Chem 402—Physical Chemistry
Homework Problem Set—Chapter 7

1. When gaseous iodine is heated, dissociation occurs:

   $I_2 \leftrightarrow 2\ I$

   It was found that when 0.0061 mol of iodine was placed in a volume of 0.5 dm^3 at 900 K, the degree of dissociation was 0.0274. Calculate K_C and K_P at that temperature.

2. When alkanes are heated, they lose hydrogen and alkenes are produced. For example,

   $C_2H_6(g) \leftrightarrow C_2H_4(g) + H_2(g)$ $\quad K = 0.36$ at 1000 K

   If this is the only reaction that occurs when ethane is heated to 1000 K, at what total pressure will ethane be (a) 10% dissociated and (b) 90% dissociated to ethylene and hydrogen.

3. The measured density of an equilibrium mixture of N_2O_4 and NO_2 at 15 ^oC and 1.103 bar is 3.62 g L^{-1}, and at 75 ^oC and 1.013 bar is 1.84 g L^{-1}. What is the enthalpy change of the reaction $N_2O_4(g) \leftrightarrow NO_2(g)$?

4. The values of K for the following reaction are known:

   $Fe_2O_3(s) + 3\ CO(g) \leftrightarrow 2\ Fe(s) + 3\ CO_2(g)$

T (^oC)	250	1000
K	100	0.0721

   At 1120 ^oC for the reaction $2\ CO_2(g) \leftrightarrow 2\ CO(g) + O_2(g)$, K = 1.4 x 10^{-12} bar. What equilibrium partial pressure of O_2 would have to be supplied to a vessel at 1120 ^oC containing solid Fe_2O_3 just to prevent formation of Fe?

5. At 250 ^oC, 1 L of partially dissociated phosphorous pentachloride gas at 1.013 bar weighs 2.690 g. Calculate the extent of reaction ξ and the equilibrium constant.

6. Assume that the following reaction is in equilibrium at 1000 K:

   $3\ C(graphite) + 2\ H_2O(g) \leftrightarrow CH_4(g) + 2\ CO(g)$

   $\Delta_r H^o(1000\ K) = 182$ kJ mol^{-1}. (a) What will be the effect on the equilibrium composition of raising the temperature at a total pressure of 1 bar? (b) What will be the effect of raising the pressure to 5 bar? (c) What will be the effect of adding nitrogen at constant pressure of 1 bar?

7. The following data apply to the reaction $Br_2(g) \leftrightarrow 2\ Br(g)$:

T (K)	1123	1172	1223	1273
K	0.408 x 10^{-3}	1.42 x 10^{-3}	3.32 x 10^{-3}	7.2 x 10^{-3}

   Determine the reaction enthalpy at 1200 K.

8. The vapor pressure of water above a mixture of $CuCl_2 \cdot H_2O(s)$ and $CuCl_2 \cdot 2H_2O(s)$ is given as a function of temperature:

T (^oC)	17.9	39.8	60.0	80.0
P (bar)	0.0049	0.0250	0.122	0.327

(a) Calculate $\Delta_r H^o$ for the reaction

$$CuCl_2 \cdot 2H_2O(s) \leftrightarrow CuCl_2 \cdot H_2O(s) + H_2O(g)$$

(b) Calculate $\Delta_r G^o$ and $\Delta_r S^o$ for the reaction at 60 ^oC.