

IB Biology C1.3 Photosynthesis - Worksheet 4

Measuring photosynthetic rate and experimental design | SL core | Total: 46 marks | Suggested time: 60 min

Name: _____	Class: _____	Date: _____
--------------------	---------------------	--------------------

Assessment instructions: Answer all sections. Show calculations and units where relevant. HL questions are marked [HL]. The answer key and marking guidance are included at the end for teacher review or self-assessment.

Learning focus: photosynthometer methods; independent and dependent variables; correction for respiration; hypothesis and validity

Section A - Multiple choice (5 marks)

1. In an experiment testing light intensity, the independent variable could be (1)
 - A. oxygen volume.
 - B. distance between lamp and pondweed.
 - C. species of pondweed kept the same.
 - D. rate of photosynthesis.
2. The dependent variable in a photosynthometer investigation is often (1)
 - A. temperature of the water bath.
 - B. type of plant.
 - C. oxygen produced per unit time.
 - D. colour of the lamp casing.
3. Biomass is an indirect measure of photosynthesis because it (1)
 - A. is exactly equal to oxygen production.
 - B. can be affected by processes other than photosynthesis.
 - C. cannot be measured in plants.
 - D. does not contain carbon.
4. Hydrogen carbonate indicator can estimate photosynthesis because dissolved CO₂ affects (1)
 - A. the pH of the solution.
 - B. the length of chloroplasts.
 - C. the wavelength of light.
 - D. the mass of oxygen atoms.
5. To investigate temperature fairly, the best control would be to keep constant the (1)
 - A. temperature being tested.
 - B. light intensity and carbon dioxide concentration.
 - C. oxygen production rate.
 - D. dependent variable.

Section B - Short answer

6. Describe two ways to measure the rate of photosynthesis in aquatic plants. (4)

7. Explain why respiration must be considered when measuring oxygen production by a plant. (3)

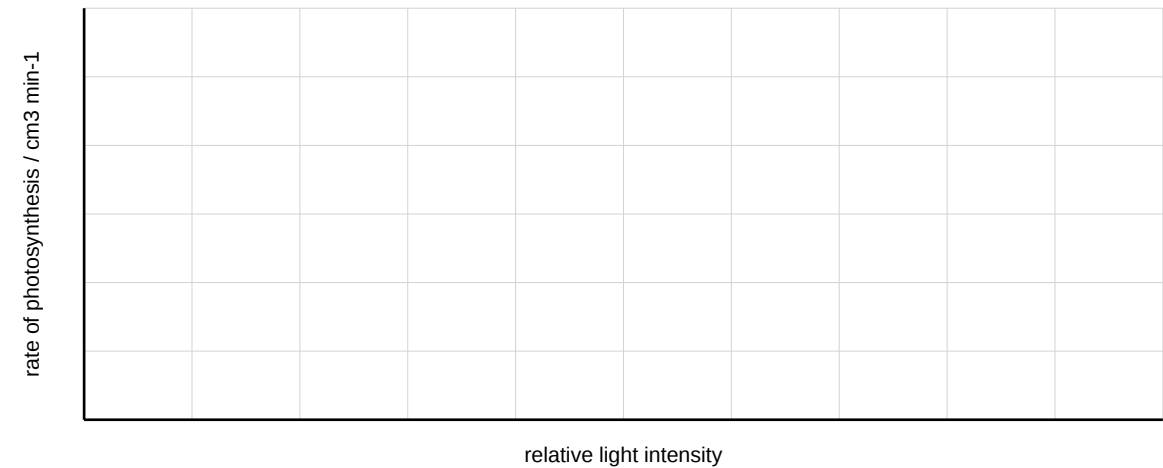
8. Write a testable hypothesis for the effect of light intensity on photosynthesis. (2)

9. Identify the independent variable, dependent variable and two controlled variables for an experiment testing carbon dioxide concentration. (4)

Section C - Data response / case study

A student placed pondweed at different distances from a lamp. The volume of oxygen collected over 5 minutes was measured. Sodium hydrogen carbonate was used to provide excess carbon dioxide and a water bath was used.

Distance from lamp / cm	Relative light intensity (1/d ²)	O ₂ volume in 5 min / cm ³	Rate / cm ³ min ⁻¹
10	0.0100	3.5	
20	0.0025	1.8	
30	0.0011	0.9	
40	0.0006	0.6	
50	0.0004	0.5	



10a. Complete the rate column. (5)

10b. Plot rate against relative light intensity on the grid. (4)

10c. Describe the relationship shown by the data. (3)

10d. Explain why the water bath was used. (2)

10e. Suggest two limitations of counting bubbles instead of measuring oxygen volume. (2)

Section D - Extended response

11. Design a valid investigation into one limiting factor of photosynthesis. Include a hypothesis, variables, method, data processing and risk management. (10)

Answer key and marking guidance

Award credit for equivalent wording. Marks should be awarded for valid biological reasoning, correct use of data, and clear links to photosynthesis. Do not require exact phrasing unless a term is specified.

Section A - Multiple choice

Question	Answer	Guidance
1	B	Changing lamp distance changes light intensity.
2	C	The measured outcome is oxygen production per time.
3	B	Biomass also depends on respiration, water content, mineral availability, growth stage and loss of tissue.
4	A	CO ₂ forms carbonic acid; pH indicators change colour.
5	B	Other limiting factors must be controlled.

Section B - Short answer

6. Award 1 mark each for method and 1 for rate processing: count oxygen bubbles per unit time; collect oxygen volume in a photosynthometer; measure CO₂ decrease with sensors or pH indicator; measure oxygen sensor change over time.
7. Up to 3 marks: respiration occurs in plant cells; it consumes oxygen and releases CO₂; measured oxygen may be net photosynthesis; correction using dark respiration gives better estimate of gross photosynthesis.
8. Award 2 marks for a directional, testable hypothesis, for example: As light intensity increases, oxygen production rate will increase until another factor becomes limiting.
9. Independent variable: CO₂ concentration, for example sodium hydrogen carbonate concentration. Dependent variable: rate of photosynthesis/oxygen production/CO₂ uptake. Controlled variables: light intensity, temperature, plant mass/species, water volume, wavelength, time.

Section C - Data response / case study

- 10a. Rates: 0.70, 0.36, 0.18, 0.12, 0.10 cm³ min⁻¹. Award 1 each.
- 10b. Award up to 4 marks: labelled axes with units where appropriate; suitable scale; correct plotting; appropriate curve/line.
- 10c. As relative light intensity increases, photosynthesis rate increases. The increase is steep at low light intensities and tends to slow/approach a plateau at higher intensities, suggesting another factor may become limiting.
- 10d. The water bath maintains constant temperature so temperature does not become an uncontrolled variable; it improves validity because enzyme activity is temperature dependent.
- 10e. Any two: bubble size varies; bubbles may dissolve or stick to plant; bubbles may be missed at high rates; counts give number not volume; human timing/counting error.

Section D - Extended response

11. Mark out of 10. Up to 2 for hypothesis linked to factor. Up to 2 for correct variables: independent, dependent, controlled. Up to 2 for practical method with enough detail and repeats. Up to 1 for valid measurement of photosynthesis rate. Up to 1 for data processing such as mean, rate calculation, graph. Up to 1 for control of confounding factors. Up to 1 for safety/ethics/risk management.