

22.1 Photosynthesis and limiting factors

Name: _____ Class: _____ Date: _____

Total: 10 marks

KEY WORDS photosynthesis • limiting factor

Objective

Photosynthesis and limiting factors. Original classroom practice for IB HL; not an official IB paper.

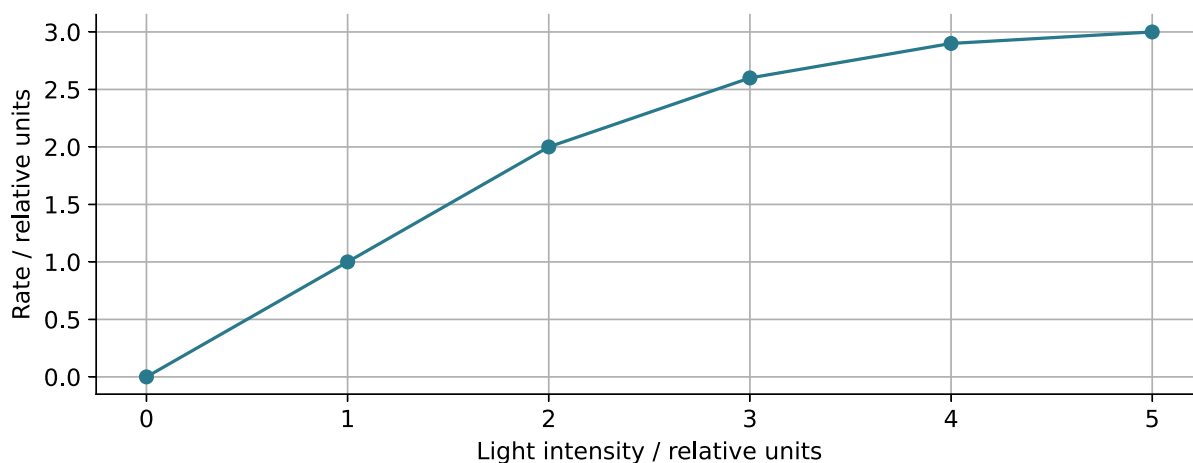
1 Key knowledge and worked examples

■ What would explain this observation?

- A brighter lamp does not always produce more oxygen from pondweed. Another factor may limit the process when light is already sufficient.

■ Build the model

- **Photosynthesis** transfers energy from light into chemical stores.
- Carbon dioxide and water form carbohydrate, releasing oxygen.
- Chlorophyll absorbs light; light intensity, temperature and carbon dioxide supply can affect rate.
- **limiting factor** : A factor whose shortage restricts rate.
- photosynthesis: Light-driven formation of carbohydrate.



■ Choose evidence that can test it

- Change only one factor when testing a limiting factor.
- At low light, extra light may increase rate.
- At a plateau, the changed factor is no longer the main limit in that range; the graph alone does not identify which other factor is limiting.

In the lab: Measure collected gas volume over a fixed time instead of assuming all bubbles have the same volume. Control temperature, plant size and carbon dioxide supply. Allow the plant to adjust before each reading and repeat.

■ Work from known quantities

- Known: 6.0 cubic centimetres of gas are collected in 3.0 minutes.
- Use $\text{rate} = \text{volume}/\text{time}$.
- $\text{Rate} = 6.0/3.0 = 2.0$ cubic centimetres per minute.
- Bubble counts can be a rough proxy, but bubbles of different size make comparisons less reliable.

Your turn: 9.0 cubic centimetres of gas are collected in 3.0 minutes. Find the rate.

■ Check the conclusion and its limits

- Moving a lamp changes light and may also change temperature.
- A photosynthesis experiment needs control of heating, not just a ruler.

Not true: All oxygen bubbles have exactly the same volume. Bubbles from pondweed vary in size and composition, so a bubble count is only a rough proxy for gas volume. Measuring collected volume, as in the calculation above, is more reliable.

Key:

- Photosynthesis transfers energy from light into chemical stores.
- Change only one factor when testing a limiting factor.
- Watch for: moving a lamp changes light and may also change temperature.

■ Write from a gas rate of 2.5 cubic centimetres per minute

- 10.0 cubic centimetres of gas are collected in 4.0 minutes.
- Find the rate. At a plateau, the factor you changed is no longer the main limit.

2 Practice

2.1 A rate-light graph reaches a plateau. What follows? Choose one answer.

- **A** Another factor may now limit the rate
- **B** Light is still certainly the only limit
- **C** Photosynthesis has stopped

[1]

2.2 9.0 cubic centimetres of gas are collected in 3.0 minutes. Find the rate. Show the relation, substitution and units.

[2]

2.3 Decide whether this claim is true and justify: Bubbles from pondweed vary in size and composition, so a bubble count is only a rough proxy for gas volume.

[2]

2.4 A factor whose shortage restricts rate: write the technical term.

[1]

3 Exam-style questions

3.1 A fictional plant produces 8 cm^3 in 4 min at low light and 12 cm^3 in 4 min at high light. Explain the change, and why an unchanged rate after a further light increase would not identify the next limiting factor. [4]

Solutions

2.1 A On the plateau, adding more light no longer raises the rate, so light is no longer the limiting factor; another factor such as carbon dioxide or temperature may now limit it. Photosynthesis has not stopped - the rate is constant, not zero.

2.2 $\text{rate} = 9.0 / 3.0 = 3.0 \text{ cm}^3/\text{min}$.

2.3 True. True. Bubbles from pondweed vary in size and composition, so a bubble count is only a rough proxy for gas volume. Measuring collected volume, as in the calculation above, is more reliable.

2.4 limiting factor. limiting factor means A factor whose shortage restricts rate.

3.1 Rates 2 and 3 cm^3/min , a 50% increase. A plateau suggests another limitation under those conditions, but does not identify it. Control temperature and carbon dioxide, allow equilibration and repeat.