CHEM-1105 CHEMICAL EQUILIBRIUM

1. Write K_c expressions for the following reactions:

   a) $Si_3N_4(s) + 4\ O_2(g) \rightleftharpoons 3\ SiO_2(s) + 2\ N_2O(g)$

   b) $SbCl_5(g) \rightleftharpoons SbCl_3(g) + Cl_2(g)$

   c) $2\ HCN(g) + 6\ H_2O(l) \rightleftharpoons 2\ NH_3(g) + 2\ CH_4(g) + 3\ O_2(g)$

2. At 25°C, the K_c for the reaction given below is 32.6.

   $6\ ClO_3F(g) \rightleftharpoons 2\ ClF(g) + 4\ ClO(g) + 7\ O_2(g) + 2\ F_2(g)$

   What is K_c for:

   $\frac{1}{3}\ ClF(g) + \frac{2}{3}\ ClO(g) + \frac{7}{6}\ O_2(g) + \frac{1}{3}\ F_2(g) \rightleftharpoons ClO_3F(g)$ **[0.559]**

3. 0.400 mole of H_2 and 1.60 mole of I_2 were placed in a 3.00 L flask and heated. At equilibrium, 60% of the H_2 had reacted. Calculate K_c for

   $H_2(g) + I_2(g) \rightleftharpoons 2\ HI(g)$ **[1.06]**

4. For the system:

   $2\ HI(g) \rightleftharpoons H_2(g) + I_2(g)$ $K_c = 0.016$ at 800 K

   If 1.00 mole of HI is placed in a 10.0 L container and allowed to come to equilibrium, what will be the concentrations of all the gases at equilibrium? **$[H_2] = [I_2] = 0.010$ M , $[HI] = 0.080$ M**

5. Sulfur trioxide decomposes according to the following reaction

   $2\ SO_3(g) \rightleftharpoons 2\ SO_2(g) + O_2(g)$

   3.50 g of SO_3 was placed in an evacuated 1.00L flask at 100.0°C. At equilibrium 43.8% of the SO_3 had decomposed. Determine K_c for the equilibrium reaction. **$[5.82 \times 10^{-3}]$**

6. At a high temperature, 0.300 moles of CH_4 was placed in a 10.0 L reaction vessel and allowed to reach equilibrium.

   $2\ CH_4(g) \rightleftharpoons C_2H_2(g) + 3\ H_2(g)$

   At equilibrium the concentration of C_2H_2 was measured to be 0.0130 mol/L. Determine the value of K_c. **[0.0482]**

7. For the equilibrium

   $2\ HI(g) \rightleftharpoons H_2(g) + I_2(g)$ $\qquad K_c = 2.5 \times 10^{-3}$ at 800°C

   0.80 mole of HI, 0.26 mole of H_2 , and 0.26 mole of I_2 were placed in a 2.0 L container at 800°C. Calculate the concentrations of all three gases at equilibrium. **[HI] = 0.60 M , [H_2] = [I_2] = 0.03 M**

8. The equilibrium constant, K_c, for the reaction

   $Br_2(g) + F_2(g) \rightleftharpoons 2\ BrF(g)$

   Is 55.3. What are the equilibrium concentrations of all the gases if the initial concentrations of Br_2 and F_2 were both 0.180 mol/L?
   [Br_2] = [F_2] = 0.038 M, [BrF] = 0.284 M

9. Bromine chloride, BrCl, a reddish gas with properties similar to Cl_2 is formed according to the reaction:
   $Cl_2(g) + Br_2(g) \rightleftharpoons 2\ BrCl(g)$ $\qquad K_c = 4.7 \times 10^{-2}$

   What % of the chlorine has reacted at equilibrium if 1.00 mole of Cl_2 and 1.00 mole of Br_2 were placed in a 5.00 L flask and allowed to reach equilibrium? **[10%]**

10. When 0.40 mole of PCl_5 is placed in a 10.0 L container, an equilibrium is established in which 0.25 mole of Cl_2 is present. Calculate K_c for the following reaction. **[0.0417]**

    $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$