5.111 Principles of Chemical Science: Week 7

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Progress Update

Over the past week I have been introduced to:

1. Bountiful notes on thermodynamics and chemical equilibrium.

More comments on Gibb's Free Energy

Recall last week it was mentioned that when Gibb's free energy, ΔG, equals zero, that a reaction is at equilibrium. A reaction is at equilibrium when its K, equilibrium constant, is equal to Q. ΔG is defined

$$\Delta G = \Delta G^\circ + RT \log(Q) \tag{1}$$

where ΔG° is dependent on the equilibrium constant,

$$\Delta G^\circ = -RT \log(K) \tag{2}$$

Reaction equilibrium

A reaction at equilibrium has reaction quotient Q equal to equilibrium constant K. We can use this to solve for the concentration(s) of reactants and products of a system at equilibrium; consider the review problem

> Phosgene ($COCl_2$) is a chemical warfare agent that decomposes by the reaction:
>
> $$COCl_2(g) \rightleftharpoons CO(g) + Cl_2(g) \qquad K = 8.3 \times 10^{-4} \text{ (at } 360°C)$$
>
> Calculate the [CO], [Cl_2], and [$COCl_2$] when 10.0 mol of phosgene decompose at 360°C and reach equilibrium in a 5.00-L flask.

By writing a RICE table, we see that we must solve for x in the equation

$$8.3 \cdot 10^{-4} = \frac{x^2}{(2-x)} \tag{3}$$

Atkins Problem

Problem: For the reaction

$$2NH_3 \leftrightarrow N_2 + 3H_2 \tag{4}$$

$K_c = 0.395$ at 350 degrees celsius. A 25.6 gram sample of NH_3 is placed in a 5 liter reaction vessel and heated to 350 degrees celsius. What are the equilibrium concentrations of the reactants and products?
Method: Get initial concentration of NH_3, write RICE table, solve the equation for x, then plug back in to placeholders.