**Name : \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Equilibrium and LeChatelier’s Principle**

Background Information: Equilibrium exists when the rates of the forward and reverse reactions are equal. When a stress is added to the reaction, the rates are no longer equal. The reaction will proceed in such a way to make the rates back to equal and establish a new equilibrium. This is known as LeChatelier’s principle.

Guiding Questions: What changes stress equilibrium reactions and how can you determine the shift in equilibrium using observations?

Pre-Lab Questions: Using the following reaction, predict the direction the reaction will shift to establish a new equilibrium:

**6CO2(g) + 6H2O(l)** ↔ **C6H12O6(s) + 6O2(g) ΔH = +2820KJ**

1. Carbon dioxide is added. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

2. The temperature is raised. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

3. Oxygen is removed. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Materials: 0.002M KSCN, Bromothymol blue, KSCN, 0.1M AgNO3, CoCl2**.**6H2O, 12M HCl, 0.1MHCl, 0.1M NaOH, 0.2M Fe(NO3)3, C2H5OH, Na2HPO4, CaCl2, test tubes, rack and holder, beaker, stirring rod, cylinders, pipets.

Procedure: Start at your assigned lab station and perform the task outlined below. At the commands of your teacher move to the next lab station and perform the task outlined below. Continue until each task is completed. Always provide observations and the direction the reaction shifted.

Station One: Equilibrium of Acid Base Indicators  **HIN(aq)** ↔ **H+ + IN-**

1. Fill a test tube half way with water. **Yellow** ↔ **blue**
2. Add 10 drops of bromothymol blue indicator.
3. Add 5 drops of 0.1M HCl to the solution and record observations.
4. Add 0.10M NaOH drop wise until a reaction is observed. Record observations.
5. Dispose of chemicals down the drain with lots of water.
6. Place test tubes in tray upside down to dry.

**Hypothesis:**

**The reaction will shift to the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ when HCl was added.**

**The reaction will shift to the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ when NaOH was added.**

**Observations:**

**Step 2: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Step 3: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Step 4: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Conclusions:**

**The reaction shifted to the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ when HCl was added because HCl adds \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and removes \_\_\_\_\_\_\_\_\_\_\_\_\_\_.**

**The reaction shifted to the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ when NaOH was added because NaOH removes \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and creates \_\_\_\_\_\_\_\_\_\_\_\_\_\_.**

Station Two: Equilibrium of Complex Ions **Fe+3 + SCN-** ↔ **FeSCN+2**

1. Pour KSCN solution into 3 separate test tubes, 1/5 way filled. **Clear** ↔ **Red**
2. Into the first test tube add 2 crystals of solid KSCN. Record observations.
3. Into the second test tube add 6 drops of Fe(NO3)3 solution. Record observations.
4. Into the third test tube add 2 crystals of Na2HPO4. Record observations.
5. Dispose of chemicals down the drain with lots of water.
6. Place test tubes in tray upside down to dry.

**Hypothesis:**

**The reaction will shift to the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ when KSCN was added.**

**The reaction will shift to the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ when Fe(NO3)3** **was added.**

**The reaction will shift to the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ when Na2HPO4****was added.**

**Observations:**

**Step 2: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Step 3: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Step 4: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Conclusions:**

**The reaction shifted to the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ when KSCN was added because KSCN adds \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and creates \_\_\_\_\_\_\_\_\_\_\_\_\_\_.**

**The reaction shifted to the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ when Fe(NO3)3** **was added because Fe(NO3)3** **adds \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and creates \_\_\_\_\_\_\_\_\_\_\_\_\_\_.**

**The reaction shifted to the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ when Na2HPO4****was added because Na2HPO4 removes \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and creates \_\_\_\_\_\_\_\_\_\_\_\_\_\_.**

Station Three: Equilibrium with Temperature **Co(H2O)6+2 + 4Cl-** ↔**CoCl4+2 + 6H2O**

1. Place one test tube into a hot water bath. **Pink** ↔ **Blue**
2. Place the second test tube in the cold water bath.
3. Record observation about the third test tube at room temperature.
4. Wait for the solutions to come to the correct temperature and record observations.
5. Place test tubes back into the test tube holder.

**Hypothesis:**

**The reaction will shift to the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ when placed in the hot water bath.**

**The reaction will shift to the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ when placed in the cool water bath.**

**Observations: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

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**Conclusions:**

**The reaction shifted to the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ when placed in the hot water bath because it creates \_\_\_\_\_\_\_\_\_\_\_\_\_\_.**

**The reaction shifted to the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ when placed in the cool water bath because it creates \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.**

Station Four: Equilibrium of a Cobalt Complex Ion **Co(H2O)6+2 + 4Cl-** ↔ **CoCl4+2 + 6H2O** **Pink** ↔ **Blue**

1. Pour the cobalt solution into four test tubes, 1/5 filled.
2. Into the first test tube add 1 pipet of water. Record observations.
3. Into the second test tube add 1 pipet of water and 5 drops of 12M HCl. Record observations.
4. Into the third test tube add 1 scoop of CaCl2. Record observations.
5. Into the fourth test tube add 10 drops of AgNO3. Record observations.
6. Dispose of chemicals down the drain with lots of water.
7. Place test tubes in tray upside down to dry.

**Hypothesis:**

**The reaction will shift to the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ when water is added.**

**The reaction will shift to the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ when HCl is added.**

**The reaction will shift to the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ when CaCl2 is added.**

**The reaction will shift to the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ when AgNO3 is added.**

**Observations:**

**Step 2: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Step 3: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Step 4: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Step 5: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Conclusions:**

**The reaction shifted to the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ when water was added because it creates \_\_\_\_\_\_\_\_\_\_\_\_\_\_.**

**The reaction shifted to the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ when HCl was added because it added \_\_\_\_\_\_\_\_\_\_and creates \_\_\_\_\_\_\_\_\_\_\_\_\_\_.**

**The reaction shifted to the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ when CaCl2 was added because it added \_\_\_\_\_\_\_\_\_\_and creates \_\_\_\_\_\_\_\_\_\_\_\_\_\_.**

**The reaction shifted to the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ when AgNO3 was added because AgNO3 removes i \_\_\_\_\_\_\_\_\_\_and creates \_\_\_\_\_\_\_\_\_\_\_\_\_\_.**

Station Five: Water and solution Equilibrium **H2O(g) ↔ H2O(l)**

1. Observes both beakers of water on the desk. Beaker 1 is at equilibrium and beaker 2 is not.
2. Write observations below and answer the questions.

**Observations: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Questions:**

1. **Which is true about equilibrium? Circle one.**
   1. **Rate of condensation equals rate of evaporation**
   2. **Amount of water equals amount of vapor**
2. **Why are unsaturated solutions not at equilibrium?**
3. **Why are supersaturated solutions not at equilibrium?**
4. **What is the name given to a solution at equilibrium?**
5. **What is equal about solution equilibrium?**

Station Six: Pressure Equilibrium

Look at the diagram on the desk. Count the number of each particle and write the before and after below the reaction:

**N2 + 3H2 ↔ 2NH3**

**Before: \_\_\_ \_\_\_ \_\_\_**

**After: \_\_\_ \_\_\_ \_\_\_**

**Questions:**

1. **Create a general rule to describe how pressure affects reactions in terms of moles of reactants and products.**
2. **Determine which way the reactions shift when pressure is added to the gaseous systems:**
   1. **PCl5 ↔ PCl3 + Cl2 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**
   2. **2N2 + 5O2 ↔ 2N2O5 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**
   3. **2NO ↔ N2 + O2 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**