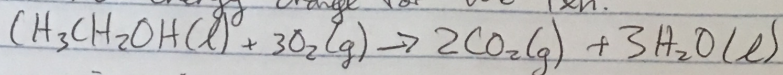


$\Delta G_{\text{rxn}}^\circ$ for a reaction can be calculated from ΔG_f° values

$$\Delta G_{\text{rxn}}^\circ = \sum n_{\text{prod.}} \Delta G_f^\circ - \sum n_{\text{react}} \Delta G_f^\circ$$

(n = stoichiometric coefficients)

Ex: Calculate free energy change for the rxn:



The std free energies are:

$$\text{O}_2 = -394.4 \text{ kJ/mol}$$

$$\text{H}_2\text{O} = -237.2 \text{ kJ/mol}$$

$$\text{CH}_3\text{CH}_2\text{OH} = -174.9 \text{ kJ/mol}$$

$$\begin{aligned}\Delta G_{\text{rxn}}^\circ &= \sum n \Delta G_f^\circ(\text{prod.}) - \sum n \Delta G_f^\circ(\text{react.}) \\ &= 2 \text{ mol}(-394.4) + 3 \text{ mol}(-237.2 \text{ kJ/mol}) \\ &= (2)(-394.4 \text{ kJ/mol}) + 3(0) \\ &= -1325.5 \text{ kJ}\end{aligned}$$

Non-standard conditions

Under non-std conditions, free energy change can be found from:

$$\Delta G = \Delta G^\circ + RT \ln Q$$

Q = react quotient

if $Q = K \Rightarrow$ at equilibrium $\Rightarrow \Delta G = 0$

$\downarrow$

$$0 = \Delta G^\circ + RT \ln K$$

$$\Delta G^\circ = -RT \ln K \quad \text{at equil.}$$

$$K = e^{-\Delta G^\circ/RT}$$

Ex: calc. the ΔG° and K at 298K for
 $2\text{NO}(\text{g}) + \text{Cl}_2(\text{g}) \rightleftharpoons 2\text{NOCl}(\text{g})$

The ΔG_f° values are:

$$\text{NOCl} = 66.07 \text{ kJ/mol}$$

$$\text{NO} = 86.6 \text{ kJ/mol}$$

$$\begin{aligned}\Delta G^\circ &= 2 \text{ mol}(66.07 \text{ kJ/mol}) - (2 \text{ mol}(86.6 \text{ kJ/mol}) + 0) \\ &= -41.06 \text{ kJ} \times 1000 \text{ J/kJ} = -41060\end{aligned}$$

$$\begin{aligned}K &= e^{-\Delta G^\circ/RT} = e^{-(-41060 \text{ J}) / (8.314 \text{ J/mol K})(298 \text{ K})} \\ &= e^{16.46} \\ &= 1.58 \times 10^7\end{aligned}$$

$K > 1 \Rightarrow$ products favored,
process spont.