Entropy and Free Energy

STUDY LIST From Paul Groves

I can…

The Driving Forces

☐ State the two driving forces for reactions, Enthalpy (ΔH) and Entropy (ΔS).

☐ State that Enthalpy (ΔH) tends toward a minimum and this means
- ΔH is negative
- ΔH is < 0
- heat is on the right (products)
- PE curve is downhill

☐ State that Entropy (ΔS) tends toward a maximum and this means
- ΔS is positive
- ΔS is > 0
- the products are more disordered (spread out) than reactants
- the entropy curve is uphill

☐ Calculate ΔH using Hess's Law or q=mcΔT and moles of reactant.

Entropy

☐ Define entropy (ΔS) as the randomness, disorder, or "spreadioutiness" of a system.

☐ Calculate entropy (ΔS) using Hess's Law with these differences:
- **elements** have values for entropy
- units for entropy are $J \cdot mol^{-1} \cdot K^{-1}$ rather than $kJ \cdot mol^{-1}$… (a conversion is usually needed).

☐ Recognize changes in entropy.

Entropy increases, ΔS +, ΔS > 0:
- from solid → liquid → gas
- fewer moles (g) → more moles (g)
- simpler → more complex molecules
- smaller molecules → longer molecules
- ionic solids with strong attractions → ionic solids with weaker attractions
- separate solute & solvent → solutions
- gas dissolved in water → escaped gas

Spontaneity (Product-Favored)

☐ Look at a reaction and state whether it is exothermic or endothermic.

☐ State whether a reaction will be product-favored depending on ΔH, ΔS, and absolute temperature.

ΔH	ΔS	Product-Favored…
+	+	at higher temperatures
–	–	at lower temperatures
–	+	at all temperatures
+	–	never (reactant-favored at all temps)

☐ Explain that many books use the term "spontaneous" for "product-favored."

*A **spontaneous** reaction does not necessarily mean a **fast** reaction. The SPEED of a reaction is **Kinetics** (Ch 15)… we are discussing whether a reaction CAN OCCUR which is **Thermodynamics** (Ch 6 and Ch 20).*

☐ Combine the effects of ΔH, ΔS, and Temperature to form ΔG, the Gibbs Free Energy: $\Delta G = \Delta H - T\Delta S$

Note watch your units for ΔH & ΔS

ΔG<0, ΔG –, product-favored reaction
ΔG>0, ΔG +, reactant-favored reaction
ΔG=0, reaction is at equilibrium

☐ Use the special case of **equilibrium** (e.g. boiling point or temperature when a reaction becomes spontaneous) to use the modified equation: $\Delta H = T\Delta S$

Link with Other Chapters

☐ Convert between K, ΔG, and E° using equations given on the AP Exam.