Chapter 14: Equilibrium
Practice Problem Set

Given reaction:

$$2HI\ (g) \rightleftharpoons H_2\ (g) + I_2\ (g)$$

a. A system of HI, H_2, and I_2 was left to equilibrate at 445 °C. Once equilibrium was established, the concentrations of HI, H_2, and I_2 were determined to be 2.506×10^{-4} M, 1.24×10^{-3} M, and 3.24×10^{-3} M, respectively. Calculate K_c at this temperature.

b. What is K_p at this temperature?

c. Draw a plot of the concentration of the reactants and products over time, assuming we began with 1M of HI.

d. If the partial pressures of HI and H_2 are found to be 3.01×10^{-3} atm and 2.04×10^{-2} atm at equilibrium, respectively, what would the partial pressure of I_2 be?

e. Calculate Q when [HI] = 2.11×10^{-4} M and [H_2] = 2.10×10^{-3} M and [I_2] = 3.4×10^{-3} M. Is the system at equilibrium? If no, in which direction is the reaction predominately proceeding?

f. How would the system respond if the volume of the reaction flask was decreased without changing the amount of reactants added?

The dissolution of $AgSO_4$, which is known to be sparingly soluble in water, is given by:

$$Ag_2SO_4\,(s) \rightleftharpoons 2Ag^+\,(aq) + SO_4^{2+}\,(aq)$$

What will the concentration of SO_4^{2-} and Ag^+ be at equilibrium when 0.342 g of Ag_2SO_4 is added to 10 L of water?

For the following scenarios, indicate which direction the equilibrium will shift when the "stressor" indicated is introduced?

(a) $CaF_2\,(s) \rightleftharpoons Ca^{2+}\,(aq) + 2\,F^-\,(aq)$; $K_{sp} = 3.44 \times 10^{-11}$

(i) Additional water is added to a system at equilibrium

(ii) $Ca(NO_3)_2$ is added

(b) $CO\,(g) + H_2\,(g) \rightleftharpoons CH_3OH\,(l)$; $K = 6.676 \times 10^{-6}$ at 298 K

(i) The volume of the reaction chamber is compressed

(ii) More H_2 is added

(c) NH_3 (aq) ⇌ NH_4^+ (aq) + OH^- (aq); $K_b = 1.8 \times 10^{-5}$

(i) The solution is basified with NaOH

(ii) The solution is acidified with HCl

(d) $MgSO_4$ (s) ⇌ Mg^{2+} (aq) + SO_4^{2-} (aq); $K_{sp} = 5.9 \times 10^{-3}$; $\Delta H = -91.38$ kJ/mol

(i) The solution is heated

(ii) The solution is cooled

(iii) Solid $BaSO_4$ is added to the reaction flask