PLI #5
7/15/21
Note: this worksheet is primarily based on class content from Wednesday.

1. The mechanism for the reaction of CH_3OH and HBr is believed to involve two steps. The overall reaction is exothermic.

   Step 1: $CH_3OH + H^+ \leftrightarrow CH_3OH_2^+$ (fast)
   Step 2: $CH_3OH_2^+ + Br^- \rightarrow CH_3Br + H_2O$ (slow)

   a. Write the overall reaction equation.

   b. What is the overall rate law, given that intermediates should not appear in the rate law?

2. An important exothermic reaction in the production of hydrogen is:

$$CO\ (g) + H_2O\ (g) \leftrightarrow H_2\ (g) + CO_2\ (g)$$

At equilibrium, how will the system shift (left, right, or no shift) in the following five cases?

   a. Gaseous carbon dioxide is removed

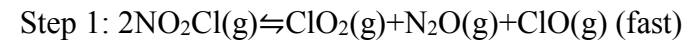
   b. Water vapor is added

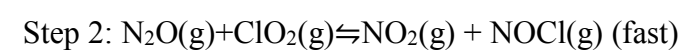
   c. Temperature is increased

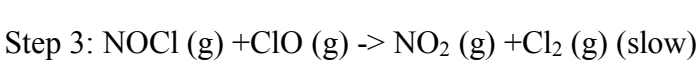
   d. Pressure is increased by decreasing the volume

   e. Gaseous hydrogen is removed

3. Nitryl chloride (NO2Cl) decomposes to nitrogen dioxide (NO2) and chlorine gas (Cl2) according to the following mechanism:







   a. Determine the overall reaction

   b. Write the rate law expression for each elementary reaction, including reverse if applicable.

   c. Identify any intermediates

   d. Determine the overall rate law expression

4. True or false!
    a. (T / F) The equilibrium constant can never be a negative number

    b. (T / F) In reactions with a single-headed arrow, the equilibrium constant has a value that is very close to zero.

    c. (T / F) As the value of the equilibrium constant increases, the speed at which the reaction reaches equilibrium increases.

5. Write the expression for Kc for the following reactions.
    a. $\mathrm{Ni(CO)_4}(g) \leftrightarrow \mathrm{Ni}\ (s) + 4\ \mathrm{CO}\ (g)$

    b. $H_2O\ (l) + H^+(aq) + OH^-(aq)$

    c. $2\mathrm{Ag}\ (s) + \mathrm{Zn}^{2+}(aq) \leftrightarrow 2\mathrm{Ag}^+(aq) + \mathrm{Zn}(s)$

    Bonus: given the equation for b, what else do we know about Kc in this reaction?

6. You place 9.61 mol of pure SO3 in an 8.0 L flask at 1000 K. At equilibrium, 0.78 mol of O2 has been formed. Calculate Kc for the reaction at 1000 K: