△G and Pressure

We can use the methods that we have seen to determine ΔG at standard conditions. However, we frequently want to calculate ΔG at other conditions. to do this we need to understand how ΔG depends on changes to pressure and temperature. The temperature dependence of ΔG can be seen in the standard Gibb's equation. Because ΔS depends on the volume of the system it is sensitive to pressure.

$$\mathrm{G} = \mathrm{G^o} + \mathrm{RT}\ \ln(\mathrm{P})$$

We can generalize this equation to deal with all the species in a reaction by using the reaction quotient Q.

$$\Delta\mathrm{G} = \Delta\mathrm{G^o} + \mathrm{RT}\ \ln(\mathrm{Q})$$

△G and Equilibrium

We know that at equilibrium ΔG equals zero. Additionally we know that at equilibrium Q equals K.

$$\Delta\mathrm{G} = 0 = \Delta\mathrm{G^o} + \mathrm{RT}\ \ln(\mathrm{K})$$

So for a system at equilibrium ΔG° will be related to RT ln(K).

$$\Delta\mathrm{G^o} = -\mathrm{RT}\ \ln(\mathrm{K})$$

We can use this relationship to quantitatively describe the relationship between temperature and the equilibrium constant.

$$\Delta H^\circ - T\Delta S^\circ = -RT\ \ln(K)$$

$$\ln(K) = -\frac{\Delta H^\circ}{R}\left(\frac{1}{T}\right) + \frac{\Delta S^\circ}{R}$$

Ex: