

20 • Entropy and Free Energy

BLUFFER'S GUIDE

1. There are two driving forces for reactions. Reactions tend toward:

minimum **Enthalpy**, ΔH (heat energy)

$\Delta H -$, $\Delta H < 0$, downhill

maximum **Entropy**, ΔS (randomness)

$\Delta S +$, $\Delta S > 0$, uphill

2. Recognize whether $\Delta S > 0$ or < 0 .

Entropy increases, $\Delta S +$, $\Delta S > 0$:

- from solid to liquid to gas
- fewer moles (g) to more moles (g)
- simpler molecules to more complex molecules
- smaller molecules to longer molecules
- ionic solids with strong attractions to ionic solids with weaker attractions
- separate solute & solvent to solutions
- gas dissolved in water to escaped gas

3. Product or Reactant favored reactions depend on ΔH , ΔS , and absolute Temp

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

4. 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).

5. Gibbs Free Energy, ΔG , puts the effects of ΔH , ΔS , and Temperature together.

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

$\Delta G < 0$, $\Delta G -$, product-favored reaction

$\Delta G > 0$, $\Delta G +$, reactant-favored reaction

$\Delta G = 0$, reaction is at equilibrium

Important:

Note that ΔH is usually in kJ/mol

ΔS is usually in J/mol·K

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