Chemistry 230 -- Quiz 7 (Take-home)
Due October 25, 2000 — Tellinghuisen

Pledge and signature:

1. (6) A gas mixture of 50% CO, 25% CO₂, and 25% H₂ (by moles) is introduced into a high-$T$ reaction vessel at 905°C, where they react to form an equilibrium mixture of these three plus H₂O(g).

(a) Write a balanced equation for this reaction.
(b) Use data in the appendix of Levine to calculate $\Delta H^\circ$, $\Delta G^\circ$, and $K^\circ$ for this reaction at 905°C. [Assume the heat capacities are independent of $T$ over the 25°-905°C range.]
(c) Determine the equilibrium composition of the gas mixture if the total $P$ is 1.00 atm.

2. (4) For equilibrium at high $T$, CO and CO₂ are also in equilibrium with respect to the reaction treated in Problem 2 on Problem Set 8. Use the results of that problem to calculate $K^\circ$ for this reaction at 905°C, and use this $K^\circ$ to estimate the pressure of O₂ present in the equilibrium reaction mix of Problem 1 above.

3. (6) For the gaseous dissociation reaction, $N_2 \rightleftharpoons 2$ N, $\Delta G^\circ$ is given approximately by

$$\Delta G^\circ (J) = 945,000 - 114.9 \, T.$$  

(a) Calculate $K^\circ$ at 3000 K.
(b) Calculate the equilibrium partial $P$ of N at this $T$ when the total $P = 1.00$ atm.
(c) What is the degree of dissociation $\alpha$ in this case? [Hint: See Problem 3 on PS 8.]
(d) Still at 3000 K, what is the total $P$ if the equilibrium mixture is 90 mol % N₂?

4. (4) Ammonia gas is heated to 300°C, where it partially dissociates to N₂ and H₂. At what total pressure is the equilibrium mole fraction of N₂ equal to 0.2? [Use Appendix data to estimate the needed equilibrium constant, treating the heat capacities as constant.]

5. (5) A certain amount of NOBr(g) is sealed in a flask, which is then heated to 350K, where the NOBr partially dissociates to NO(g) and Br₂(g). At equilibrium the total pressure is 0.675 atm, and the vapor density is 2.219 g/L.

(a) Write a balanced chemical equation for this dissociation, with $\nu = -1$ for NOBr.
(b) Calculate the partial pressures of the three components at equilibrium, and the equilibrium constant $K^\circ$. 