AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 4.4.1.2

Rate of photosynthesis

Past-paper questions

Tier	**Higher**
Question groups	**8**
Available paper years	**2018–2025**

Using this booklet

1. Answer the questions in order and show your working.
2. Original question numbers and marks are retained.
3. Print at actual size (100%) for measuring questions.
4. Use the companion answer booklet to check your work.

Name: _____ **Date:** _____

Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

4.4.1.2 Rate of photosynthesis

Question 01

June 2018 | 8464/B/1H | Original Q3

0 3 This question is about photosynthesis.

0 3 . 1 What is the correct balanced equation for photosynthesis?

[1 mark]

Tick **one** box.

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ ☐

$O_2 + H_2O \rightarrow C_6H_{12}O_6 + CO_2$ ☐

$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$ ☐

$6O_2 + 6CO_2 \rightarrow 6H_2O + C_6H_{12}O_6$ ☐

0 3 . 2 What type of reaction is photosynthesis?

[1 mark]

Tick **one** box.

Aerobic ☐

Endothermic ☐

Exothermic ☐

Oxidation ☐

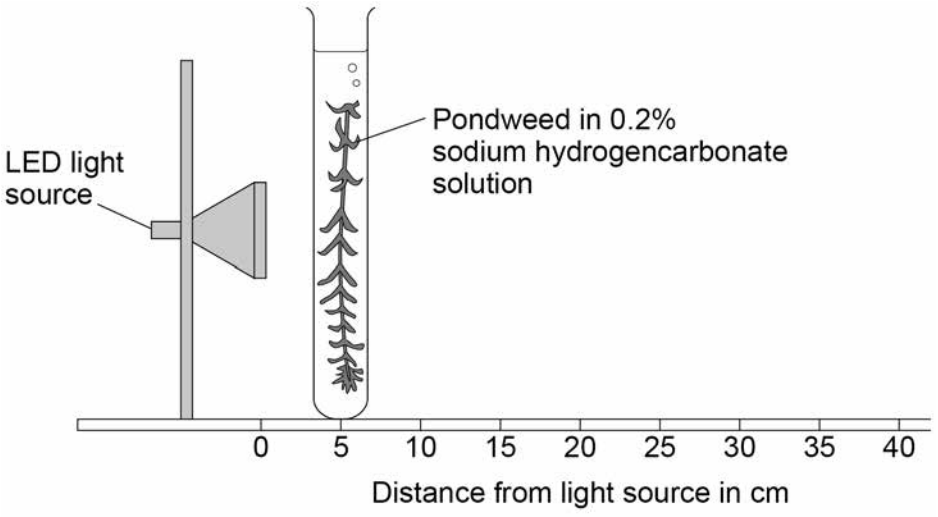
4.4.1.2 Rate of photosynthesis

Question 01 · continued

A student investigated the effect of light intensity on the rate of photosynthesis.

Figure 5 shows the apparatus used.

Figure 5



Sodium hydrogencarbonate solution releases carbon dioxide gas for the pondweed.

This is the method used.

1. Place the pondweed at 5 cm from the light source.
2. Measure the rate of photosynthesis by counting the number of bubbles produced in 1 minute.
3. Repeat with the pondweed at 10 cm and at 20 cm from the light source.

0 3 . 3 Counting the number of bubbles produced in 1 minute is **not** an accurate way to measure the rate of photosynthesis.

Suggest **two** ways the method could be improved to measure the rate of photosynthesis more accurately.

[2 marks]

1 _____

_____

2 _____

_____

Question 3 continues on the next page

4.4.1.2 Rate of photosynthesis

Question 01 · continued

0 3 . 4 The LED light source does **not** get hot.

Explain why it is important that the pondweed remains at a constant temperature.

[2 marks]

0 3 . 5 Light intensity can be calculated using the inverse square law:

$$I \propto \frac{1}{d^2}$$

Where I is light intensity and d is the distance of the pondweed from the light source.

The student placed the pondweed at 5, 10 and 20 cm from the light source.

Explain how light intensity changes as the distance of the pondweed from the light source is doubled.

You **must** include calculations in your answer.

[3 marks]

4.4.1.2 Rate of photosynthesis

Question 01 · continued

0 3 . 6 The student's results are shown in **Table 1**

Table 1

Distance of the pondweed from the light source in cm	Number of bubbles produced in 1 minute
5	129
10	31
20	8

Predict how many bubbles of gas would be produced in 1 minute if the pondweed was placed 40 cm from the light source.

Give a reason for your prediction.

[2 marks]

0 3 . 7 Describe how the student could change the method to investigate the effect of carbon dioxide concentration on the rate of photosynthesis.

You should include:

- how to change the independent variable
- **two** control variables.

Use **Figure 5** on page 9 to help you answer this question.

[3 marks]

14

4.4.1.2 Rate of photosynthesis

Question 02

June 2018 | 8464/B/2H | Original Q1

0 1 Many biotic and abiotic factors can affect the growth of plants.

0 1 . 1 Are the factors in **Table 1** biotic or abiotic?

[2 marks]

Tick **one** box for each factor.

Table 1

Factor	Biotic	Abiotic
Diseases		
Herbivores		
Temperature		
Water		

Two students investigated the effect of light intensity on the distribution of small plants.

The plants are growing under a tree in a park.

The students made the following hypothesis:

'As you move outwards from a tree there will be more plant growth.'

0 1 . 2 Explain why the students thought their hypothesis would be correct.

[3 marks]

Question 02 · continued

0 1 . 3 The students used two pieces of equipment.

Give the scientific name of each piece of equipment.

[2 marks]

A square frame measuring 0.5 m × 0.5 m _____

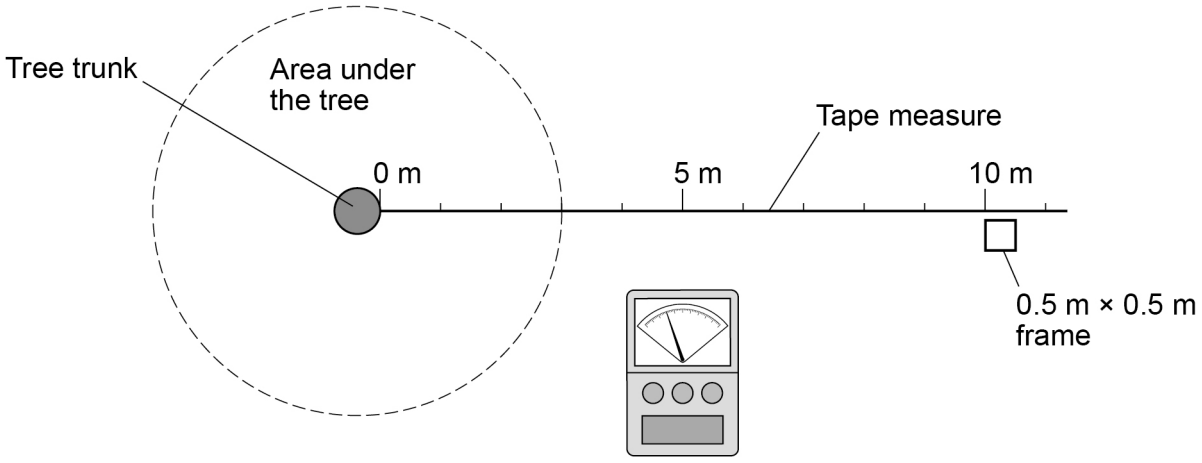
An electronic device to measure light intensity _____

This is the method used.

1. Fix one end of a tape measure at the base of the tree.
2. Fix the other end of the tape measure 11 metres from the tree.
3. At 0 metres put the square frame on the ground.
4. Identify all the plant species growing inside the frame.
5. Estimate and record the percentage cover of each plant species.
6. Measure the light intensity inside the frame.
7. Put the square frame on the ground every 2 metres along the tape to 10 metres.
8. Repeat steps 4 – 6 in every frame.

Figure 1 shows the equipment in this investigation.

Figure 1



0 1 . 4 Calculate the total area sampled.

[1 mark]

_____

_____

Total area sampled = _____ m^2

4.4.1.2 Rate of photosynthesis

Question 02 · continued

0 1 . 5 The whole investigation was done as quickly as possible on the same day.

Suggest **one** reason why.

[1 mark]

0 1 . 6 Give **one** way the investigation could be improved.

[1 mark]

Table 2 shows the results.

Table 2

	Distance from tree in metres					
	0	**2**	**4**	**6**	**8**	**10**
Percentage cover of grass	15	50	35	16	15	15
Percentage cover of plantain	0	5	10	40	25	30
Percentage cover of daisy	0	0	0	4	20	10
Percentage cover of clover	1	10	25	40	40	45
Total percentage cover of plants	16	65	70	100	100	100
Light intensity in arbitrary units	37	59	150	175	>200	>200

0 1 . 7 Which plant species in **Table 2** will only grow at high light intensity?

[1 mark]

4.4.1.2 Rate of photosynthesis

Question 02 · continued

0 1 . 8 What conclusion can be made about the relationship between light intensity and the total percentage cover of plants?

Use data from **Table 2** in your answer.

[2 marks]

0 1 . 9 Light intensity might **not** be the cause of this pattern of plant distribution.

Suggest **one** different factor that may cause these results.

Give **one** reason for your answer.

[2 marks]

Factor

Reason

15

4.4.1.2 Rate of photosynthesis

Question 03

November 2020 | 8464/B/1H | Original Q5

0 5 This question is about photosynthesis and food production.

0 5 . 1 How can oxygen production be used to show the **rate** of photosynthesis?

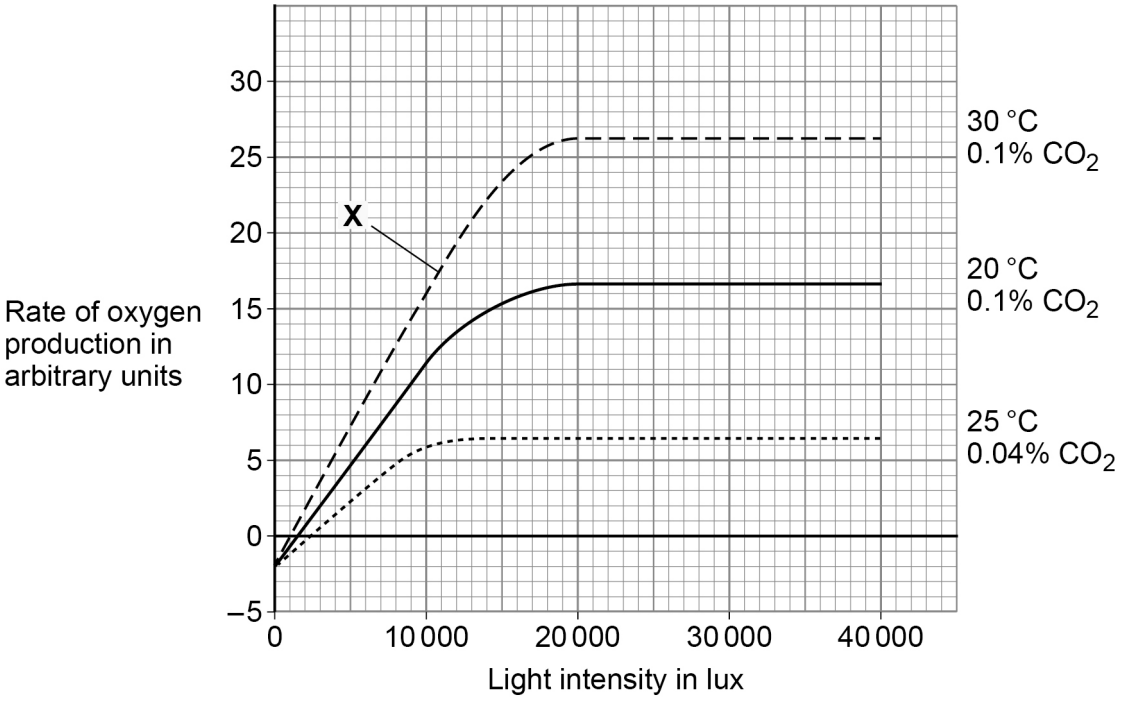
[1 mark]

Scientists investigated factors affecting the rate of photosynthesis in tomato plants.

The tomato plants were growing in a commercial greenhouse in the UK during winter.

Figure 5 shows the results.

Figure 5



The percentage of carbon dioxide in the Earth's atmosphere is 0.04%

0 5 . 2 Name the factor that is limiting the rate of photosynthesis at point **X**.

[1 mark]

4.4.1.2 Rate of photosynthesis

Question 03 · continued

Farmers growing tomatoes commercially try to control the rate of photosynthesis and make maximum profit.

A farmer can control the temperature and carbon dioxide concentration in a greenhouse.

0 5 . 3 What is the **minimum** light intensity a farmer should use to get the maximum rate of photosynthesis shown in **Figure 5**?

[1 mark]

Light intensity = _____ lux

0 5 . 4 The light intensity you gave in Question **05.3** may **not** give the farmer maximum profit.

Explain why.

[3 marks]

0 5 . 5 Explain the results when the light intensity was 0 lux.

Use **Figure 5**.

[4 marks]

10

4.4.1.2 Rate of photosynthesis

Question 04

November 2021 | 8464/B/1H | Original Q1

0 1 Plants absorb light for photosynthesis.

0 1 . 1 Which is the equation for photosynthesis?

[1 mark]

Tick (✓) **one** box.

$C_6H_{12}O_6 + 6\,O_2 \rightarrow 6\,CO_2 + 6\,H_2O$ ☐

$6\,CO_2 + 6\,H_2O \rightarrow C_6H_{12}O_6 + 6\,O_2$ ☐

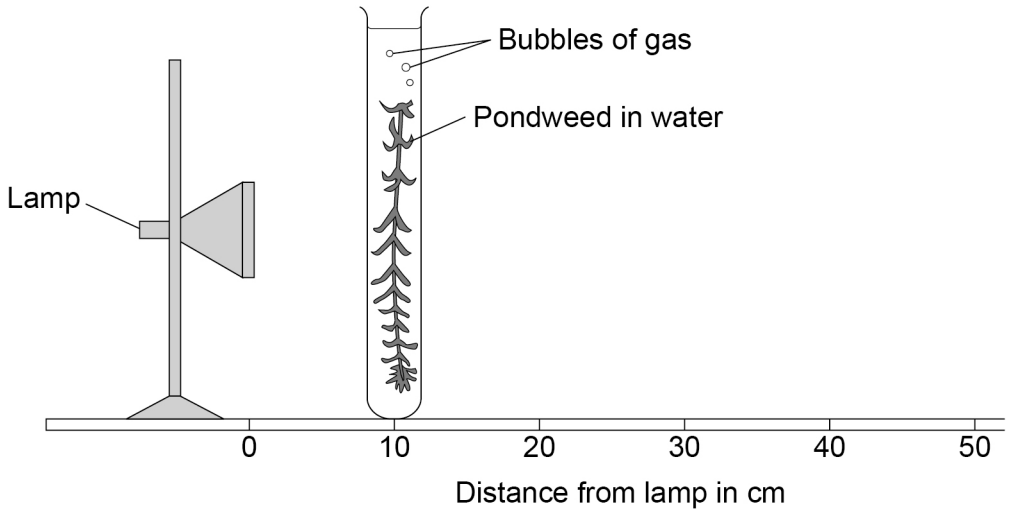
$6\,H_2O + 6\,O_2 \rightarrow C_6H_{12}O_6 + 6\,CO_2$ ☐

$6\,O_2 + 6\,CO_2 \rightarrow C_6H_{12}O_6 + 6\,H_2O$ ☐

A student investigated the effect of light intensity on the rate of photosynthesis.

Figure 1 shows the apparatus.

Figure 1



4.4.1.2 Rate of photosynthesis

Question 04 · continued

This is the method used.

1. Set up the apparatus as shown in **Figure 1**.
2. Place the pondweed 10 cm away from the lamp.
3. Switch on the lamp.
4. Record the number of bubbles of gas produced in 5 minutes.
5. Repeat steps 2 to 4 with the pondweed at different distances from the lamp.

0 1 . 2 What was the independent variable in this investigation?

[1 mark]

Tick (✓) **one** box.

- Distance of the pondweed from the lamp ☐
- Length of the piece of pondweed ☐
- Number of bubbles of gas produced ☐
- Time taken to collect the gas ☐

Question 1 continues on the next page

4.4.1.2 Rate of photosynthesis

Question 04 · continued

The lamp gets warm when it is on. This causes the temperature of the water to increase.

0 1 . 3 Explain how an increase in temperature would affect the results of this investigation.

[2 marks]

0 1 . 4 Suggest **one** way the investigation could be improved so the temperature of the water does **not** increase.

[1 mark]

0 1 . 5 Suggest **two** improvements to the investigation so the results would be more valid.

Do **not** refer to controlling the temperature of the water.

[2 marks]

1

2

4.4.1.2 Rate of photosynthesis

Question 04 · continued

Table 1 shows the results.

Table 1

Distance of pondweed from the lamp in cm	Number of bubbles of gas produced in 5 minutes
10	120
20	56
30	31
40	16
50	10

0 1 . 6 Calculate the rate of photosynthesis when the pondweed was 40 cm from the lamp.

Give the rate of photosynthesis as the number of bubbles of gas produced per minute.

[1 mark]

Rate = _____ bubbles of gas produced per minute

0 1 . 7 Give **one** conclusion that can be made from **Table 1**.

[1 mark]

4.4.1.2 Rate of photosynthesis

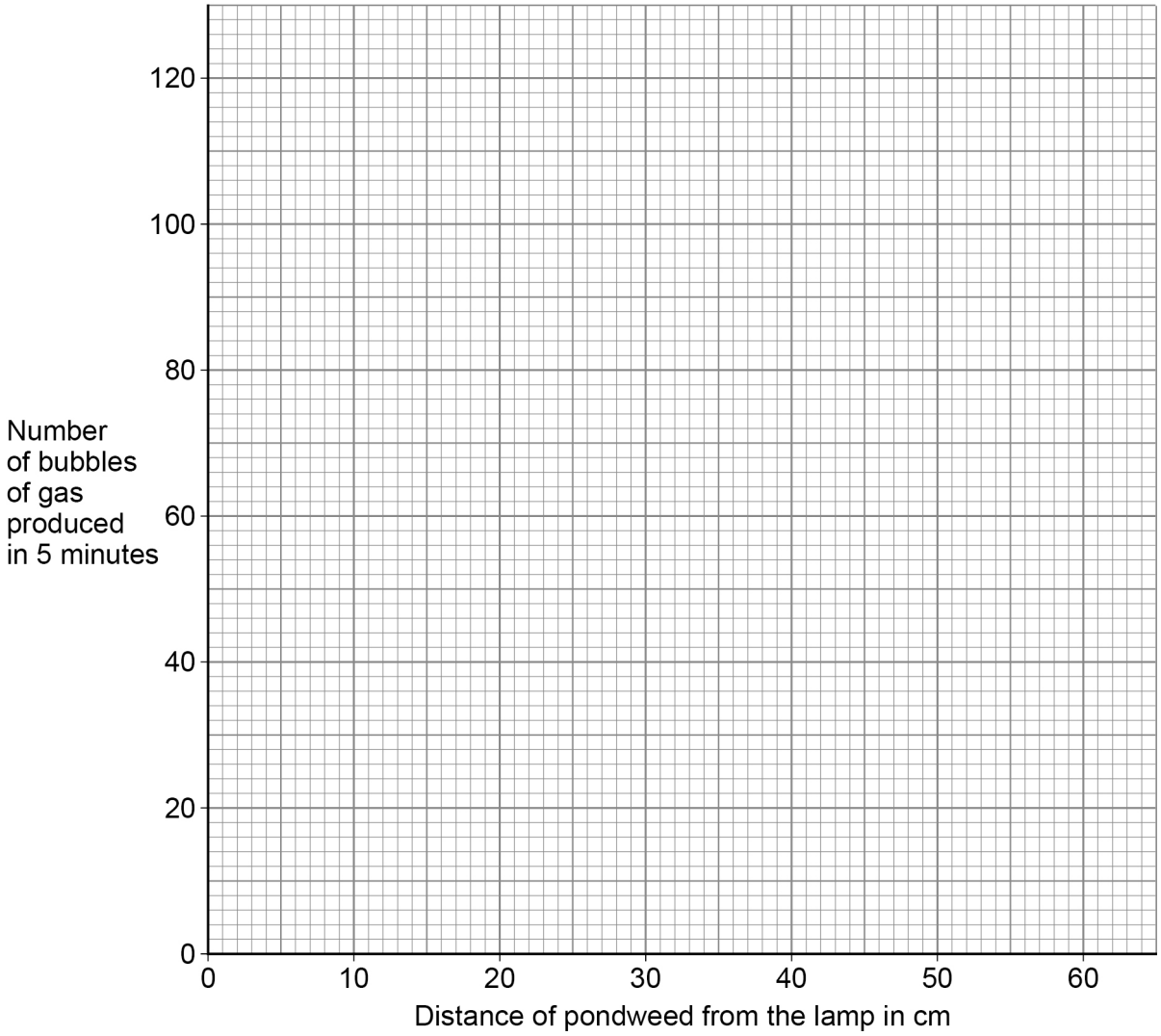
Question 04 · continued

0 1 . 8 Plot the data from **Table 1** on **Figure 2**.

Draw a line of best fit.

[3 marks]

Figure 2



0 1 . 9 Predict the number of bubbles that would be produced in 5 minutes if the pondweed was 60 cm from the lamp.

Use **Figure 2**.

[1 mark]

Number of bubbles produced in 5 minutes = _____

13

4.4.1.2 Rate of photosynthesis

Question 05

June 2022 | 8464/B/1H | Original Q4

0 4 Photosynthesis is an important chemical reaction in plants.

0 4 . 1 Why is light needed for photosynthesis?

[1 mark]

0 4 . 2 What is the equation for photosynthesis?

[1 mark]

Tick (✓) **one** box.

$C_6H_{12}O_6 + CO_2 \rightarrow 6\,O_2 + 6\,H_2O$ ☐

$CO_2 + H_2O \rightarrow CH_2O + O_2$ ☐

$6\,CO_2 + 6\,H_2O \rightarrow C_6H_{12}O_6 + 6\,O_2$ ☐

$6\,O_2 + 6\,H_2O \rightarrow C_6H_{12}O_6 + 6\,CO_2$ ☐

4.4.1.2 Rate of photosynthesis

Question 05 · continued

0 4 . 3 A student investigated the effect of different colours of light on the rate of photosynthesis at room temperature.

The student used pondweed in water.

A piece of pondweed was placed in red light, then in blue light and then in green light.

Each colour of light was the same intensity.

Describe how the student should make accurate measurements to obtain valid results for the rate of photosynthesis.

[4 marks]

Question 4 continues on the next page

4.4.1.2 Rate of photosynthesis

Question 05 · continued

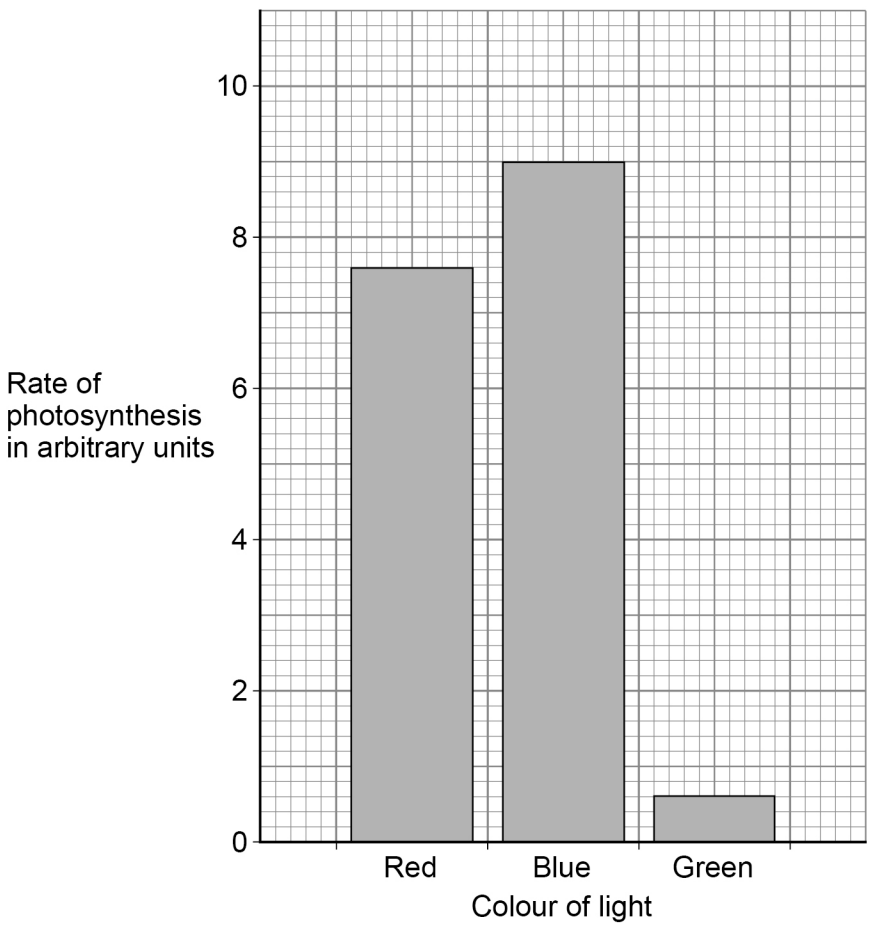
A scientist investigated the effect of different wavelengths of light on the rate of photosynthesis.

The wavelength of light determines the colour of the light.

Figure 8 shows the student's results.

Figure 9 shows the scientist's results.

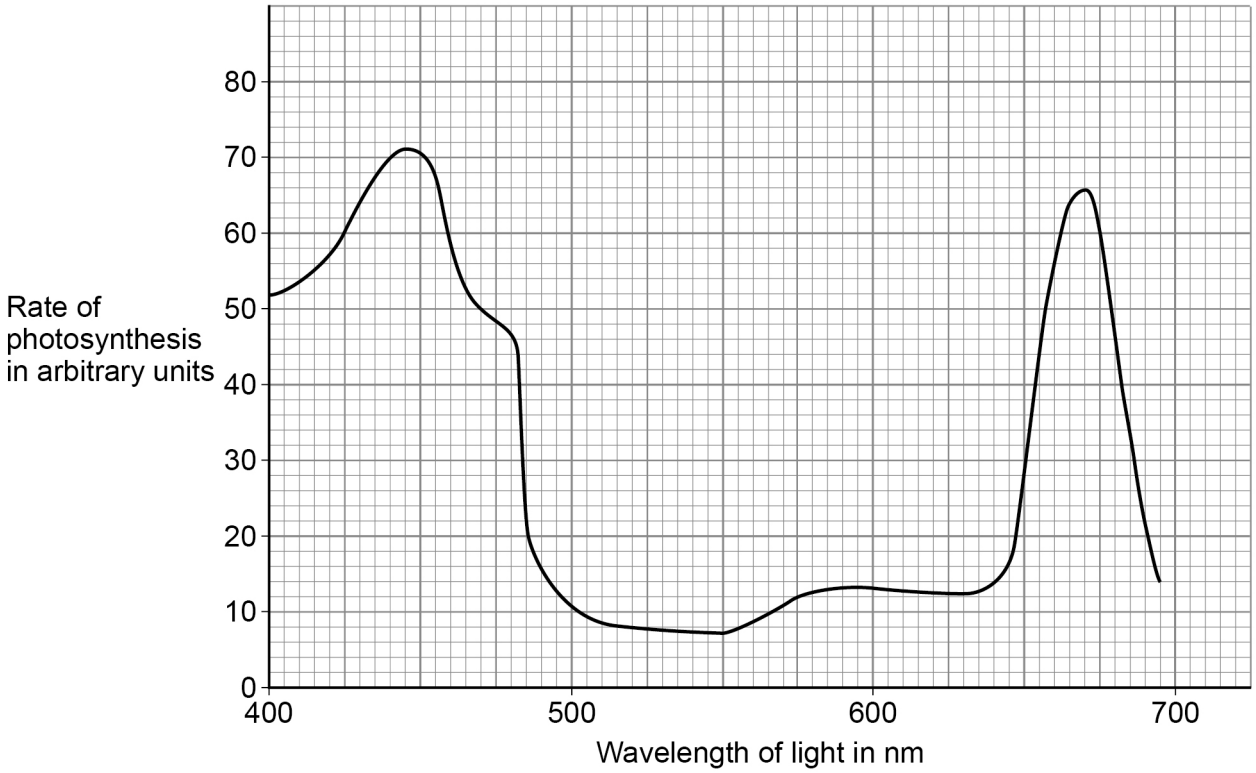
Figure 8



4.4.1.2 Rate of photosynthesis

Question 05 · continued

Figure 9



0 4 . 4 Why are the results for the two investigations presented differently?

[2 marks]

0 4 . 5 Suggest the range in wavelength of green light.

Use **Figure 8** and **Figure 9**.

[1 mark]

Range in wavelength of green light = from _____ nm to _____ nm

9

4.4.1.2 Rate of photosynthesis

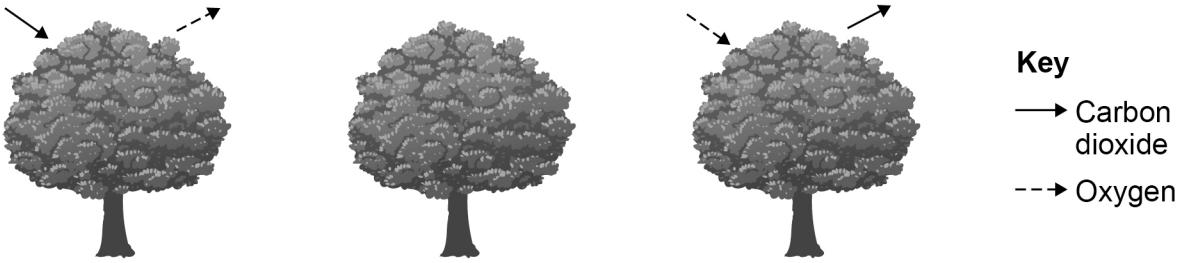
Question 06

June 2023 | 8464/B/1H | Original Q5

0 5 Light intensity varies during 24 hours.

Figure 6 shows the overall exchange of carbon dioxide and oxygen for a tree at three different light intensities.

Figure 6



Explain the overall exchange of carbon dioxide and oxygen at the three different light intensities.

[6 marks]

6

4.4.1.2 Rate of photosynthesis

Question 07

June 2024 | 8464/B/1H | Original Q4

0 4 This question is about photosynthesis.

0 4 . 1 What is the symbol equation for photosynthesis?

[1 mark]

Tick (✓) **one** box.

- $6\,CO_2 + C_6H_{12}O_6 \rightarrow 6\,H_2O + 6\,O_2$ ☐
- $C_6H_{12}O_6 + 6\,O_2 \rightarrow 6\,CO_2 + 6\,H_2O$ ☐
- $6\,CO_2 + 6\,H_2O \rightarrow C_6H_{12}O_6 + 6\,O_2$ ☐
- $6\,O_2 + 6\,H_2O \rightarrow 6\,CO_2 + C_6H_{12}O_6$ ☐

Question 4 continues on the next page

4.4.1.2 Rate of photosynthesis

Question 07 · continued

A student investigated the relationship between temperature and the rate of photosynthesis.

The student measured the volume of gas produced by an aquatic plant in 1 hour.

The student collected the gas in a measuring cylinder.

Table 2 shows the results.

Table 2

Temperature in °C	Volume of gas produced in 1 hour in cm^3
10	1
15	2
20	4
25	8
30	16
35	16
40	2
45	0

0 4 . 2 Describe the effect of increasing temperature on the **rate** of photosynthesis.

Use data from **Table 2**.

[3 marks]

4.4.1.2 Rate of photosynthesis

Question 07 · continued

0 4 . 3 Explain why no gas was produced by the plant at 45 °C.

[2 marks]

0 4 . 4 How could the student increase the accuracy of the results?

[1 mark]

Tick (✓) **one** box.

- Repeat the investigation, collecting the gas for 24 hours. ☐
- Repeat the investigation, measuring the volume of gas to 0.5 cm^3. ☐
- Repeat the investigation using a different aquatic plant. ☐
- Repeat the investigation, using temperatures of 5 °C and 50 °C. ☐

Question 4 continues on the next page

4.4.1.2 Rate of photosynthesis

Question 07 · continued

A person grows tomatoes in a greenhouse.

0 4 . 5 The mean temperature of the greenhouse is 15 °C.

A heater would keep the temperature of the greenhouse at 25 °C.

Suggest **two** reasons **against** using a heater set at 25 °C in the greenhouse.

Do **not** refer to cost in your answer.

[2 marks]

1 _____

_____

2 _____

_____

0 4 . 6 The person cut a stem from one of the tomato plants.

The cut stem was placed in soil to grow new roots.

Which tissue in the cut stem will differentiate into new root cells?

[1 mark]

Tick (✓) **one** box.

- Epidermis ☐
- Meristem ☐
- Mesophyll ☐
- Phloem ☐

10

4.4.1.2 Rate of photosynthesis

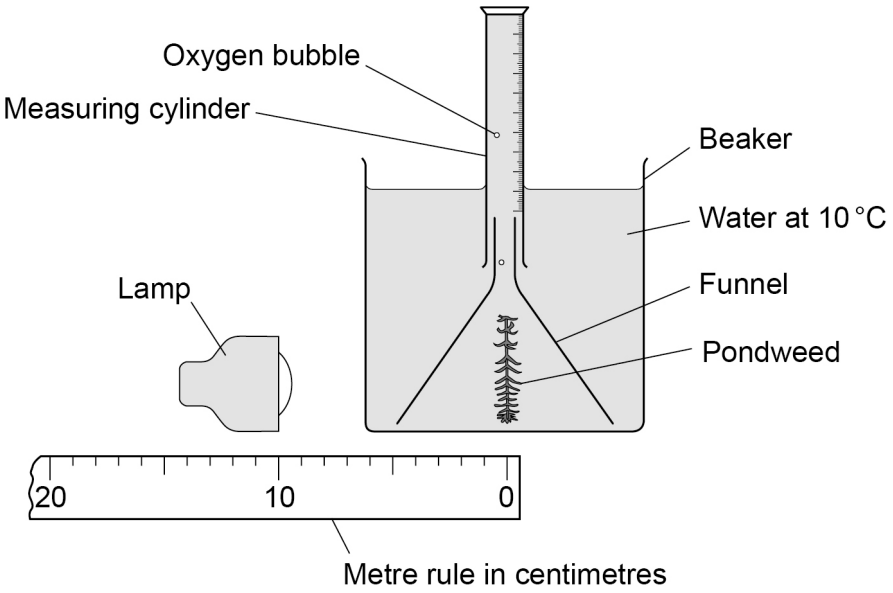
Question 08

0 3 Photosynthesis is important for plant growth.

A student used pondweed to investigate the rate of photosynthesis.

Figure 3 shows the apparatus used.

Figure 3



This is the method used.

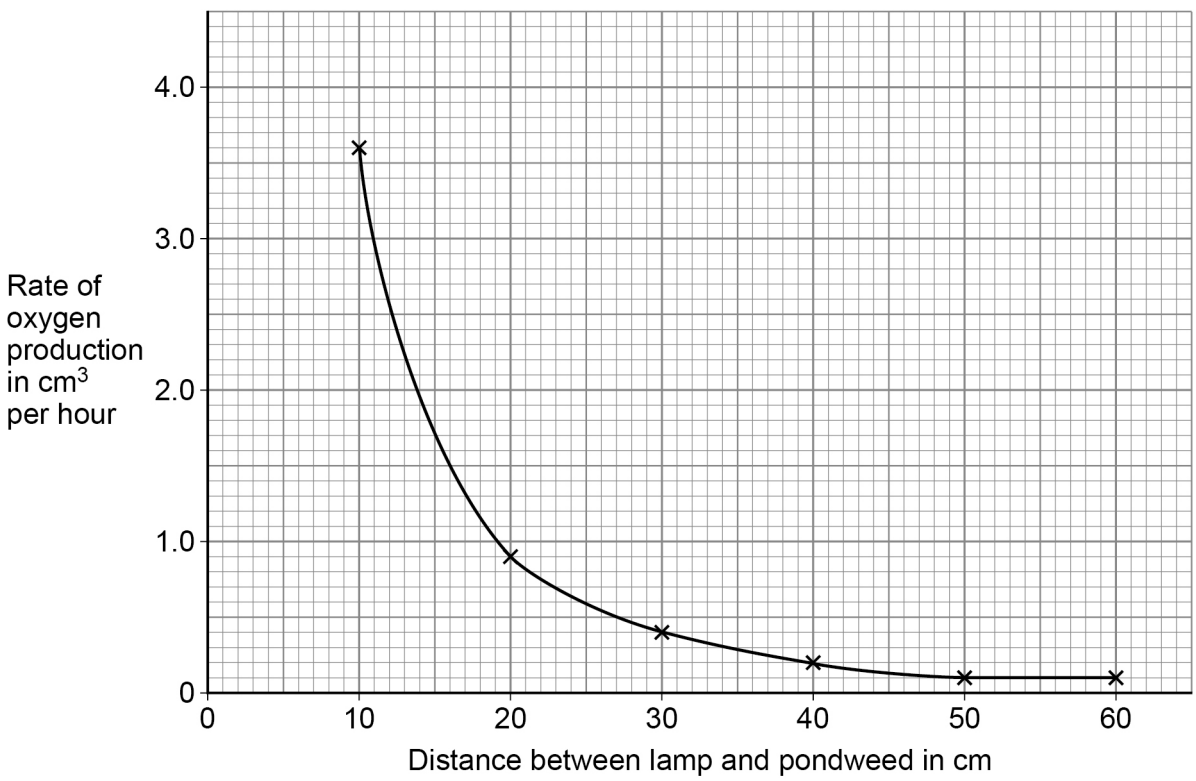
1. Set up the apparatus as shown in **Figure 3**.
2. Switch on the lamp.
3. After 2 hours, record the volume of oxygen collected in the measuring cylinder.
4. Repeat steps 1 to 3 a further five times, increasing the distance between the lamp and the pondweed each time.
5. Calculate the rate of oxygen production for each distance.

Question 3 continues on the next page

4.4.1.2 Rate of photosynthesis

Figure 4 shows the results.

Figure 4



0 3 . 1 Which measuring cylinder should the student have used to give the most accurate results?

[1 mark]

Tick (✓) **one** box.

- 10 cm^3 measuring cylinder with intervals of 0.1 ± 0.01 cm^3 ☐
- 10 cm^3 measuring cylinder with intervals of 0.2 ± 0.01 cm^3 ☐
- 20 cm^3 measuring cylinder with intervals of 0.1 ± 0.02 cm^3 ☐
- 20 cm^3 measuring cylinder with intervals of 0.2 ± 0.02 cm^3 ☐

4.4.1.2 Rate of photosynthesis

Question 08 · continued

0 3 . 2 Light intensity can be calculated using the inverse square law.

The equation shows the inverse square law.

$$\text{light intensity} \propto \frac{1}{(\text{distance from light source})^2}$$

Explain how light intensity changed as the distance of the pondweed from the light source was doubled.

Include calculations in your answer.

Use data from **Figure 4**.

[3 marks]

Question 3 continues on the next page

4.4.1.2 Rate of photosynthesis

Question 08 · continued

The student did the investigation at 10 °C.

The student repeated the investigation at 20 °C and again at 80 °C.

0 3 . 3 Explain how repeating the investigation at **20 °C** would affect the results.

[3 marks]

0 3 . 4 Explain how repeating the investigation at **80 °C** would affect the results.

[2 marks]

9