexual reproduction requires energy.

State **three** uses of energy in organisms **other than in reproduction**.

1 .....

2 .....

3 ..... [3]

[Total: 3]

27 Amino acids are transported in plants.

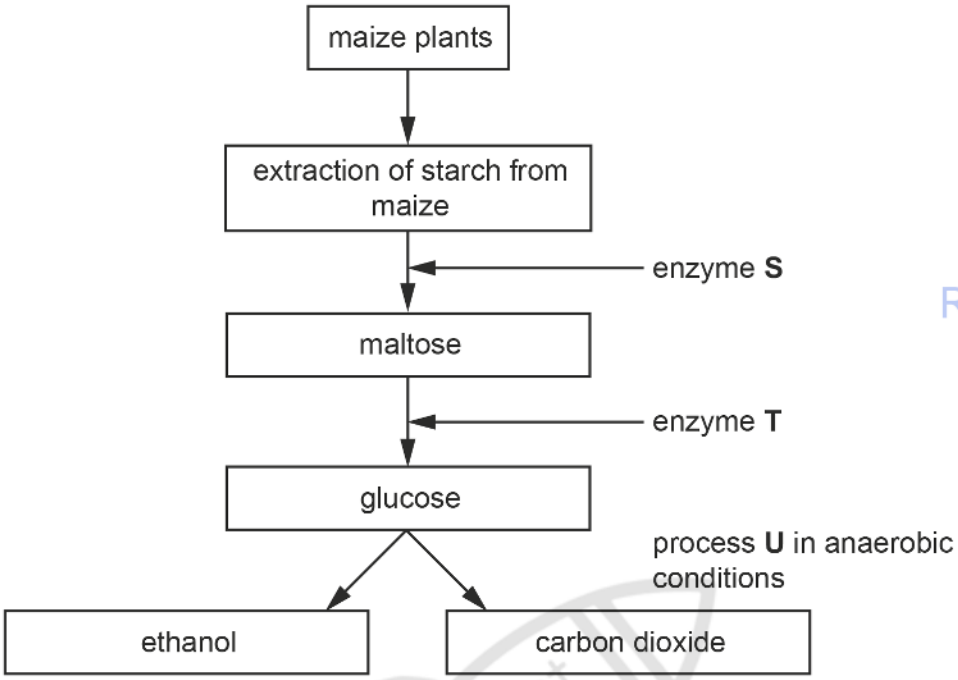
State the name of a mineral ion that becomes part of an amino acid.

..... [1]

[Total: 1]

28 Yeast is used in the production of ethanol to manufacture a type of biofuel.

The diagram is a flow chart of the process.



Carbon dioxide may be collected from process **U** and sold for use in glasshouses.

Explain why carbon dioxide is used in glasshouses.

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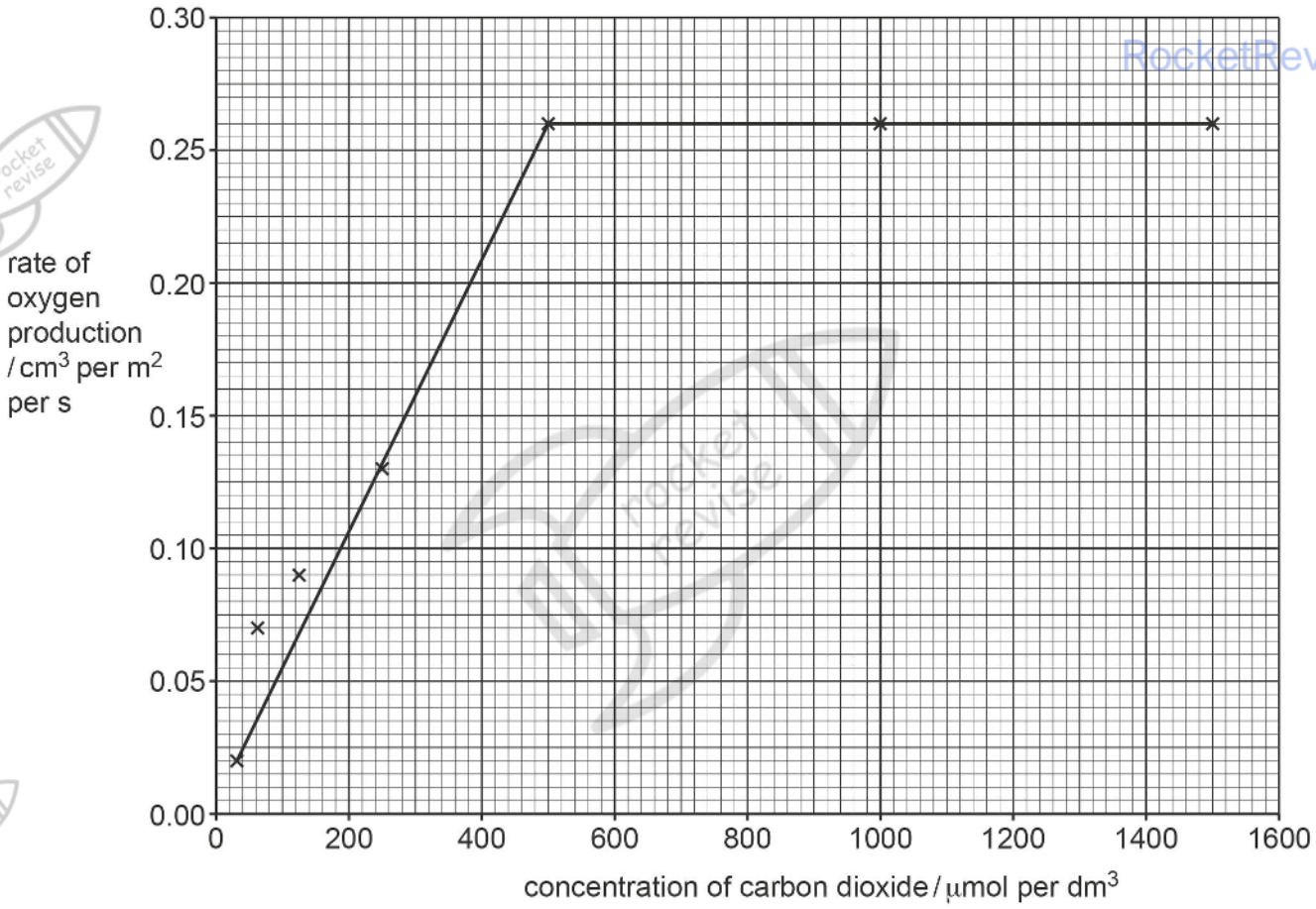
[4]

[Total: 4]

29 The effect of carbon dioxide concentration on the rate of oxygen production in an aquatic plant was measured.

- A lamp was used to keep the light intensity constant.
- The oxygen gas released by the plant was collected in a gas syringe.
- The plant was placed in water that was kept constant at 20 °C.

The graph shows the results.



The rate of oxygen production was assumed to be the same as the rate of photosynthesis.

Suggest why the rate of oxygen production was **not** the same as the rate of photosynthesis.

.....

.....

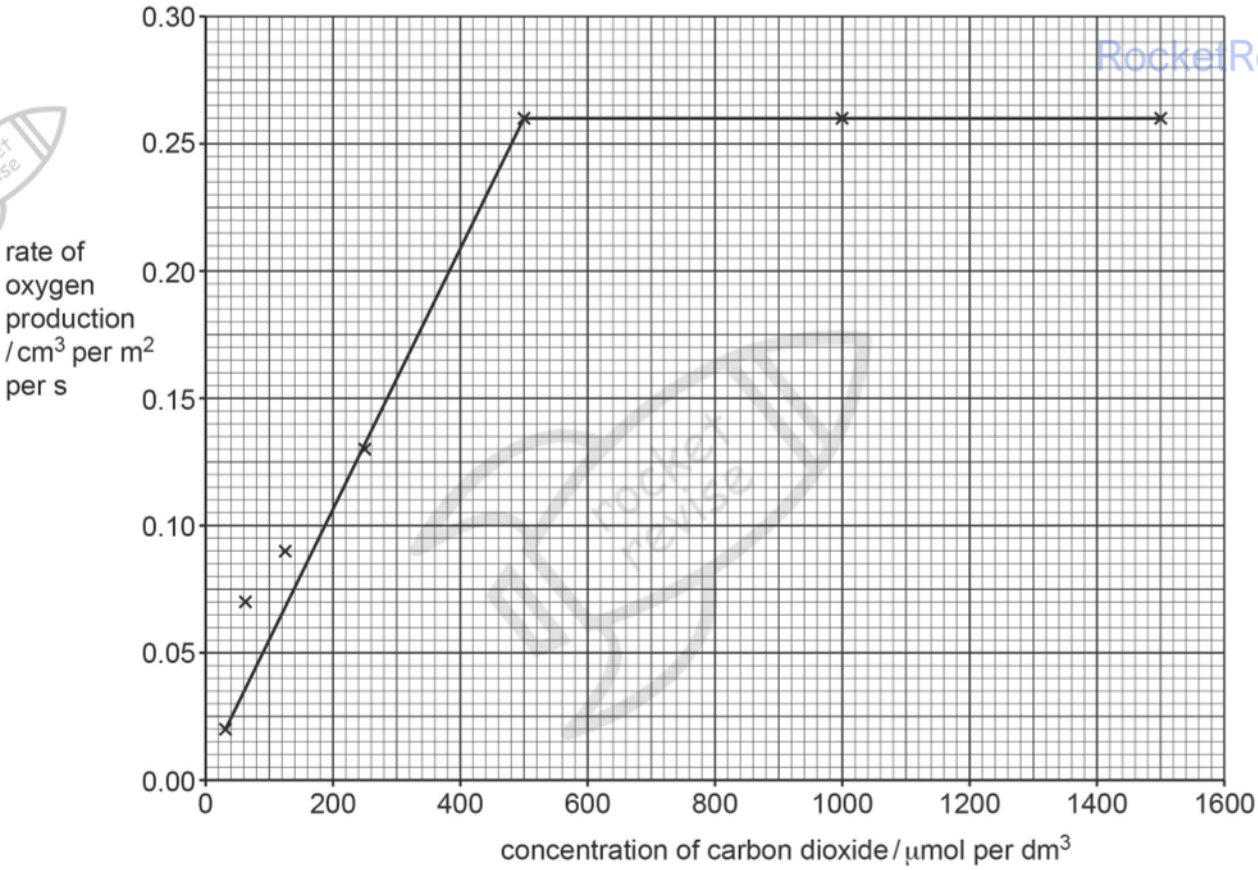
..... [2]

[Total: 2]

30 The effect of carbon dioxide concentration on the rate of oxygen production in an aquatic plant was measured.

- A lamp was used to keep the light intensity constant.
- The oxygen gas released by the plant was collected in a gas syringe.
- The plant was placed in water that was kept constant at 20 °C.

The graph shows the results.



Explain the results shown in the graph.

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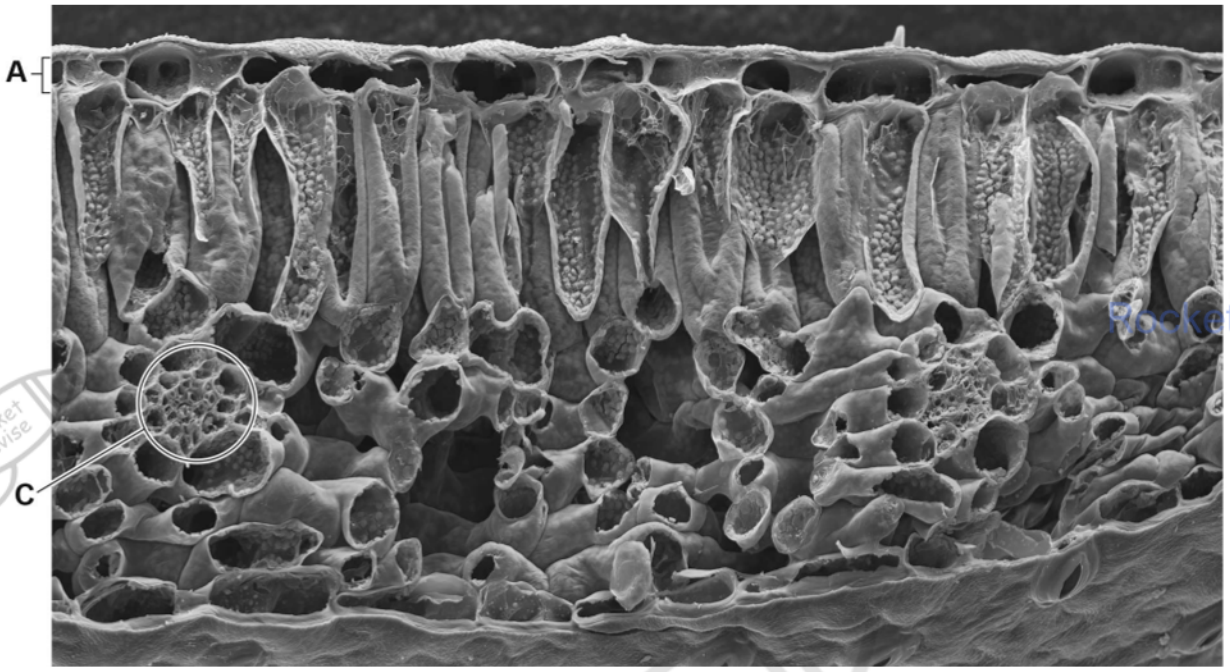
..... [3]

[Total: 3]

31 The photomicrograph is of a cross section of part of a leaf.



Describe how the tissue labelled **B** is adapted to maximise photosynthesis.

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.....

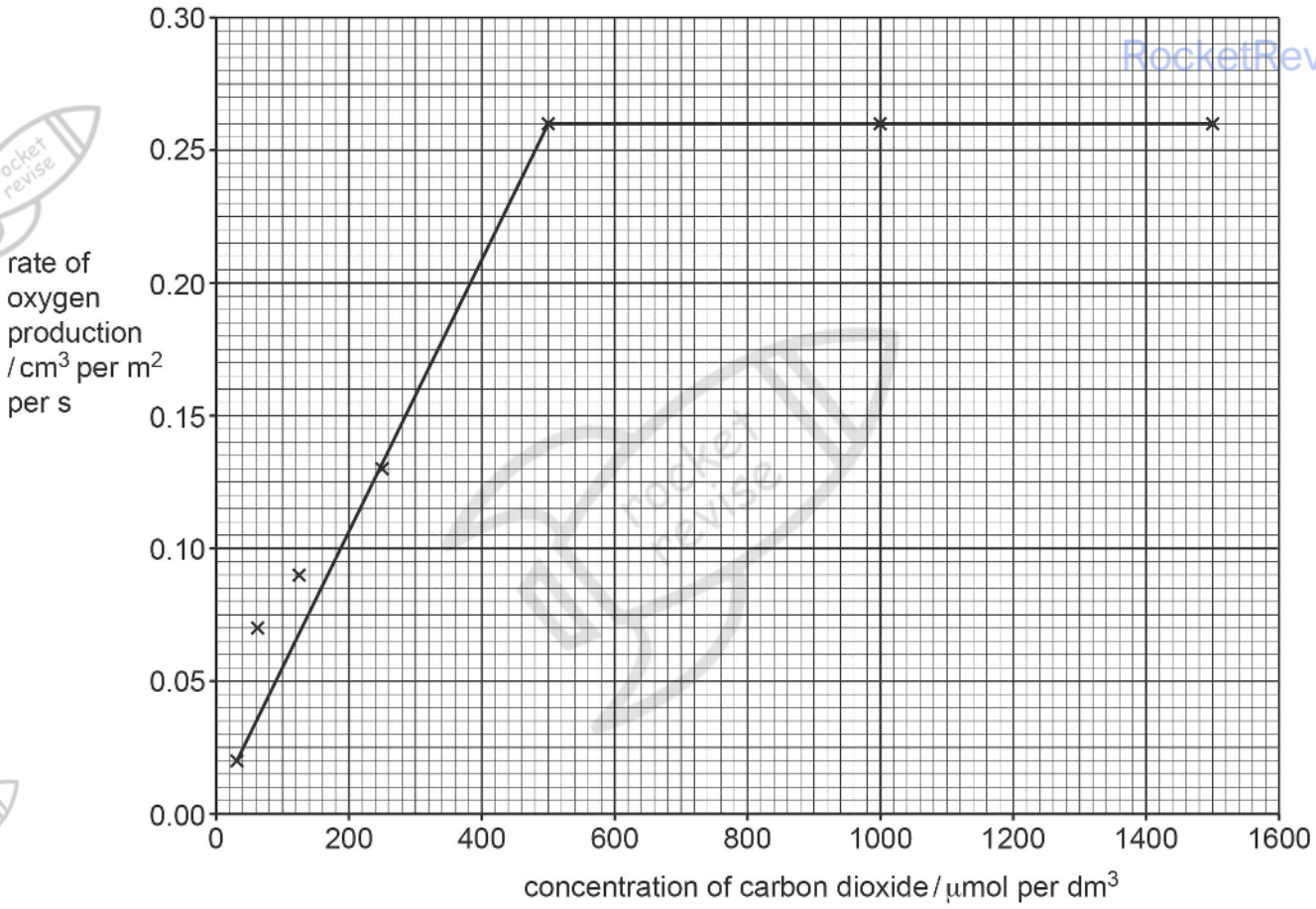
..... [3]

[Total: 3]

32 The effect of carbon dioxide concentration on the rate of oxygen production in an aquatic plant was measured.

- A lamp was used to keep the light intensity constant.
- The oxygen gas released by the plant was collected in a gas syringe.
- The plant was placed in water that was kept constant at 20 °C.

The graph shows the results.



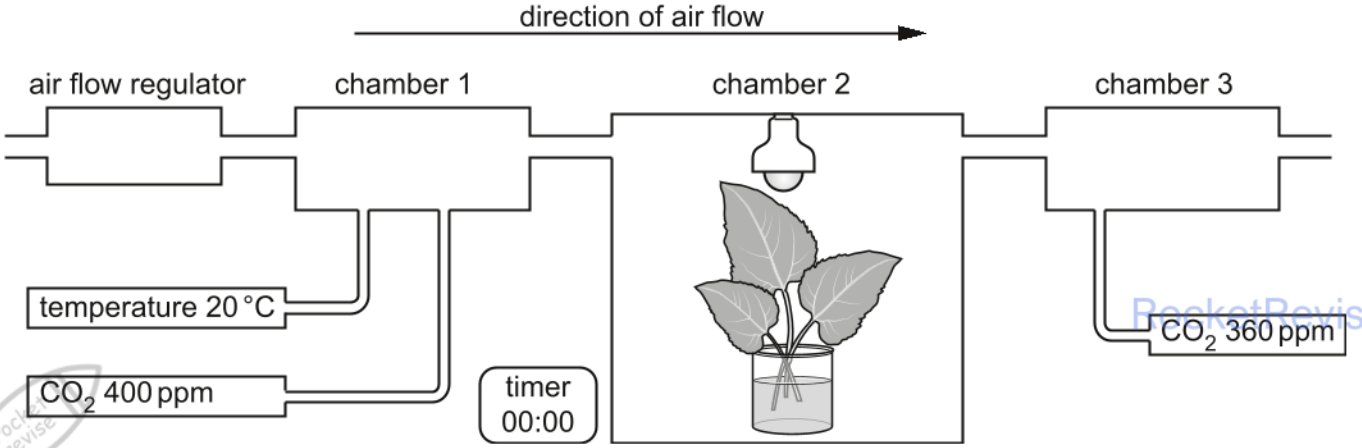
The investigation was repeated with the same type of aquatic plant at 10 °C.

Draw a line **on the graph** to predict the results at 10 °C. [2]

[Total: 2]

33 Scientists measured the rate of photosynthesis in the leaves of a sunflower plant, *Helianthus annuus*.

The scientists used the apparatus shown in the diagram to measure the rate of photosynthesis.



The apparatus in the diagram maintains a constant temperature and a constant humidity.

Explain why temperature has an effect on the rate of photosynthesis.

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..... [4]

[Total: 4]

34 Some crops are grown in controlled environments. Glasshouses are an example of a controlled environment. The photograph shows a glasshouse where lettuces are growing.

Discuss the advantages of growing crops in glasshouses.

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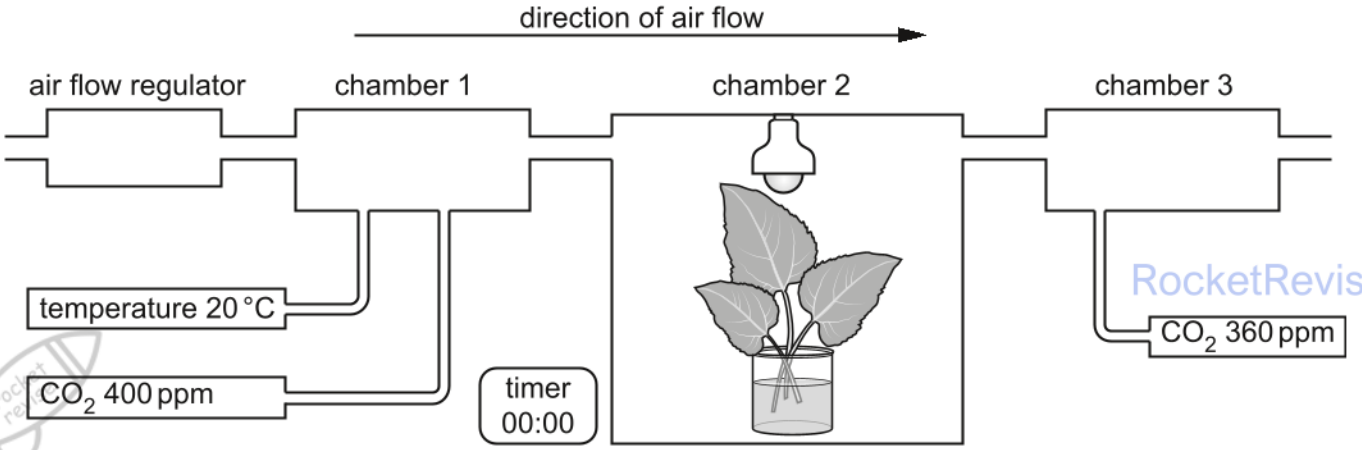
..... [6]

[Total: 6]

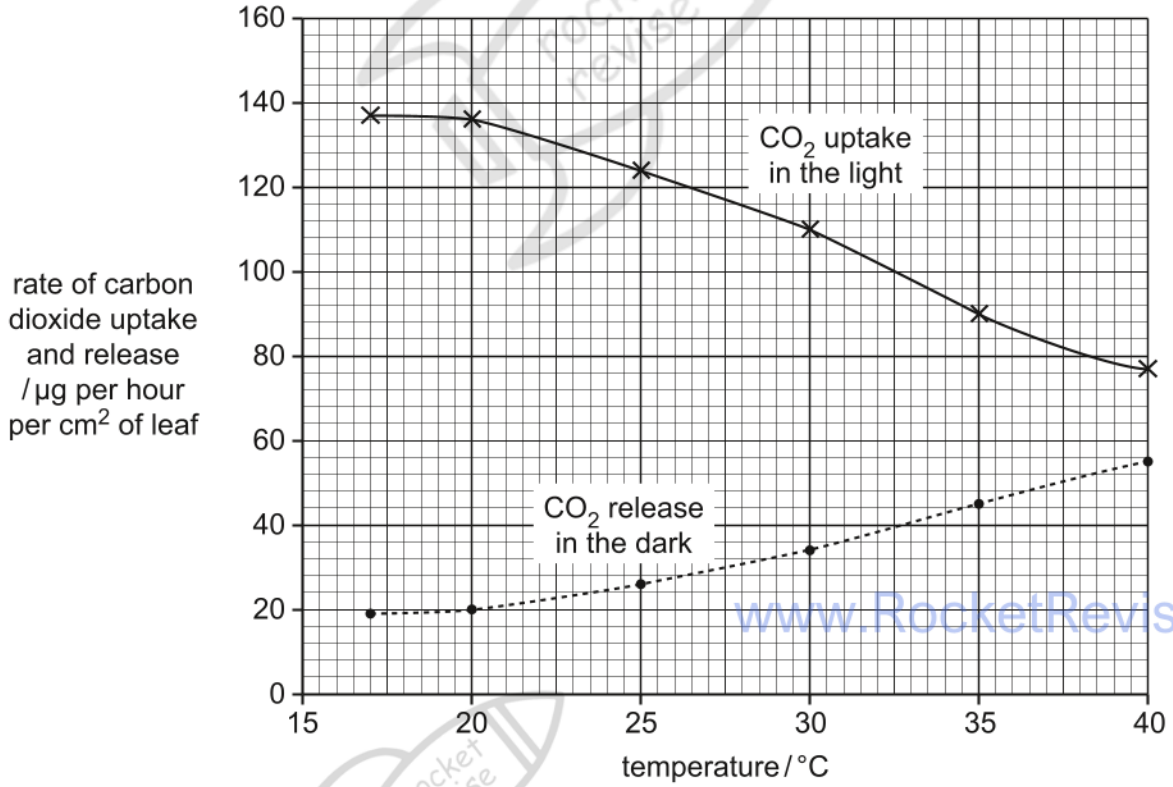
35 Scientists measured the rate of photosynthesis in the leaves of a sunflower plant, *Helianthus annuus.*

The scientists used the apparatus shown in the diagram to measure the rate of photosynthesis, at different temperatures.



They measured the rate of uptake of carbon dioxide in the light and then they measured the rate of release of carbon dioxide in the dark.

The results are shown in the graph.



The scientists determined that photosynthesis in the leaves at 35 °C used carbon dioxide at a rate of 135 µg per hour per cm^2 of leaf. The graph shows that the rate of carbon dioxide uptake at 35 °C was 90 µg per hour per cm^2 of leaf.

Explain why the rate at which carbon dioxide is used in photosynthesis is greater than the rate of carbon dioxide uptake.

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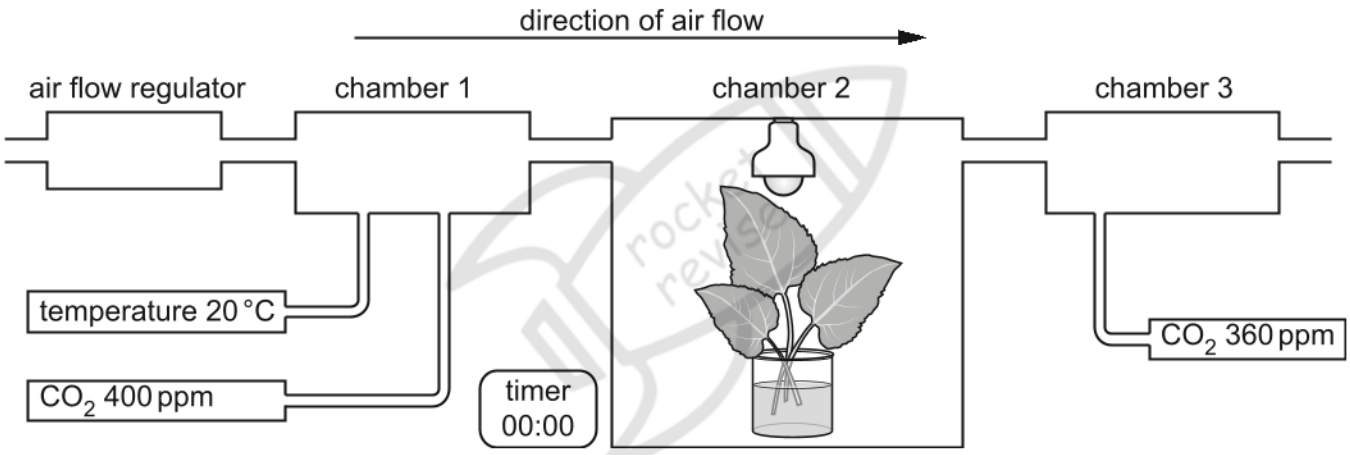
..... [2]

[Total: 2]

36 Scientists measured the rate of photosynthesis in the leaves of a sunflower plant, *Helianthus annuus*.

The scientists used the apparatus shown in the diagram to measure the rate of photosynthesis.



The apparatus in the diagram maintains a constant temperature and a constant humidity.

The apparatus was left for 15 minutes.

Explain how the scientists would use the readings for the concentration of carbon dioxide in chambers 1 and 3 to calculate the rate of photosynthesis.

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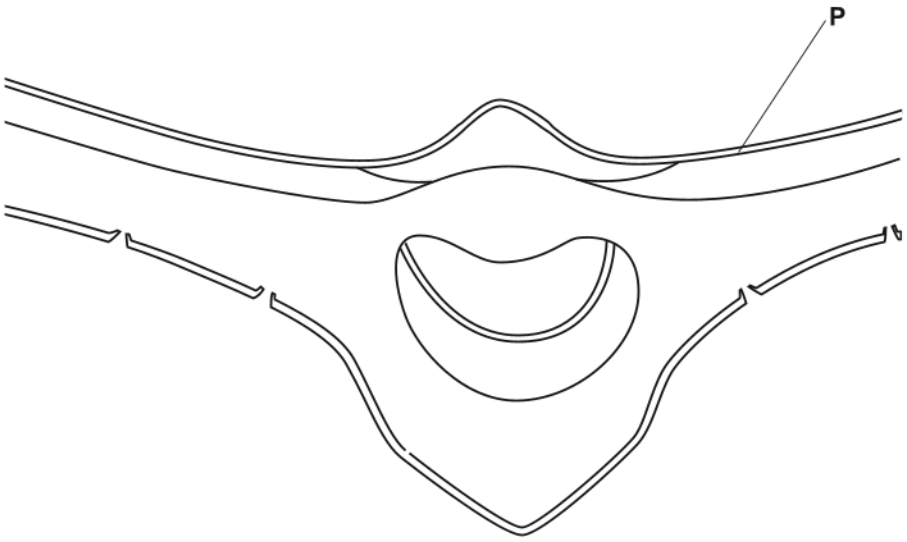
.....

.....

..... [2]

[Total: 2]

37 The diagram shows the positions of the different tissues in part of a dicotyledonous leaf.



Identify the tissues described in the table by:

- drawing label lines with the corresponding letter on the diagram **and**
- stating the name of each tissue in the table.

The label, line and name of the tissue for letter **P** has been completed for you on the diagram and in the table.

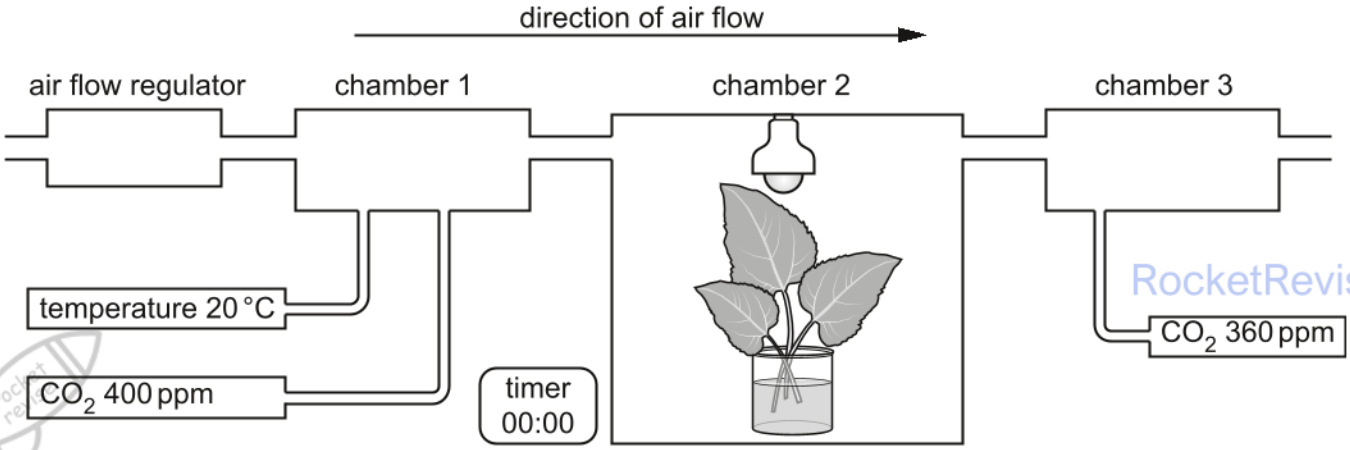
letter	description	name of the tissue
P	a protective transparent layer that allows light to reach the inner tissues	upper epidermis
Q	conducts water from the stem	
R	contains many interconnected air spaces	
S	transports sucrose and amino acids	
T	traps the most light energy to synthesise carbohydrates	

[4]

[Total: 4]

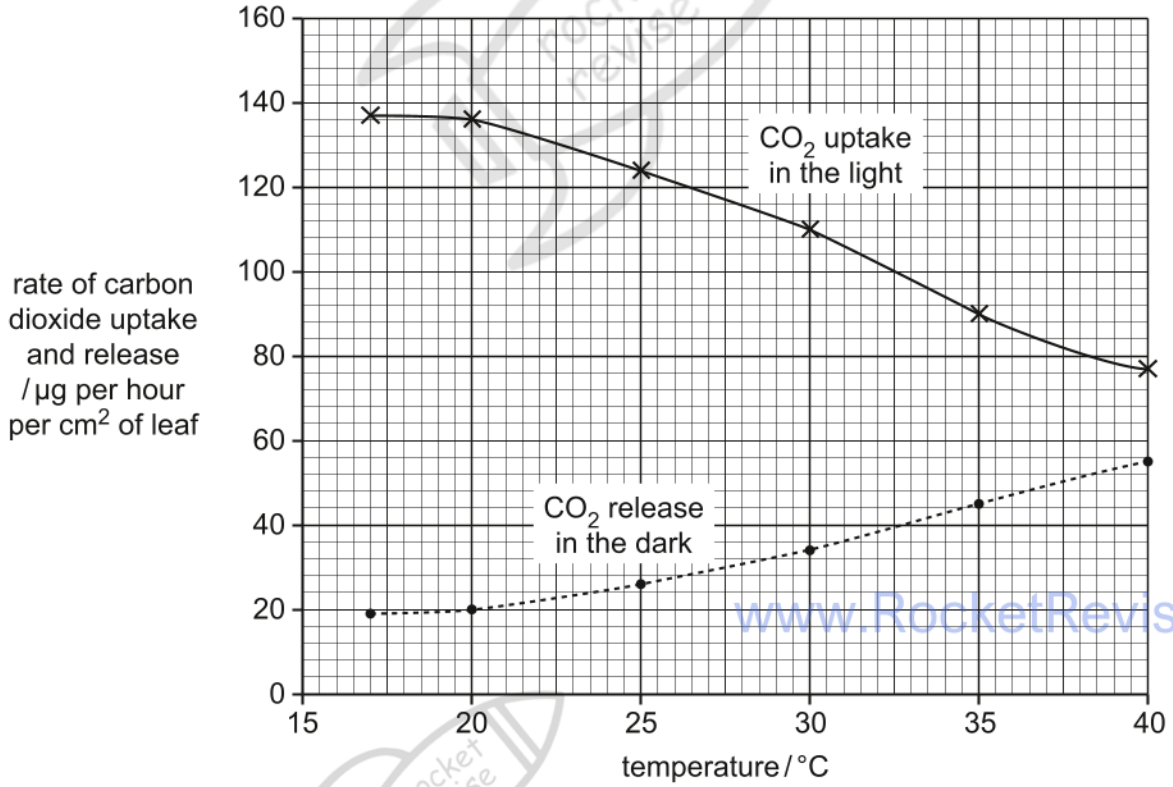
38 Scientists measured the rate of photosynthesis in the leaves of a sunflower plant, *Helianthus annuus.*

The scientists used the apparatus shown in the diagram to measure the rate of photosynthesis at different temperatures.



They measured the rate of uptake of carbon dioxide in the light and then they measured the rate of release of carbon dioxide in the dark.

The results are shown in the graph.



Use the information in the graph to complete the table.

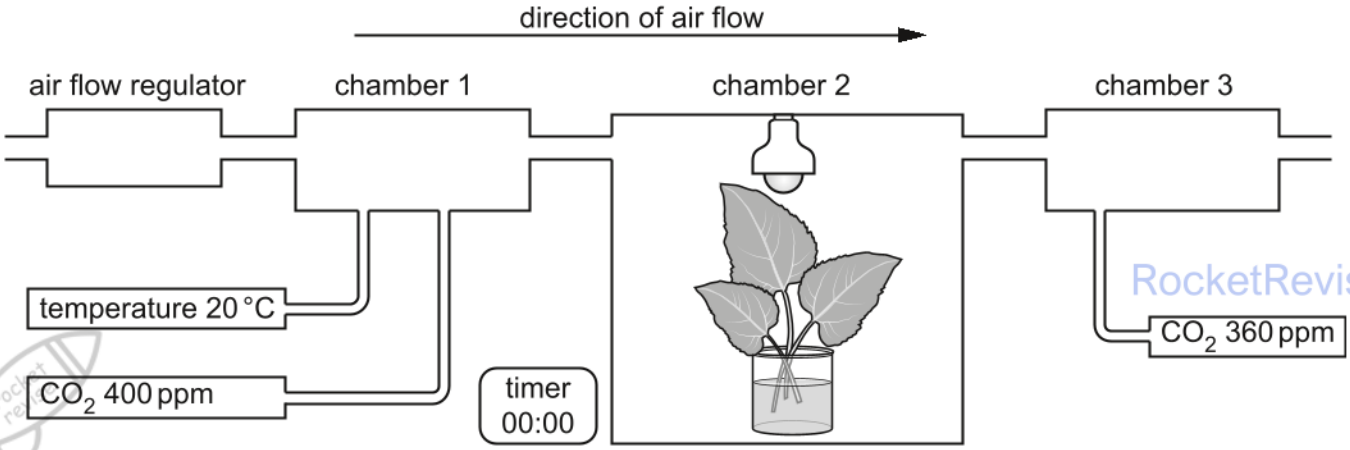
temperature / °C	rate of uptake of carbon dioxide in the light / µg per hour per cm^2 of leaf	rate of release of carbon dioxide in the dark / µg per hour per cm^2 of leaf
20		
35	90	45

[2]

[Total: 2]

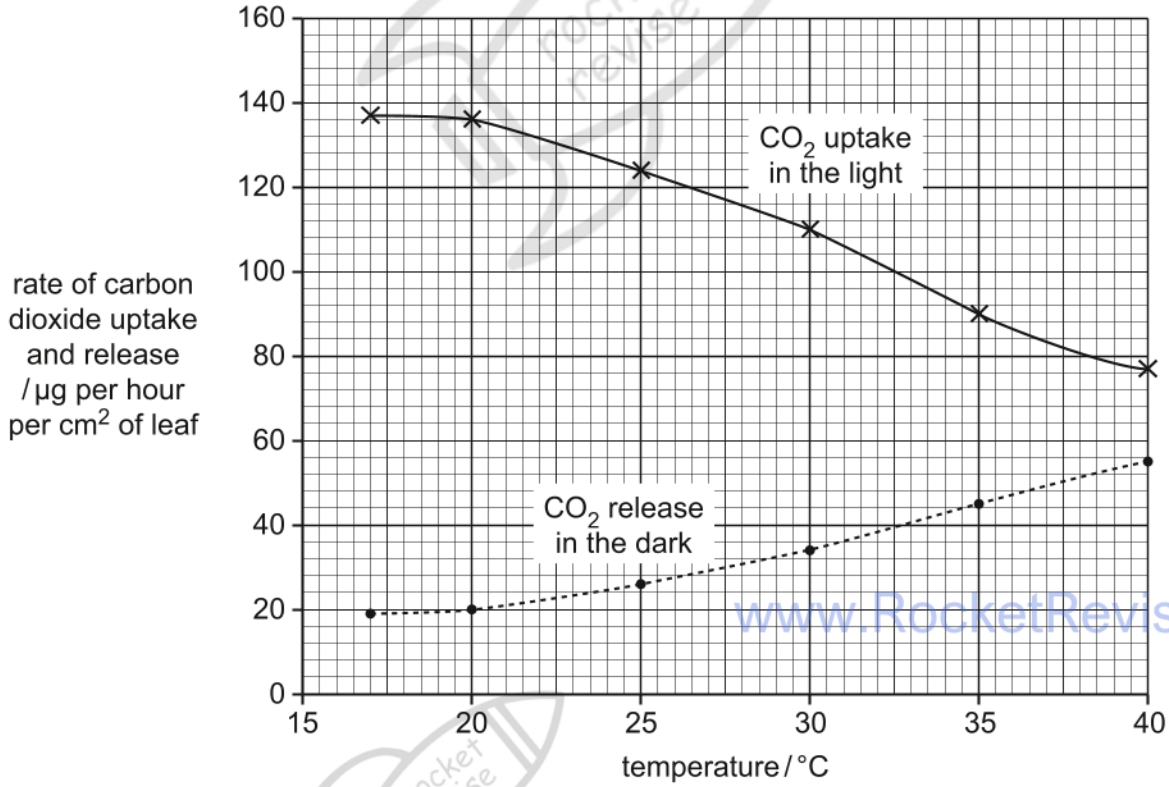
39 Scientists measured the rate of photosynthesis in the leaves of a sunflower plant, *Helianthus annuus*.

The scientists used the apparatus shown in the diagram to measure the rate of photosynthesis. at different temperatures.



They measured the rate of uptake of carbon dioxide in the light and then they measured the rate of release of carbon dioxide in the dark.

The results are shown in the graph.



The table shows the rate of uptake of carbon dioxide in the light and the release of carbon dioxide in the dark, in µg per hour per cm^2 of leaf, at 20°C and 35°C.

temperature / °C	rate of uptake of carbon dioxide in the light / µg per hour per cm^2 of leaf	rate of release of carbon dioxide in the dark / µg per hour per cm^2 of leaf
20	136	20
35	90	45

Explain why the results in the table are expressed as 'per cm^2 of leaf' rather than 'per leaf'.

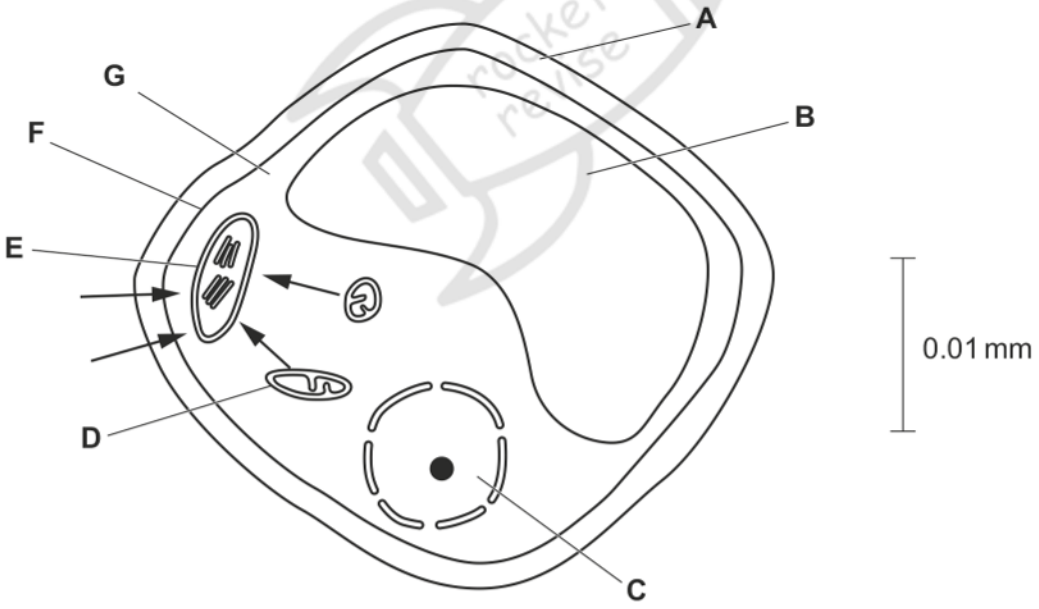
.....

.....

..... [1]

[Total: 1]

40 The diagram shows a spongy mesophyll cell from the leaf of a plant. The arrows show the net direction of movement of carbon dioxide molecules during daylight.



Carbon dioxide is a raw material for photosynthesis.

State the process by which carbon dioxide travels into the leaf from the air.

..... [1]

[Total: 1]