

Chemistry 230
Problem Set # 8 — 10/18/99

Recommended Problems: Chapt. 6: 1-6, 18, 28-33, 36, 37, 40, 41, 48

1. Use data in the Appendix to calculate the conventional chemical potential for $\text{NH}_3(g)$ at 325 K and 2.65 bar pressure. [Use the convention that $H_{m,298}^\circ = 0.0$ for elements in their standard states at 25°C.]
2. Consider the reaction, $\text{CO}(g) + \frac{1}{2} \text{O}_2(g) \rightleftharpoons \text{CO}_2(g)$. (a) Use data in the Appendix and the expression for H° found in Section 5.5 to obtain an expression for $\ln K^\circ_P(T)$ valid from 300 to 2000 K. (b) Use this expression to calculate K°_P at 1500 K.
3. Many reactions involve *dissociation* of a starting substance into products. The simplest case is
$$\text{A}(g) \rightleftharpoons 2 \text{B}(g)$$
If we start with n_0 of A, we define the degree of dissociation α as that fraction of n_0 that has dissociated when equilibrium is reached. Obtain an expression for α as a function of K°_P and P .
Dissociation reactions are almost always endothermic. How will changes in P and T affect α ?
4. Do Problem 6.9, except make the temperature 500 K, and do not neglect the T -dependence of H° . Also, calculate the degree of dissociation α under conditions where (a) the total pressure is maintained at 0.900 bar, and (b) where the pressure would be 0.900 bar if the gas remained entirely PCl_5 , but where the volume is held constant (thus yielding increased P at equilibrium). [**Hint:** The T -dependence of H° can be accommodated through Eq. 5.18, as discussed on p. 172. For the α calculations, you may need to re-express K°_P for the reaction, $\text{A}(g) \rightleftharpoons \text{B}(g) + \text{C}(g)$, since this form is appropriate for the PCl_5 dissociation.]
5. Problem 6.44 in Levine. (d) Also calculate K°_P for the reaction at 500 K and determine the equilibrium pressures of the three gases. (e) Then verify that these values indeed minimize G for the reaction.
6. Repeat the previous problem, but now hold the volume constant, and calculate the Helmholtz free energy A as a function of α . For comparison with the previous results, make the initial pressure 4.00 bar (as in problem 6.44). Determine the equilibrium pressures and verify that these minimize A for the reaction.