

GCSE Combined Science: Trilogy

Worksheet: Rate of photosynthesis

TIME 30 min	TOTAL 30 marks	CALCULATOR Allowed	DIFFICULTY Easy, Medium
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Topics: Rate of photosynthesis

NAME	CLASS	DATE
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- Use black ink or black ball-point pen. Pencil should only be used for drawing.
- Answer all questions in the spaces provided.
- In all calculations, show clearly how you work out your answer.
- The marks for questions are shown in brackets.

0 1

A student is investigating the effect of the distance of a lamp from a piece of pondweed on the rate of photosynthesis, by counting the bubbles of oxygen given off per minute.

0 1 . 1

Write a hypothesis for this investigation, including scientific reasoning to justify your prediction.

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[2 marks]

0 1 . 2

Identify the independent and dependent variables. Give **one** variable that should be controlled, and explain why.

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[3 marks]

0 2

A student counted the bubbles of gas released by a piece of pondweed in bright light. The student counted 20 bubbles in 5 minutes.

0 2 . 1

Calculate the rate of bubble production, in bubbles per minute.

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Rate = bubbles per minute

[2 marks]

0 2 . 2

Give **one** reason why counting bubbles may not give an accurate measure of the rate of photosynthesis.

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[1 mark]

0 3

The rate of photosynthesis in a plant is affected by several factors.

0 3 . 1

Which piece of apparatus would let a student measure the volume of gas produced by pondweed directly, rather than by counting bubbles?

Tick (✓) **one** box.

A thermometer

☐

A gas syringe

☐

A measuring jug

☐

A stopwatch

☐

[1 mark]

0 3 . 2

Name **three** factors that can limit the rate of photosynthesis.

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[3 marks]

0 3 . 3

Give **one** variable that should be kept constant when investigating the effect of light intensity on the rate of photosynthesis, to make it a fair test.

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[1 mark]

0 4

Light intensity is inversely proportional to the square of the distance from a lamp.
A lamp is moved from 15 cm to 60 cm away from some pondweed.

0 4 . 1

Calculate the light intensity at 60 cm as a fraction of the light intensity at 15 cm.

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.....

Fraction =

[2 marks]

0 5

Instead of counting bubbles, a student used a data logger with an oxygen probe placed in the water next to some pondweed, to measure the concentration of dissolved oxygen every 10 seconds.

0 5 . 1

Suggest **two** advantages of using a data logger with an oxygen probe, rather than counting bubbles, to measure the rate of photosynthesis.

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[2 marks]

0 5 . 2

Explain why some of the oxygen produced by the pondweed might not be detected by the oxygen probe.

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[2 marks]

0 5 . 3

Suggest **one** reason the student should let the apparatus settle for a short time after changing the light intensity, before taking readings.

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[1 mark]

0 6

Table 1 shows the rate of photosynthesis of pondweed at different temperatures. Light intensity and carbon dioxide concentration were kept high enough not to limit the rate.

Table 1

Temperature in °C	10	20	30	40	50
Rate of photosynthesis in mm ³ of oxygen per minute	4	11	19	6	0

0 6 . 1

What is the optimum temperature for photosynthesis shown in Table 1?

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Optimum temperature = °C

[1 mark]

0 6 . 2

Explain the pattern of results shown in Table 1.

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[3 marks]

0 6 . 3

Suggest why almost no photosynthesis occurred at 50 °C.

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[1 mark]

0 7

Light intensity is inversely proportional to the square of the distance from a lamp.
A lamp is moved from 5 cm to 10 cm away from some pondweed.

0 7 . 1

Calculate the light intensity at 10 cm as a fraction of the light intensity at 5 cm.

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.....

Fraction =

[2 marks]

0 8

Table 2 shows the rate of photosynthesis of a plant at different light intensities, with a low and with a high concentration of carbon dioxide. The temperature was kept constant.

Table 2

Light intensity in arbitrary units	5	10	15	20	25	30	35	40
Rate with low CO ₂ concentration in arbitrary units	3	6	9	12	12	12	12	12
Rate with high CO ₂ concentration in arbitrary units	3	6	9	12	15	18	18	18

0 8 . 1

At a light intensity of 10 arbitrary units, the rate of photosynthesis is the same with the low and the high carbon dioxide concentration.
What does this show about the factor limiting the rate at this light intensity?

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.....

[1 mark]

0 8 . 2

At a light intensity of 40 arbitrary units, the rate with the high carbon dioxide concentration is greater than the rate with the low carbon dioxide concentration. Explain what this shows.

[2 marks]

END OF QUESTIONS

Original practice questions written to match the specification. Not produced by, affiliated with or endorsed by AQA.

Mark scheme

GCSE Combined Science: Trilogy · Worksheet: Rate of photosynthesis · 30 marks

Question 1 (5 marks)

01.1 [2 marks]

- a suitable hypothesis, e.g. 'as the distance increases, the number of bubbles produced per minute will decrease' (1)
- with reasoning, e.g. because light intensity decreases as the distance increases, and light (energy) is needed for photosynthesis, so less light means a slower rate when light is the limiting factor (1)

01.2 [3 marks]

- independent variable: distance between the lamp and the pondweed (1)
 - dependent variable: number of bubbles of oxygen given off per minute (1)
 - control, e.g. the concentration of sodium hydrogencarbonate solution, the species/length of pondweed, or the water temperature — these must be kept the same because they also affect the rate of photosynthesis, so changing them as well as distance would make it impossible to attribute any change in rate to light intensity alone (1)
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Question 2 (3 marks)

02.1 [2 marks]

Answer: 4 bubbles per minute

- $20 \div 5$ (1)
- 4 (bubbles per minute) (1)

02.2 [1 mark]

- the bubbles may be different sizes (1)
- some bubbles may be missed, e.g. if they are released very quickly (1)
- some of the oxygen produced dissolves in the water instead of forming bubbles (1)

Any 1 of the points above.

Question 3 (5 marks)

03.1 [1 mark]

Correct: A gas syringe

03.2 [3 marks]

- light intensity (1)
- carbon dioxide concentration (1)
- temperature (1)
- amount of chlorophyll (1)

Any 3 of the points above.

03.3 [1 mark]

- carbon dioxide concentration (1)
- temperature (1)
- species / amount (mass or length) of pondweed (1)

Any 1 of the points above.

Question 4 (2 marks)

04.1 [2 marks]

Answer: $\frac{1}{16}$ (= 0.0625)

- the distance is multiplied by 4, so the light intensity is divided by 4^2 (or multiplied by $(15 \div 60)^2$) (1)
- $\frac{1}{16}$ (= 0.0625) (1)

Notes: Allow the answer as a fraction or a decimal.

Question 5 (5 marks)

05.1 [2 marks]

- it gives a continuous, more precise numerical measurement of the oxygen produced, rather than relying on counting bubbles of varying size (1)
- it can take readings automatically and very frequently, which would be difficult to do accurately by counting bubbles by eye (1)
- results are stored and processed by a computer, reducing recording errors (1)

Any 2 of the points above.

05.2 [2 marks]

- some oxygen may escape from the water as bubbles rather than dissolving (1)
- some of the oxygen produced may be used by the plant itself for respiration (1)

05.3 [1 mark]

- to allow the rate of photosynthesis, and the dissolved oxygen concentration, to reach a new steady rate at the new light intensity (1)

Question 6 (5 marks)

06.1 [1 mark]

Answer: 30 °C

- 30 (°C) (1)

06.2 [3 marks]

- as temperature increases from 10 °C to 30 °C, the rate increases because the enzymes controlling photosynthesis work faster (1)
- above 30 °C the rate decreases sharply (1)
- because the enzymes controlling photosynthesis become denatured, so their active site changes shape and they no longer work effectively (1)

06.3 [1 mark]

- nearly all of the enzymes needed for photosynthesis have been denatured by this temperature (1)
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Question 7 (2 marks)

07.1 [2 marks]

Answer: $\frac{1}{4}$ (= 0.25)

- the distance is multiplied by 2, so the light intensity is divided by 2^2 (or multiplied by $(5 \div 10)^2$) (1)
- $\frac{1}{4}$ (= 0.25) (1)

Notes: Allow the answer as a fraction or a decimal.

Question 8 (3 marks)

08.1 [1 mark]

- light intensity is the limiting factor (not carbon dioxide concentration) (1)
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08.2 [2 marks]

- with the low carbon dioxide concentration, carbon dioxide concentration is the factor limiting the rate at this light intensity (1)
 - because increasing the carbon dioxide concentration increases the rate, but increasing the light intensity above 20 units does not (1)
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