

IB Biology C1.3 Photosynthesis - Worksheet 1

Foundations: energy, products and equations | SL core | Total: 42 marks | Suggested time: 55 min

Name: _____	Class: _____	Date: _____
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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: light energy transformed into chemical energy; photosynthesis equation; oxygen as a by-product; ecosystem dependence

Section A - Multiple choice (5 marks)

- Which statement best describes the main energy transformation in photosynthesis? (1)
 - Chemical energy is transformed into light energy.
 - Light energy is transformed into chemical energy in carbon compounds.
 - Thermal energy is transformed into kinetic energy.
 - ATP is transformed directly into sunlight.
- The oxygen released by plants during photosynthesis is produced directly from the splitting of (1)
 - carbon dioxide.
 - glucose.
 - water.
 - ATP.
- Carbon dioxide is best described as being (1)
 - oxidized to form oxygen.
 - reduced to form a carbon compound.
 - split to provide replacement electrons.
 - released as the main waste product.
- A photoautotroph is an organism that (1)
 - uses light energy to produce organic compounds from inorganic substances.
 - must consume other organisms for all carbon compounds.
 - uses carbon dioxide only during cell respiration.
 - cannot use pigments.
- In darkness, a healthy plant cell will usually (1)
 - stop both respiration and photosynthesis.
 - continue photosynthesis but stop respiration.
 - continue respiration while photosynthesis falls greatly or stops.
 - release oxygen at a higher rate than in light.

Section B - Short answer

6. Write the word equation and the balanced symbol equation for photosynthesis. (4)

7. Explain why photosynthesis supplies most of the chemical energy needed in ecosystems. (3)

8. State one reactant and one product shared between photosynthesis and aerobic respiration, and explain how their roles differ. (4)

9. Distinguish between autotrophs, heterotrophs and photoautotrophs. (3)

Section C - Data response / case study

A student used pondweed to investigate oxygen production in light and darkness. Oxygen volume was recorded over 10 minutes. A separate dark trial measured respiration only.

Condition	Oxygen collected / cm ³ in 10 min	Notes
Bright white light	4.8	net oxygen release
Dim white light	1.2	net oxygen release
Darkness	-0.6	oxygen used by respiration

10a. Calculate the net oxygen production rate in bright light in cm³ min⁻¹. (2)

10b. Calculate the approximate gross photosynthetic oxygen production rate in bright light after correcting for respiration. (3)

10c. Explain why the value in darkness is negative. (2)

10d. Use the data to compare the effect of bright and dim light on photosynthesis. (3)

10e. Identify two controlled variables that would improve the validity of this investigation. (2)

Section D - Extended response

11. Explain how the reactants and products of photosynthesis link plants to the rest of an ecosystem. Include the origin of oxygen and the fate of glucose in your answer. (8)

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	Light is converted to chemical energy in glucose/carbon compounds.
2	C	Photolysis of water releases oxygen.
3	B	Hydrogen/electrons from water reduce carbon dioxide.
4	A	Photoautotrophs use light to make organic molecules.
5	C	Respiration continues day and night; photosynthesis depends on light.

Section B - Short answer

6. Award 1 mark for word equation: carbon dioxide + water → glucose + oxygen, in light. Award 1 mark for balanced symbol equation: $6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$. Award 1 mark for light requirement. Award 1 mark for correct reactant/product placement.

7. Up to 3 marks: photosynthesis produces carbon compounds/food; glucose stores chemical energy in bonds; producers begin food chains; heterotrophs obtain energy by feeding on producers/consumers; photosynthesis supplies oxygen for aerobic respiration.

8. Up to 4 marks: oxygen is product of photosynthesis but reactant in aerobic respiration; carbon dioxide is reactant in photosynthesis but product of respiration; glucose is made in photosynthesis and broken down in respiration; water is used/split in photosynthesis and formed in respiration.

9. Up to 3 marks: autotrophs make their own organic compounds from inorganic substances; heterotrophs obtain organic compounds by feeding; photoautotrophs are autotrophs using light as energy source.

Section C - Data response / case study

10a. $4.8 \text{ cm}^3 / 10 \text{ min} = 0.48 \text{ cm}^3 \text{ min}^{-1}$. Award 1 for division by time and 1 for correct answer/unit.

10b. Respiration uses 0.6 cm^3 in 10 min, so gross oxygen production = $4.8 + 0.6 = 5.4 \text{ cm}^3$ in 10 min = $0.54 \text{ cm}^3 \text{ min}^{-1}$. Award 1 for adding respiration correction, 1 for correct corrected volume, 1 for rate/unit.

10c. Negative value means oxygen is being consumed. Respiration continues in darkness but photosynthesis has stopped or is too low to replace oxygen used.

10d. Bright light gives 4.8 cm^3 in 10 min compared with 1.2 cm^3 in dim light; rate is four times higher in bright light. This supports light intensity as a limiting factor.

10e. Any two: same pondweed mass/length/species; same temperature; same CO_2 concentration; same time interval; same light wavelength; same water volume; same distance/positioning except intended treatment.

Section D - Extended response

11. Mark out of 8. Award up to 2 for reactants: CO_2 provides carbon and water supplies hydrogen/electrons. Up to 2 for products: glucose/carbohydrates store chemical energy and oxygen is released. Up to 2 for ecosystem links: producers support food chains, carbon compounds pass to heterotrophs, energy is available for respiration. Up to 1 for oxygen coming from water photolysis. Up to 1 for glucose fates: respiration, starch/cellulose/sucrose/biomass. Accept a well-structured alternative explanation with correct detail.