

Entropy, Gibbs energy and spontaneity

AP Chemistry · Test

Name: _____ Date: _____ Class: _____ Mark: ____ / 20

Answer all questions and show your working. A calculator is allowed. Use $R = 8.314 \text{ J}/(\text{mol}\cdot\text{K})$ and $T = 298 \text{ K}$ unless the question states otherwise. Convert ΔS to $\text{kJ}/(\text{mol}\cdot\text{K})$ when combining it with ΔH .

Level: AP Chemistry · **Curriculum:** AP Chem Unit 9

Time: 45 minutes · 8 questions · Total: 20 marks · Calculator allowed

Question 1 Entropy basics (2 marks)

Define entropy, give its unit and state the sign of ΔS for evaporation. (2 marks)

Question 2 Entropy of a decomposition (3 marks)

Calculate ΔS° for $2\text{KClO}_3(\text{s}) \rightarrow 2\text{KCl}(\text{s}) + 3\text{O}_2(\text{g})$. S° ($\text{J}/(\text{mol}\cdot\text{K})$): KClO_3 143.1, KCl 82.6, O_2 205.1. (3 marks)

Question 3 Gibbs calculation (3 marks)

A reaction has $\Delta H = -120 \text{ kJ}$ and $\Delta S = -250 \text{ J/K}$.

- Calculate ΔG at 298 K and state whether it is spontaneous. (2 marks)
- Calculate the temperature above which it is no longer spontaneous. (1 mark)

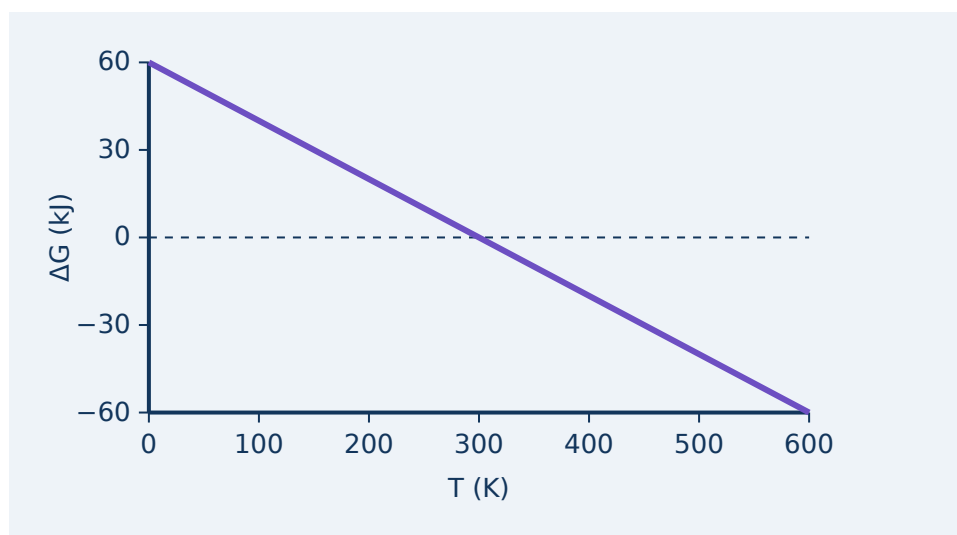
Question 4 K from ΔG° (3 marks)

$\Delta G^\circ = -15.0 \text{ kJ}$ at 298 K. Calculate K and state what the size of K tells you about the equilibrium position. (3 marks)

Question 5 Sign combinations (2 marks)

Explain why a reaction with ΔH positive and ΔS positive is spontaneous only at high temperature. (2 marks)

Question 6 Reading a graph (3 marks)



ΔG against T for a reaction.

- Read ΔH from the graph. (1 mark)
- State the temperature at which $\Delta G = 0$. (1 mark)
- Calculate ΔS in $\text{J}/(\text{mol}\cdot\text{K})$. (1 mark)

Question 7 Non-standard conditions (2 marks)

A reaction has $\Delta G^\circ = -5.0 \text{ kJ}$ at 298 K and the reaction quotient is $Q = 50$. Calculate ΔG and say in which direction the reaction proceeds. (2 marks)

Question 8 Comparing entropies (2 marks)

Which has the greater entropy at 298 K: (a) 1 mol $\text{H}_2\text{O}(\text{l})$ or 1 mol $\text{H}_2\text{O}(\text{g})$; (b) 1 mol $\text{CH}_4(\text{g})$ or 1 mol $\text{C}_3\text{H}_8(\text{g})$? Explain each. (2 marks)