Week 6 Problems – February 13, 2019

1. A certain partial pressure of A is added to a rigid vessel and allowed to react until it reaches equilibrium. At equilibrium the pressure of A_2 is found to be 8.0 x 10^{-3} bar. What was the initial partial pressure of A?

   $2A\ (g) \rightleftharpoons A_2\ (g)$ $\qquad K_p = 6.9 \times 10^{-3}$

2. For the reaction below, 4.5 moles of each reactant is added to a 2.0 L aqueous solution and allowed to reach equilibrium. What is the concentration of B_2 at equilibrium?

   $2A + 4B \rightleftharpoons A_2B + 2B_2$ $\qquad K_c = 3.4 \times 10^{-7}$

3. For the reaction below, 3.0 bar of every species is added to a rigid vessel and allowed to reach equilibrium. What is the pressure of A at equilibrium?

   $2A\ (g) \rightleftharpoons B\ (g) + C\ (g)$ $\qquad K_p = 2.6 \times 10^{-2}$

4. Baking soda (sodium bicarbonate) decomposes according to the following endothermic reaction ($\Delta H = 129.2$ kJ mol^{-1}):

   $2NaHCO_3(s) \rightleftharpoons Na_2CO_3(s) + CO_2(g) + H_2O(g)$

   What effect would each of the following have on the reaction? (i.e. which way would the equilibrium shift?)
   a. Increasing the volume of the reaction vessel
   b. Increasing the external pressure (by adding inert gas)
   c. Increasing the temperature of the reaction vessel
   d. Opening the reaction vessel to the atmosphere
   e. Condensing the gaseous water and removing it from the system

5. Why is the acetate ion, CH_3COO^-, a base according to the Bronsted-Lowry model?
   a. What is the conjugate acid of CH_3COO^-?
   b. Write a balanced equation in which CH_3COO^- acts as a base in water.

6. Complete the table below:

$[H_3O^+]$	$[OH^-]$	pH	pOH
1.00 x 10^{-7} M			
	3.21 x 10^{-12} M		
			4.64

7. Write the dissociation reaction and corresponding K_a equilibrium expression for each of the following acids in water.
   a. HCN
   b. HOC_6H_5
   c. $C_6H_5NH_3^+$

8. For each of the following aqueous reactions, identify the acid, the base, the conjugate base, and the conjugate acid
   a. $Al(H_2O)_6^{3+} + H_2O \rightleftharpoons H_3O^+ + Al(H_2O)_5\ (OH)^{2+}$
   b. $H_2O + HONH_3^+ \rightleftharpoons HONH_2 + H_3O^+$
   c. $HOCl + C_6H_5NH_2 \rightleftharpoons OCl^- + C_6H_5NH_3^+$

9. Calculate [H+] in the following solutions at 25°C. Identify each solution as neutral, acidic, or basic.
   a. $[OH^-] = 1.5$ M
   b. 10.5 g of potassium hydroxide in 250.0 mL aqueous solution
   c. $[OH^-] = 1.0 \times 10\text{-}7$ M
   d. [NaOH] = 7.3 x 10-4 M
10. Consider the following exothermic reaction at equilibrium. Predict how the following changes affect the number of moles of each component (at equilibrium) by completing the table below (use the terms increase, decrease, or no change).

$$N_2\,(g) + 3H_2\,(g) \rightleftharpoons 2NH_3$$

	N_2	H_2	NH_3
Add N_2			
Remove H_2			
Add HCl			
Add Ne (g) – At constant volume			
Increase the temperature			
Decrease the volume			
Add a catalyst			