

Exercise walk-through

22.1

Photosynthesis and limiting factors

International Baccalaureate · IB Diploma · Biology · HL

22.1 Photosynthesis and limiting factors

Name: _____ Class: _____ Date: _____ **Total: 10 marks**

KEY WORDS photosynthesis • limiting factor

Objective

Photosynthesis and limiting factors. Supported HL concept preparation; original classroom practice, not an official IB paper or assessed learner work.

1 Key knowledge and worked examples

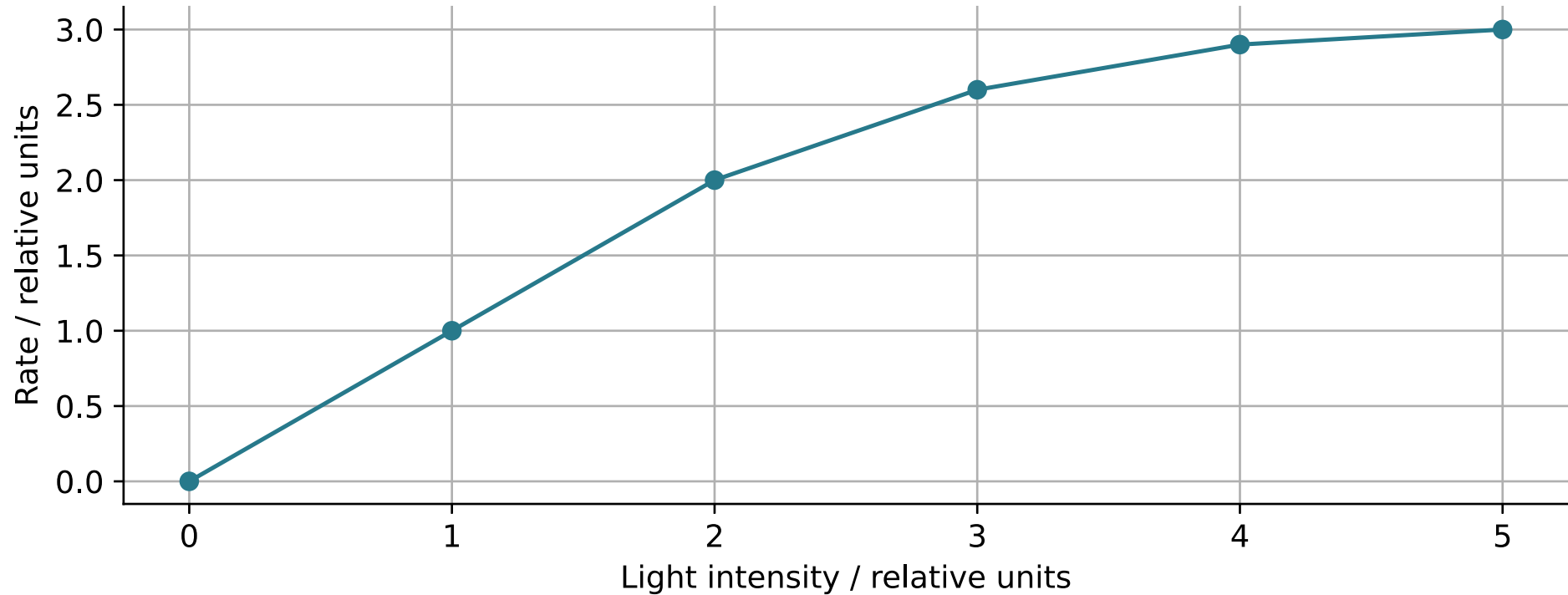
■ What would explain this observation?

- A brighter lamp does not always produce more oxygen from pondweed. Another factor may limit the process when light is already sufficient.
- Start with a prediction. State the quantities or features you would compare, then decide what evidence could distinguish two explanations.

■ 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.
- 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

- State the known values and their units. Choose the relation because its assumptions

fit this case, then rearrange before substitution.

- 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.

Example:

9.0 cubic centimetres of gas are collected in 3.0 minutes. Find the rate. Use the same sequence: known quantities $\rightarrow$ model $\rightarrow$ relation $\rightarrow$ substitution $\rightarrow$ unit and interpretation.

■ 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.

- Return to the original observation. Explain what the result supports, which conditions it assumes, and one way to test a competing explanation.

Warn:

All oxygen bubbles have exactly the same volume. This claim is false: Moving a lamp changes light and may also change temperature. A photosynthesis experiment needs control of heating, not just a ruler.

Key:

Photosynthesis and limiting factors: 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.

Exercises 2.1·2.3

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

- **A** Light is still certainly the only limit
- **B** Another factor may now limit the rate
- **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: All oxygen bubbles have exactly the same volume.

[2]

Exercises 2.1-2.3

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

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

[1]

2.1 B 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.

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

[2]

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

2.3 Decide whether this claim is true and justify: All oxygen bubbles have exactly the same volume.

[2]

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

Exercises 2.4·3.1

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.

Exercises 2.4·3.1

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

[1]

3 Exam-style questions

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

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.

3.1 Rates 2 and $3 \text{ cm}^3/\text{min}$, 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.