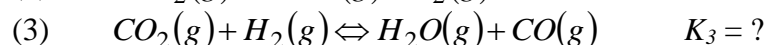
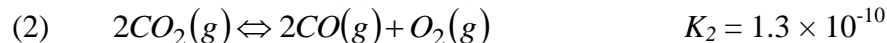
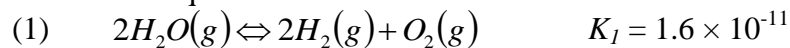


## Unit 2, Homework No. 1: Chemical Equilibria

Date issued: Monday, October 4, 2011. This homework is due on or before October 7, 5:00 pm. Late homework assignments will not be graded. Solutions will be available one day after the due date.

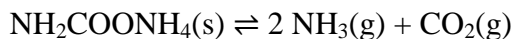
1. At 1565 K, consider the equilibrium constants for the reactions:



(a) What is the equilibrium constant for the reaction (3) at that temperature?

(b) Show that the manner in which equilibrium constants are calculated is consistent with the manner in which the  $\Delta G_r^\circ$  values are calculated when combining two or more equations by determining  $\Delta G_r^\circ$  values for (1) and (2) and using those values to calculate the  $\Delta G_r^\circ$  value and  $K_3$  for reaction (3).

2. The decomposition of ammonium carbamate,  $NH_2COONH_4$ , takes place according to the equation:



Show that if all the  $NH_3(g)$  and  $CO_2(g)$  result from the decomposition of ammonium carbamate, then  $K = (4/27)P^3$ , where  $P$  is the total pressure at equilibrium. **Hint:** you can calculate the partial pressure of a component by multiplying the mole fraction of that component by the total vapor pressure.

3. When solid  $NH_4HS$  and 0.200 mol of gaseous  $NH_3$  were placed into a 2.0 L vessel at 24 °C, the equilibrium  $NH_4HS(s) \leftrightarrow NH_3(g) + H_2S(g)$ , for which  $K = 1.6 \times 10^{-4}$ , was reached. What are the equilibrium concentrations of  $NH_3$  and  $H_2S$ ?

4. A mixture of 0.0560 mol  $O_2$  and 0.0200 mol  $N_2O$  is placed in a 1.00 L reaction vessel at 25 °C. When the reaction  $2 N_2O(g) + 3 O_2(g) \leftrightarrow 4 NO_2(g)$  is at equilibrium, 0.0200 mol  $NO_2$  is present.

(a) What are the equilibrium concentrations?

(b) What is the value of  $K$ ?

5. Calculate the pH of a buffer system containing 0.40 M  $CH_3COOH$  and 0.55 M  $CH_3COONa$ . What is the pH of the buffer after the addition of 0.10 mole of  $HCl$  to 1.0 L of the solution? Assume no change in the volume of the solutions.

6. Phosphate buffers, that is, buffers containing the phosphate group, are present in biological systems such as the blood plasma. Describe how you would prepare a phosphate buffer with a pH of 7.40, assuming ideal behavior.