

Gibbs Energy & Temperature Dependence of Spontaneity

THE FINAL SPONTANEITY TEST

$$\Delta G = \Delta H - T \Delta S$$

The ultimate criterion for predicting the direction of a chemical reaction.

Why ΔG ? Because ΔH (enthalpy) and ΔS (entropy) alone often give conflicting predictions. Gibbs brings them together to give a final verdict.

Deconstructing the Gibbs Equation

$G = H - TS$: THE ULTIMATE COMPETITION



The Enthalpy Effect (ΔH)

The system's drive to minimize energy.

Goal: Wants ΔH to be negative (exothermic).



The Entropy Effect ($T\Delta S$)

The system's drive to maximize disorder.

Goal: Wants ΔS to be positive (more chaotic).

Temperature (T) is the volume knob. It dictates how much 'weight' the Entropy effect has in this competition.

The Sign Criterion

PREDICTING THE OUTCOME

$$\Delta G < 0$$

SPONTANEOUS



Net energy is available to do useful work. The forward reaction happens naturally.

$$\Delta G = 0$$

EQUILIBRIUM



The system is perfectly balanced. No net change occurs.

$$\Delta G > 0$$

NON-SPONTANEOUS



The forward reaction requires external energy. (The reverse reaction is spontaneous).



You've Learned the Theory. Let's Test Them Now.

$$E=mc^2$$



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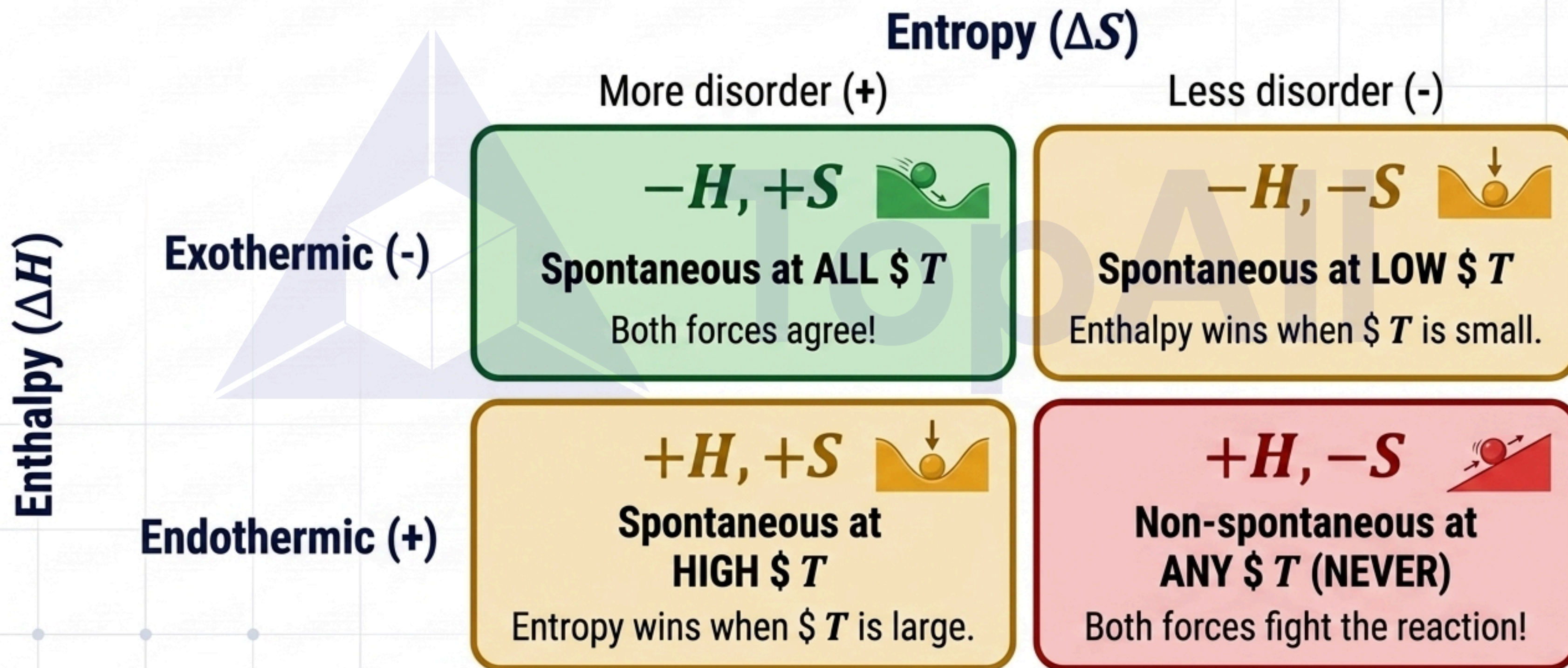
Key Highlights

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Temperature Dependence

THE 4 CASES OF SPONTANEITY (THE MATRIX)



AVOID THESE NUMERICAL TRAPS



\$T\$ must **ALWAYS** be in **Kelvin** (K). Never plug Celsius into the equation. ($K = ^\circ\text{C} + 273$).

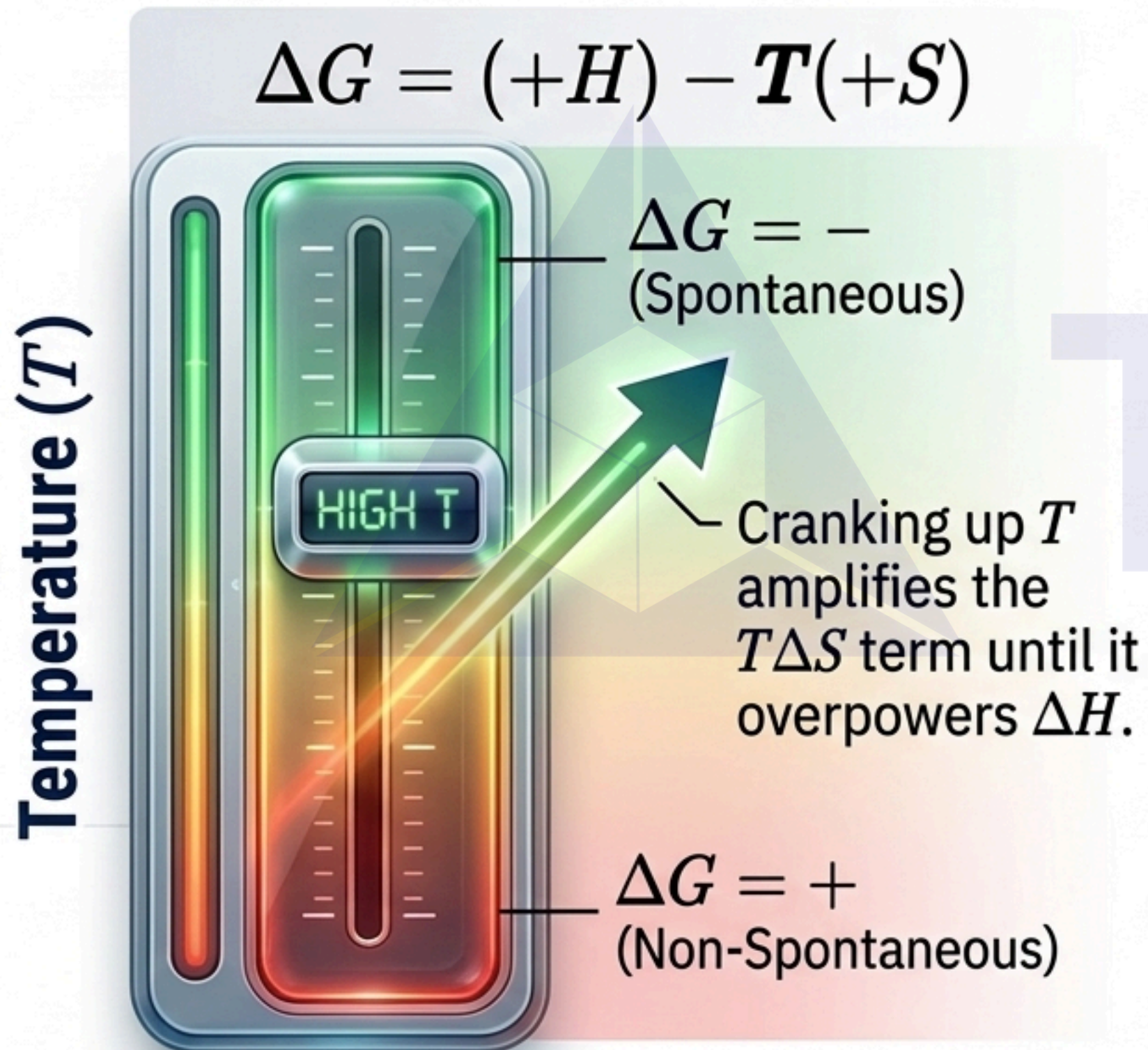
ΔH in $\frac{\text{kJ}}{\text{mol}}$ vs. ΔS in $\text{J/K}\cdot\text{mol}$

You MUST divide ΔS by 1000 (or multiply ΔH by 1000) before subtracting. Match the units!



Don't blindly memorize the 2x2 table. Plug the signs directly into $\Delta G = \Delta H - T\Delta S$ and deduce if ΔG becomes negative mathematically.

THE TEMPERATURE SLIDER & KEY TAKEAWAYS



- $\Delta G < 0$ is the ultimate mathematical test for spontaneity.
- $\Delta G = \Delta H - T\Delta S$ represents the balance between heat (ΔH) and disorder (ΔS).
- Temperature (T) determines which term dominates when they have the same sign.
- Always check units in numericals: T in Kelvin, match J with kJ.



You've Learned the Theory.

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