CHEMISTRY YEAR 11 - MODULE 4 - LESSON 13

⚖️ Gibbs Free Energy & Spontaneity

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

width=device-width, initial-scale=1.0

- Key facts and terms for ⚖️ Gibbs Free Energy & Spontaneity
- How the main ideas in ⚖️ Gibbs Free Energy & Spontaneity connect

2. Success Criteria

By the end, you should be able to:

- Key facts and terms for ⚖️ Gibbs Free Energy & Spontaneity
- Where this lesson fits in Module 4
- How the main ideas in ⚖️ Gibbs Free Energy & Spontaneity connect

3. Key Terms

Enthalpy change (ΔH)
The heat energy exchanged at constant pressure during a reaction.

Exothermic
A reaction releasing heat to surroundings (ΔH < 0).

Endothermic
A reaction absorbing heat from surroundings (ΔH > 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. Q6 (6 marks) Explain, using the equation $\Delta G = \Delta H - T\Delta S$, why the decomposition of calcium carbonate ($\text{CaCO}_3 \to \text{CaO} + \text{CO}_2$) is non-spontaneous at room temperature but spontaneous in a lime kiln at 900°C. In your answer, identify the ΔH/ΔS combination category and calculate the crossover temperature.

BAND 3 6 MARKS

2. Q7 (6 marks) The rusting of iron: $4\text{Fe(s)} + 3\text{O}_2\text{(g)} \to 2\text{Fe}_2\text{O}_3\text{(s)}$ has $\Delta H° = -1648 \text{ kJ mol}^{-1}$ and $\Delta S° = -549 \text{ J K}^{-1}\text{mol}^{-1}$. (a) Calculate ΔG° at 25°C. (b) Is rusting spontaneous? (c) Calculate T cross . (d) Rusting is slow at room temperature. Distinguish between the thermodynamic and kinetic aspects of this observation.

BAND 4 6 MARKS

3. Q8 (8 marks) Evaluate the statement: "The Haber process is run at 400–500°C because the reaction is thermodynamically spontaneous at high temperatures." Is this statement correct? In your answer, calculate ΔG° at both 25°C and 450°C, explain the concept of T cross , and distinguish between thermodynamic and kinetic factors. Use: $\Delta H° = -92.4 \text{ kJ mol}^{-1}$; $\Delta S° = -198.9 \text{ J K}^{-1}\text{mol}^{-1}$.

BAND 5 8 MARKS

6. Extend: Apply the Idea

BAND 5/6 5 MARKS

A student gives a memorised answer about ⚖️ Gibbs Free Energy & Spontaneity 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 ⚖️ Gibbs Free Energy & Spontaneity?

- [ ] 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 ⚖️ Gibbs Free Energy & Spontaneity?

- [ ] 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: Key facts and terms for ⚖️ Gibbs Free Energy & Spontaneity

BAND 3 2 MARKS

SUCCESS CRITERION 2

Prove that you can: Where this lesson fits in Module 4

BAND 4 3 MARKS

SUCCESS CRITERION 3

Prove that you can: How the main ideas in ⚖️ Gibbs Free Energy & Spontaneity connect

BAND 5 4 MARKS

One thing I still need help with: