**Name: Period: Seat#:**

**Worksheet #7**

**Directions:** Complete the following chart by choosing from the following options:  
Equilibrium Shift: *left, right, no change ∆* [ ] / Temp: *increase, decrease, no change ∆* Keq: *no, yes*

**A (g) + B (aq) ↔ C (s) ∆Hrxn = 453 kJ**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Stressor** | **Eq. Shift** | **∆ [A]** | | **∆ [B]** | **∆ [C]** | **∆ Temp** | **∆ Keq** |
| 1. The pressure of A in the reaction chamber is increased |  |  | |  |  |  |  |
| 1. The temperature of the reaction is increased by 20°C |  |  | |  |  |  |  |
| 1. A catalyst is added to the system |  |  | |  |  |  |  |
| 1. As the reaction progresses, more of compound B is steadily added to the reaction chamber |  |  | |  |  |  |  |
| 1. An inhibitor is added to the reaction chamber |  |  | |  |  |  |  |
| 1. Argon gas is added to the reaction chamber, doubling the pressure |  |  | |  |  |  |  |
| 1. Why are solids and liquids not included in Keq expressions? | | | 1. Write the equilibrium constant expression for Keq   4H3O+(aq) + 2Cl -(aq) + MnO2(s)↔Mn2+(aq)+ 6H2O(l) + Cl2 g) | | | | |
| 1. Suppose that for the unbalanced reaction: \_\_\_\_N2 (g) + \_\_\_\_Cl2 (g) ↔ \_\_\_\_NCl3 (g) it is determined that, at a particular temperature, the equilibrium concentrations are [N2] = 0.000104 M, [Cl2] = 0.000201 M, and [NCl3] = 0.141 M. Calculate that value of Keq for the reaction at this temperature. | | | | | | | |
| 1. Gaseous phosphorus pentachloride decomposes to chlorine gas and gaseous phosphorus trichloride. In a certain experiment, at a temperature where Keq = 8.96E-2, the equilibrium concentrations of PCl5 and Cl2 were found to be 5.67E-3M and 0.233M, respectively. Calculate the concentration of PCl3 present at equilibrium. | | | | | | | |
| 1. C2H4 (g) + H2 (g) ↔ C2H6 (g) Kc = 0.99 The initial concentrations of C2H4 (g), is 0.335M and that of hydrogen is 0.526M, and there is no C2H6 at the start. Which direction will the reaction shift to reach equilibrium (show the calculation – Hint: K vs Q)? What is the concentration for each substance at equilibrium? *[C2H4] = 0.236 M, [H2] = 0.427 M, [C2H6] = 0.0995 M* | | | | | | | |
| 1. 2NO (g) + 2H2 (g) ↔ N2 (g) + 2H2O (g) Determine the value of the equilibrium constant, Kc, for the reaction. Initially a mixture of 0.100 M NO, 0.050 M H2, 0.100 M H2O was allowed to reach equilibrium (initially there was no N2). At equilibrium the concentration of NO was found to be 0.062 M *6.5E2* | | | | | | | |
| 1. N2O4 (g) ↔ 2NO2 (g) A reaction flask is charged with 3.00 atm of dinitrogen tetraoxide gas and 2.00 atm of nitrogen dioxide gas. At 25°C, the gases are allowed to reach equilibrium. The pressure of the nitrogen dioxide was found to have decreased by 0.952 atm. Estimate the value of Kp for this system. *3.16* | | | | | | | |
| 1. HSO4-(aq) + H2O(l) ↔ H3O+(aq) + SO42-(aq) K = 1.2 x 10-5  The initial concentrations are [HSO4-] = 0.50M, [H3O+] = 0.020M, [SO42-] = 0M.    1. Which way would the reaction shift to reach equilibrium? (show the calculation – Hint: K vs Q)    2. What are the equilibrium concentrations of the products and the reactants? | | | | | | | |
| 1. For the unbalanced reaction: \_\_\_\_N2 (g) + \_\_\_\_ H2 (g) ↔ \_\_\_\_NH3 (g) show your calculations for Keq given the following equilibrium concentrations during each of the three experiments below:  |  |  |  |  | | --- | --- | --- | --- | | **Experiment #1** | [N2] = 0.921 M | [H2] = 0.763 M | [NH3] = 0.157 M | | **Experiment #2** | [N2] = 0.399 M | [H2] = 1.197 M | [NH3] =0.203 M | | **Experiment #3** | [N2] = 2.59 M | [H2] = 2.77 M | [NH3] =1.82 M |   What does the value of Keq tell you about the relative concentrations of the reactants versus the products at equilibrium? Explain why. (Hint: Large Keq vs Small Keq) | | | | | | | |

**Ksp – Solubility Product** **Constant**

The solubility product constant, Ksp​, is the equilibrium constant for a solid substance dissolving in an aqueous solution. It represents the level at which a solute dissolves in solution. The more soluble a substance is, the higher the Ksp value it has.

In order to determine the Ksp of a substance you need to write the dissociation reaction first. You write the Ksp equation the same way as a normal Keq - products over reactants, and solids do not factor into the equations.

Do not forget to balance your dissociation reactions! The coefficients are the exponents in your Ksp equations so the balancing matters!

*Examples:*

Sn(OH)2 (s) ↔ Sn2+ (aq) + 2OH- (aq) Ksp = [Sn2+][OH-]2

Ag2CrO4 (s) ↔ 2Ag+ (aq) + CrO42- (aq) Ksp = [Ag+]2 [CrO42-]

Fe(OH)3 (s) ↔ Fe3+ (aq) + 3OH- (aq) Ksp = [Fe3+] [OH‑]3

|  |  |
| --- | --- |
| **Balanced Dissociation Equation** | **Ksp Expression** |
| 1. Lead (II) Chloride (s) |  |
| 1. Silver dichromate (s) |  |
| 1. Strontium phosphate (s) |  |
| 1. Cu3(PO4)2 (s) |  |
| 1. CuSCN (s) |  |
| 1. CdS (s) |  |

1. Explain the differences between equilibrium constant (Keq) and solubility product constant (Ksp)

1. If iron (III) phosphate (s) has a Ksp value of 1.3E-22, do you expect it to be considered “soluble” or “insoluble” on an old fashioned solubility chart like we used first semester (R-25)? Justify your answer.