1125 Review Session

Q center

Exam 5

1. Consider the following reaction: $BF_3(g) + NH_3(g) \rightarrow BF_3NH_3(g)$

   The reaction is first order in BF3 and first order in NH3. Write the rate expression for the reaction:

   Rate = k[BF3][NH3]

2. At a certain temperature, 0.860 mol SO3 is placed in a 3.00 L container.

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

   At equilibrium, 0.140 mol O_2 is present. Calculate Kc.

Initial	0.860	0	0
Change	-2x=-2(0.140)	+2x=2(0.140)	+0.140=x
Equilibrium	0.860-0.280=0.580	0.280	0.140

   Molarity:

$$[SO_3]_{eq} = \frac{0.580\ mol}{3.00L} = \mathbf{0.193\ M}$$

$$[SO_2]_{eq} = \frac{0.280\ mol}{3.00L} = \mathbf{0.0933\ M}$$

$$[O_2]_{eq} = \frac{0.140\ mol}{3.00L} = \mathbf{0.0467\ M}$$

   K

$$K_c = \frac{[SO_2]_{eq}^2[O_2]_{eq}}{[SO_3]_{eq}^2}$$

$$\boldsymbol{K_c} = \frac{\mathbf{0.0933^2 * 0.0467}}{\mathbf{0.193^2}} = \mathbf{0.0109}$$

3. Calculate the equilibrium constant for the reaction:

   $$Q_{(g)} + X_{(g)} \rightleftharpoons 2M_{(g)} + N_{(g)}$$

   Given that:

$$M_{(g)} \rightleftharpoons Z_{(g)} \qquad K=3.33$$
$$6R_{(g)} \rightleftharpoons 2N_{(g)}+4Z_{(g)} \qquad K=0.463$$
$$3X_{(g)}+3Q_{(g)} \rightleftharpoons 9R_{(g)} \qquad K=11.7$$

To get the desired reaction it is necessary to modify the given reactions. First, the desired reaction has Q and R as reactants with a coefficient of 1. Reaction 3 has Q and R as reactant but with a coefficient of 3. Thus, Reaction 3 needs to be divided into 3 (factor of 1/3). Then, M is a product in the desired reaction with a coefficient of 2. Reaction 1 has M as a reactant with a coefficient of 1. Therefore, Reaction 1 is reversed and multiplied by 2. Finally, the desired reaction has N as a product with 1 as a coefficient so Reaction 2 needs to be divided by 2 (factor ½). Thus:

$$2Z_{(g)} \rightleftharpoons 2M_{(g)} \qquad K=(1/3.33)^2=0.0902$$
$$3R_{(g)} \rightleftharpoons N_{(g)}+2Z_{(g)} \qquad K=(0.463)^{1/2}=0.680$$
$$X_{(g)}+Q_{(g)} \rightleftharpoons 3R_{(g)} \qquad K=(11.7)^{1/3}=2.27$$

And:

$$\mathbf{Q_{(g)}+X_{(g)} \rightleftharpoons 2M_{(g)}+N_{(g)} \qquad K=(0.0902)(0.680)(2.27)=0.139}$$

4. Which of the following will increase the concentration of reactants for the following reaction:

$$CH_3NH_{2(aq)}+H_2O_{9l0} \rightleftharpoons CH_3NH_{3(aq)}^{+}+OH^{-}_{(aq)}$$
$$\Delta H^{o}_{rxn}=103 \text{ kJ/mol}$$

   a. **Adding more KOH**
   b. Adding KBr
   c. Increasing the temperature
   d. **Adding CH_3NH_3Br**
   e. Adding HBr

5. Consider this equilibrium reaction:

$$Br_{2(g)}+Cl_{2(g)} \rightleftharpoons 2BrCl_{(g)} \qquad K_c=7.0$$

If the composition of the reaction mixture at 400 L is [BrCl]=0.00581 M, [Br_2]=0.00216 M, and [Cl_2]=0.000396, predict to what side the reaction shifts to get to the equilibrium.

$$Q=\frac{[BrCl]^2}{[Br_2][Cl_2]}$$
$$Q=\frac{0.00581^2}{(0.00216)(0.000396)}=39.6$$

Q>K reaction shifts to the left, reactants.

6. For the following reactions determine whether the forward or reverse reaction is favored:

   a. $Ag_2CrO_{4(s)} \rightleftharpoons 2Ag^{+}_{(aq)}+ CrO_4^{2-}{}_{(aq)}$ $\qquad K=1.1 \times 10^{-12}$
      Reverse reaction favored
   b. $2NO_{(g)}+O_{2(g)} \rightleftharpoons 2NO_{2(g)}$ $\qquad K=2.5 \times 10^{10}$
      Forward reaction favored
   c. $HCN_{(aq)} +OH^{-}_{(aq)} \rightleftharpoons CN^{-}_{(aq)}+H^{+}_{(aq)}$ $\qquad K=5.1 \times 10^{-8}$
      Reverse reaction favored

7. At 25 °C gaseous I_2 and Cl_2 react to form ICl.

$$I_{2(g)} + Cl_{2(g)} \leftrightharpoons 2ICl_{(g)} \qquad K_p = 9.1$$

Suppose that a sealed container initially contains 0.250 atm of I_2 and 0.250 M of Cl_2. Calculate the equilibrium partial pressures of I_2, Cl_2 and ICl at this temperature:

Initial	0.250	0.250	0
Change	-x	-x	+2x
Equilibrium	0.250-x	0.250-x	2x

$$K_P = \frac{P_{2ICl}}{P_{I_2}P_{Cl_2}} = 9.1$$
$$\frac{(2x)^2}{(0.250 - x)^2} = 9.1$$
$$\frac{2x}{0.250 - x} = 3.017$$
$$2x = 3.017(0.250 - x)$$
$$2x = 0.754 - 3.017x$$
$$2x + 3.017x = 0.754$$
$$5.017x = 0.754$$
$$x = 0.150$$

$$\boldsymbol{[I_2]_{eq} = 0.250 - 0.100 = 0.100\ atm}$$
$$\boldsymbol{[Cl_2]_{eq} = 0.250 - 0.100 = 0.100\ atm}$$
$$\boldsymbol{[ICl]_{eq} = 2 * 0.150 = 0.300\ atm}$$

8. SOCl2 dissociates into SO2 and Cl2 via the following reaction:

$$SOCl_{2(g)} \leftrightharpoons SO_{2(g)} + Cl_{2(g)} \qquad K_p = 1.23x10^{-6}$$

At 500 K.
Calculate K_C for this reaction at 500 K

$$K_P = K_c(RT)^{\Delta n}$$
$$K_c = \frac{K_P}{(RT)^{\Delta n}}$$
$$K_c = \frac{1.23x10^{-6}}{(0.08206 * 500)^1}$$
$$\boldsymbol{K_c = 2.998x10^{-8}}$$