

Hess's Law Applied — Photosynthesis & Respiration

Use this worksheet after reading the lesson to practise the key ideas and prove you can meet the success criteria.

Name _____

Date _____

Class _____

1. Key Ideas

Every cell in your body right now is breaking down glucose and releasing 2803 kJ mol^{-1} of energy. Plants do the exact reverse — absorbing 2803 kJ mol^{-1} of sunlight to build glucose. Hess's Law predicts this perfectly: reverse a reaction, reverse the sign of ΔH . But here is the puzzle — photosynthesis is endothermic, so how do plants actually run it continuously without violating the laws of thermodynamics?

- $\Delta H(\text{photosynthesis}) = +2803 \text{ kJ mol}^{-1}$;
 $\Delta H(\text{respiration}) = -2803 \text{ kJ mol}^{-1}$
- Why Hess's Law requires the ΔH values to be equal and opposite (reverse reaction rule)

2. Success Criteria

By the end, you should be able to:

- $\Delta H(\text{photosynthesis}) = +2803 \text{ kJ mol}^{-1}$;
 $\Delta H(\text{respiration}) = -2803 \text{ kJ mol}^{-1}$
- The two values are equal and opposite because the equations are exact reverses
- ATP hydrolysis releases $\approx -30.5 \text{ kJ mol}^{-1}$ per mole — used to power endothermic reactions

3. Key Terms

Enthalpy change (ΔH)

The heat energy exchanged at constant pressure during a reaction.

Exothermic

A reaction releasing heat to surroundings ($\Delta H < 0$).

Endothermic

A reaction absorbing heat from surroundings ($\Delta H > 0$).

Calorimetry

The experimental measurement of heat changes during chemical processes.

Hess's Law

The total enthalpy change is independent of the pathway taken.

Entropy

A measure of the disorder or randomness of a system.

4. Activity: Build the Lesson Map

Use the lesson to complete the table. Keep answers brief but specific.

Prompt	Your answer
Main concept	
Important example	
Common mistake to avoid	
How this links to the next lesson	

5. Short Answer Questions

1. Explain this lesson goal in your own words: " $\Delta H(\text{photosynthesis}) = +2803 \text{ kJ mol}^{-1}$; $\Delta H(\text{respiration}) = -2803 \text{ kJ mol}^{-1}$ ". Use one specific example from the lesson.

BAND 3 **2 MARKS**

2. Apply this idea to a new example: "The two values are equal and opposite because the equations are exact reverses". Show your reasoning clearly.

BAND 4 **3 MARKS**

3. Analyse why this idea matters for understanding Hess's Law Applied — Photosynthesis & Respiration: "ATP hydrolysis releases $\approx -30.5 \text{ kJ mol}^{-1}$ per mole — used to power endothermic reactions".

BAND 5 **4 MARKS**

6. Extend: Apply the Idea

BAND 5/6

5 MARKS

A student gives a memorised answer about Hess's Law Applied — Photosynthesis & Respiration but does not use evidence or reasoning.

Improve the answer by writing a stronger response that uses accurate terminology, a relevant example and a clear explanation.

7. Multiple Choice

1. What is the best first step when answering a question about Hess's Law Applied — Photosynthesis & Respiration?

- A. Identify the key concept being tested
- B. Write every fact from memory
- C. Ignore the command word
- D. Skip examples and evidence

2. Which answer would show stronger understanding of Hess's Law Applied — Photosynthesis & Respiration?

- A. An answer with accurate terms and reasoning
- B. A copied definition only
- C. A single-word response
- D. An answer with no example

3. What should you do if a question asks you to explain?

- A. Link the idea to a reason or cause
- B. List unrelated facts
- C. Only draw a diagram
- D. Write the shortest possible answer

8. Success Criteria Proof

Finish with evidence that you can do each success criterion.

SUCCESS CRITERION 1

Prove that you can: $\Delta H(\text{photosynthesis}) = +2803 \text{ kJ mol}^{-1}$; $\Delta H(\text{respiration}) = -2803 \text{ kJ mol}^{-1}$

BAND 3 **2 MARKS**

SUCCESS CRITERION 2

Prove that you can: The two values are equal and opposite because the equations are exact reverses

BAND 4 **3 MARKS**

SUCCESS CRITERION 3

Prove that you can: ATP hydrolysis releases $\approx -30.5 \text{ kJ mol}^{-1}$ per mole — used to power endothermic reactions

BAND 5 **4 MARKS**

One thing I still need help with:
