

The Gibbs Free Energy Equations & Relations

$\Delta G = -T\Delta S_{\text{universe}}$	Relates Gibbs Free Energy (ΔG) with the entropy of the universe ($\Delta S_{\text{universe}}$). By the second law of thermodynamics, $\Delta S_{\text{universe}}$ must always increase; therefore, ΔG must be negative for product favored reactions.
$\Delta G = \Delta H - T\Delta S$	Relates ΔG to enthalpy (ΔH) and entropy (ΔS); also known as the "two headed snake" equation. Enthalpy and entropy can combine to make some reactions always product favored ($\Delta G < 0$) or always reactant favored ($\Delta G > 0$); in addition, sometimes enthalpy and entropy "fight" one another, making the final value of ΔG temperature dependent.
$\Delta G = -RT \ln K$	Relates ΔG with the equilibrium constant (K). R = gas constant ($8.314 \text{ J K}^{-1} \text{ mol}^{-1}$), T = temperature (K). If ΔG is product favored ($\Delta G < 0$), K is greater than 1; if ΔG is reactant favored ($\Delta G > 0$), K is less than 1.
$\Delta G = -nFE$	Relates ΔG with the potential of a chemical cell (E). n = number of electrons transferred, F = Faraday constant ($96,485 \text{ C mol}^{-1}$). If ΔG is product favored ($\Delta G < 0$), E is greater than 0 (positive); if ΔG is reactant favored ($\Delta G > 0$), E is less than 0 (negative).
$\Delta G = \sum \Delta G_{\text{products}} - \sum \Delta G_{\text{reactants}}$	Used to calculate the Gibbs Free Energy (ΔG) for a reaction using tables of standardized ΔG values. Like enthalpy, ΔG will be zero for elements in their standard states ($\text{O}_{2(\text{g})}$, $\text{Mg}_{(\text{s})}$, $\text{Br}_{2(\text{l})}$, etc. - all will have $\Delta G = 0$).

	ΔG	K	E	$\Delta S_{\text{universe}}$
Product Favored	-	> 1	+	+
Reactant Favored	+	< 1	-	-

ΔH	ΔS	ΔG
-	+	- (always product favored)
+	-	+
-	-	Depends on temperature, generally product favored at low T
+	+	Depends on temperature, generally product favored at high T