Unit 4: Gaseous Equilibrium Review WS

1. A mixture of SO_2, O_2, and SO_3 at 1000 K contains the gases at the following concentrations: $[SO_2] = 5.0 \times 10^{-3}$ M, $[O_2] = 1.9 \times 10^{-3}$ M, $[SO_3] = 6.9 \times 10^{-3}$ M. Kc = 279 at 1000 K.
   a. Which way will the reaction $2\ SO_2(g) + O_2(g) \leftrightarrow 2\ SO_3(g)$ shift to reach equilibrium?
   b. What is the value of Kp at this temperature?

2. $CO_2(g) + H_2(g) \leftrightarrow CO(g) + H_2O(g)$
   Laboratory measurements at 986°C show that there is 0.110 mol of each of CO and H_2O and 0.0870 mol each of H_2 and CO_2 at equilibrium in a 1.0 L container.
   a. Calculate the Kc at this temperature.
   b. Calculate the total pressure in the container at equilibrium.
   c. If 0.100 mol of H_2 and 0.100 mol of CO_2 are added to the equilibrium mixture, then calculate the equilibrium concentrations for all gases after equilibrium is reestablished according to Le Chatelier's Principle.

3. $2\ NO(g) + O_2(g) \leftrightarrow 2\ NO_2(g) + \text{heat}$
   Predict the shift that will occur with each of the following changes.
   a. Adding more O_2
   b. Removing NO
   c. Increasing temperature
   d. Decreasing volume

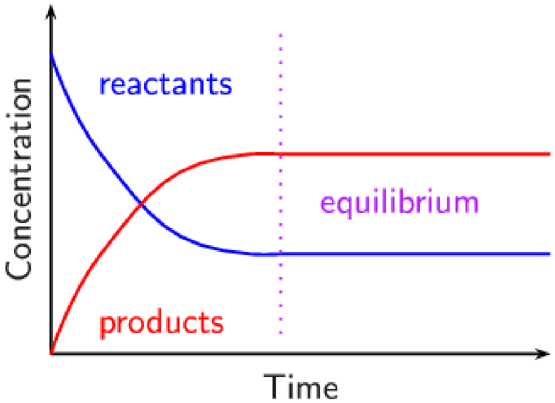
4. Calculate Kc for the reaction: $Fe(s) + H_2O(g) \leftrightarrow FeO(s) + H_2(g)$
   Given the following information:

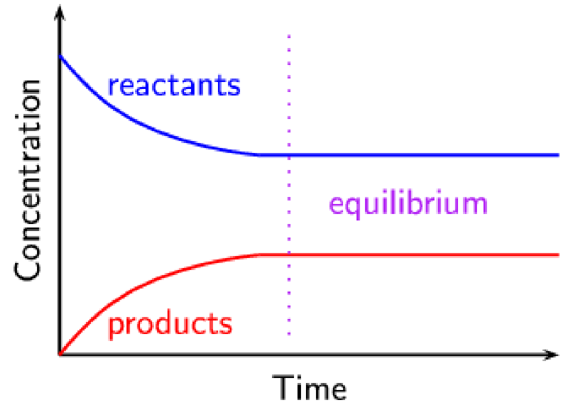
   $CO_2(g) + H_2(g) \leftrightarrow CO(g) + H_2O(g)$ Kc = 0.625
   $2\ Fe(s) + 2CO_2(g) \leftrightarrow 2\ FeO(s) + 2\ CO(g)$ Kc = 2.25

$$NH_4HS(s) \leftrightarrow NH_3(g) + H_2S(g)$$

5. The Kc value for the decomposition of solid NH_4HS is 1.8×10^{-4} at 25°C.
   a. When 1.0 mol of the solid is placed in a 1.0 L flask it decomposes according to the equation above. What are the equilibrium concentrations of the two gases?
   b. What is the total pressure at equilibrium?
   c. What is the percent of NH_4HS decomposed when equilibrium is reached?
   d. What is the percent of NH_4HS that remains?

6. Identify each graph as either reactant favored or product favored. Then give an appropriate K value for each.





7. What is the expression for Kc of the following reaction?

$$H_2(g) + I_2(g) \leftrightarrow 2HI(g) \qquad \Delta H° > 0$$

   a. $Kc = \dfrac{[I_2][H_2]}{[HI]}$

   b. $Kc = \dfrac{[2HI]}{[H_2][I_2]}$

   c. $Kc = \dfrac{[HI]}{[H_2] + [I_2]}$

   d. $Kc = \dfrac{[HI]^2}{[H_2][I_2]}$

8. Under which of the following conditions does the equilibrium constant change for the reaction in Question 7?
   a. Changing the size of the container
   b. Introducing more I_2 into the container
   c. Changing the temperature
   d. Changing the concentration of HI
   e. None of the above, it is always constant

9. Ammonia is produced commercially by the Haber process in which nitrogen and hydrogen react by the reaction: $N_2(g) + 3H_2(g) \leftrightarrow 2NH_3(g)$ + heat

   Once the system is at equilibrium, which of the following changes will NOT result in a shift to the product side?

   a. Removal of ammonia
   b. Addition of nitrogen
   c. Decreasing the size of the container
   d. Removal of hydrogen
   e. Decreasing the temperature