Homework 9

1. (a) The equilibrium constant for the isomerization of cis-2-butene to trans-2-butene is $K = 2.07$ at 400 K. Calculate the standard reaction Gibbs energy. (b) The standard reaction Gibbs energy of the isomerization of cis-2-pentene to trans-2-pentene at 400 K is –3.67 kJ mol^{-1}. Calculate the equilibrium constant of the isomerization.

2. At 2257 K and 1.00 atm total pressure, water is 1.77% decomposed at equilibrium by way of the reaction $2\ H_2O(g) \leftrightarrows 2\ H_2(g) + O_2(g)$. Calculate (a) K, (b) $\Delta_r G^{\varnothing}$, and (c) $\Delta_r G$ at this temperature.

3. Dinitrogen tetraoxide is 18.46% dissociated at 25°C and 1.00 bar in the equilibrium $N_2O_4(g) \leftrightarrows 2\ NO_2(g)$. Calculate (a) K at 25°C, (b) $\Delta_r G^{\varnothing}$, (c) K at 100°C given that $\Delta_r H^{\varnothing} = +57.2$ kJ mol^{-1} over the temperature range.

4. From information in the Data Section, calculate the standard Gibbs energy and the equilibrium constant at (a) 298 K and (b) 400 K for the reaction $PbO(s) + CO(g) \leftrightarrows Pb(s) + CO_2(g)$. Assume that the reaction enthalpy is independent of temperature.

5. Calculate the percentage change in the equilibrium constant K_x of the reaction $H_2CO(g) \leftrightarrows CO(g) + H_2(g)$ when the total pressure is increased from 1.0 bar to 2.0 bar at constant temperature.

6. A sealed container was filled with 0.3 mol $H_2(g)$, 0.400 mol $I_2(g)$, and 0.200 mol HI(g) at 870 K and total pressure 1.00 bar. Calculate the amounts of the components in the mixture at equilibrium given that $K = 870$ for the reaction $H_2(g) + I_2(g) \leftrightarrows HI(g)$.

7. Express the equilibrium constant of a gas-phase reaction $A + 3\ B \leftrightarrows 2\ C$ in terms of the equilibrium value of the extent of reaction, ξ, given that initially A and B were present in stoichiometric proportions. Find an expression for ξ as a function of the total pressure, p, of the reaction mixture and sketch a graph of the expression obtained.