Gibbs (Free) energy

A proxy for the total entropy change

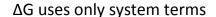
Relationship between S and H

- For a given energy change (ΔH at constant pressure), the change in entropy (ΔS) will be greater at lower temperatures
- We can relate them by:

• Units of S are J/K, and H are J.
$$\Delta \mathrm{S} = rac{\Delta H}{T}$$

Total entropy change – hard to

- Use a proxy Gibbs Free energy ΔG
- We will express the changes that take place only in terms of the system – not the surroundings.





• And we know that
$$\Delta S = \Delta H/T$$

•
$$\Delta S_{total} = \Delta S_{system} + \Delta H_{surroundings} / T$$

•
$$\Delta H_{\text{system}} = -\Delta H_{\text{surroundings}}$$

•
$$\Delta S_{\text{total}} = \Delta S_{\text{system}} - \Delta H_{\text{system}} / T$$

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$$-T\Delta S_{total} = \Delta H_{system} - T\Delta S_{system}$$

- $\Delta G = \Delta H T\Delta S$
- Use ΔG (or ΔG° at standard state 298K) to find out if the process will "go" (be spontaneous)
- Enthalpy (ΔH) tells us about thermal energy but during every change some energy is lost – spreads out – and becomes useless
- ΔG tells us what is left available free to do work

Free energy

- When ΔG is negative equivalent to ΔS (for the universe) being positive.
 - Criterion for a process to "go"
 - Often termed "spontaneous" but this it misleading
 many spontaneous reactions take a long time to happen.
- But ΔG is temperature dependent so we have to look at both ΔH and ΔS to predict the sign of ΔG

ΔG and temperature

ΔН	ΔS	ΔG
Negative (exothermic)	Positive (system entropy increases)	Negative at all temperatures – (always thermodynamically favored
Positive (endothermic)	Negative (system entropy decreases)	Positive at all temperatures (never thermodynamically favored)
Negative (exothermic)	Negative (system entropy decreases)	Depends on the temperature, as T increases ΔG will become more positive and the reaction will
Positive (endothermic)	Positive (system entropy increases)	Depends on the temperature, as T increases ΔG will become more negative and the reaction will