**Worksheet #11 Review, Ktrial, & Size of Keq**

1. 2 CrO4-2 (aq) + 2H+ (aq) ⇌ Cr2O7-2 (aq) + H2O (l)

Calculate the Keq if the following amounts were found at equilibrium in a 2.0L volume. CrO4-2 = .030 mol, H+ = .020 mol, Cr2O7-2 = 0.32 mol, H2O = 110 mol

**Do not count water. It is a liquid!!**

**Keq = (0.16)**

 **(0.015)2(0.010)2**

**Keq = 7.1 X 106**

1. PCl5 (s) + H2O (g) ⇌ 2HCl (g) + POCl3 (g) Keq= 11

At equilibrium the 4.0L flask contains the indicated amounts of the three chemicals.

PCl5 = .012 mol H2O = 0.016 mol HCl = 0 .120 mol Calculate [POCl3].

 **Keq = [HCl]2[POCl3]**

 **[H2O]**

 **11 = [0.030]2[POCl3]**

 **[.0040]**

**[POCl3] = (11)(0.0040)**

 **[0.030]2**

**[POCl3] = 49**

1. 6.0 moles H2S are placed in a 2.0L container. At equilibrium 5.0 moles H2 are present. Calculate the Keq

**2H2S (g) ⇌ 2H2 (g) + S2 (g)**

**I 3.0 0 0**

**C 2.5 2.5 1.25**

**E 0.5 2.5 1.25**

 **Note the loss of 1 significant digit**

 **Keq = (2.5)2(1.25)**

 **(0.5)2**

**Keq = 3 x 101**

 4.0 moles H2 and 2.0 moles Br2 are placed in a 1.0L container at 180oC. If the [HBr] = 3.0 M at equilibrium, calculate the Keq.

**H2 (g) + Br2 (g)** ⇌ **2HBr (g)**

 **I 4.0 2.0 0**

 **C -1.5 -1.5 +3.0**

 **E 2.5 0.5 3.0**



**Keq = (3.0)2 Note the loss of significant digits here (2.5)(.5)**

**Keq = 7**

1. At 2000C, Keq= 11.6 for 2NO(g) ⇌ N2 (g) + O2 (g). If some NO is placed in a 2.0 L vessel and the equilibrium [N2] = 0.120 M,

calculate all other equilibrium concentrations

 **2NO(g)** ⇌ **N2 (g) + O2 (g)**

**I x 0 0**

 **C 0.240 0.120 0.120**

 **E x – 0.240 0.120 0.120**

 **(0.120)2 = 11.6**

 **(x – 0.240)2**

 **0.120 = 3.4058**

 **x – 0.240**

 **x = 0.275 M**

**[N2] = [O2] = 0.120 M [NO] = 0.035 M**

1. At 800oC, Keq = 0.279 for CO2 (g) + H2 (g) ⇌ CO (g) + H2O (g).

If 2.00 moles CO( g) and 2.00 moles H2O (g) are placed in a 500 ml container, calculate all equilibrium concentrations.

 Note that when two products are placed in a container it shifts to the left to get to equilibrium.

 **CO2 (g) + H2 (g)** ⇌ **CO (g) + H2O (g).**

 **I 0 0 4.00 4.00**

 **C x x x x**

 **E x x 4.00 - x 4.00 - x**

 **0.279 = (4-x)2**

 **(x)2**

 **0.5282 = 4 - x**

 **x**

 **0.5282x = 4 – x**

 **1.5282x = 4**

 **[CO2] = [H2] = x = 2.62 M**

 **[CO] = [H2O] = 4.00 - x = 1.38M**

1. CO(g) + H2O(g) ⇌ CO2(g) + H2(g)  Keq= 10.0 at 690oC. If at a certain time [CO] = 0.80M, [H2O] = 0.050M, [CO2] = 0.50M and [H2] = 0.40M, is the reaction at equilibrium? If not, how will it shift in order to get to equilibrium

 **Ktrial = 5 Keq = 10 -therefore the reaction is not at equilibrium and shifts right**

1. For the reaction: CO (g)+ H2O(g)⇌ CO2(g)+ H2(g) Keq= 10.0 at 690oC. The following concentrations were observed: [CO] =2.0M, [H2] = 1.0M, [CO2]=2.0M, [H2O] = 0.10M. Is the reaction at equilibrium? If not, how will it shift in order to get to equilibrium?

 **Ktrial = 10 Keq = 10 - therefore the reaction is at equilibrium**

1. For the same equation above the following concentrations were observed: [CO] = 1.5M, [H2] = 1.2, [CO2] = 1.0M, [H2O] = .10M. Is

the reaction at equilibrium? If not, how will it shift in order to get to equilibrium?

 **Ktrial = 8 Keq = 10 -therefore the reaction is not at equilibrium and shifts right**

1. At a certain temperature the Keq for a reaction is 75. 2O3(g) ⇌ 3O2(g)

Predict the direction in which the equilibrium will proceed, if any, when the following amounts are introduced to a 10 L vessel. a) 0.60 mole of O3 and 3.0 mol of O2

**Ktrial = (0.30)3 = 7.5 < Keq Therefore the reaction will shift to the right to reach equilibrium.**

 **(0.060)2**

b) 0.050 mole of O3 and 7.0 mol of O2

**Ktrial = (0.70)3 = 13720 > Keq Therefore the reaction will shift to the left to reach equilibrium.**

 **(0.0050)2**

) 1.5 mole of O3 and no O2

**Ktrial = (0)3 = 0 < Keq Therefore the reaction will shift to the right to reach equilibrium.**

 **(0.15)2**

1. Consider the following equilibrium:

* + 1. 2NO2 (g) ⇌ N2O4 (g) Keq = 2.2
		2. Cu2+(aq) + 2Ag(s) ⇌ Cu(s) + 2Ag+ (aq) Keq = 1 x 10-15 **Favors reactants to the greatest extent**
		3. Pb2+ (aq) + 2 Cl- (aq) ⇌ PbCl2(s) Keq = 6.3 x 104 **Favors products to the greatest extent**
		4. d) SO2(g) + O2 (g) ⇌ SO3 (g) Keq = 110

* + 1. Which equilibrium favors products to the greatest extent?
		2. Which equilibrium favors reactants to the greatest extent?

1. What is the only way to change the value of the Keq?

 **The only way to change the value of the Keq is by changing the temperature.**

1. In the reaction: A + B ⇌ C + D + 100kJ, what happens to the value of Keq if we increase the temperature?

 **The Keq will decrease.**

1. If the value of Keq decreases when we decrease the temperature, is the reaction exothermic or endothermic?

 **The reaction is endothermic.**

1. In the reaction; W + X + 100kJ ⇌ Y + Z, what happens to the value of Keq if we increase the [X]? Explain your answer.

 **The Keq will remain the same because the only way to change Keq is by changing the temperature.**

1. If the value of Keq increases when we decrease the temperature, is the reaction exothermic or endothermic?

 **The reaction is exothermic.**

1. Predict whether reactants of products are favored in the following equilibrium systems

* + 1. CH3COOH(aq) ⇌ H+(aq) + CH3COO-(aq) Keq = 1.8 x 10-5 **Reactants**
		2. H2O2(aq) ⇌ H+(aq) + HO2(aq) Keq = 2.6 x 10-12 **Reactants**
		3. CuSO4(aq) + Zn(s) ⇌ Cu(s) + ZnSO4(aq) Keq = 1037 **Products**

18.) What effect will each of the following have **on the Keq** of the reaction shown below:

**2NO2(g) + heat** ⇌ **N2O4(g) Keq = 2.2**

1. adding a catalyst **Remains constant**
2. increasing the concentration of a reactant **Remains constant**
3. increasing the concentration of a product **Remains constant**
4. decreasing the volume **Remains constant**
5. decreasing the pressure **Remains constant**
6. increasing the temperature **Increases**
7. decreasing the temperature **Decreases**