Chemistry Hour\_\_\_\_\_ Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  
Dr. Wexler  
Reversible Reactions (HS-PS1-6)  
Date\_\_\_\_\_  
 **Background:**   
In some chemical reactions, the reactants are not entirely converted to products. This is because as the products form, they react to re-form the reactants in a reverse reaction.

When the rate of the forward reaction is equal to the rate of the reverse reaction, the system is said to be at equilibrium. At equilibrium, the concentrations of the reactants and products do not change, and these concentrations are determined by the equilibrium constant (k) of the reaction.

Le Chatelier’s principle states that if a system at equilibrium is subjected to a stress, the equilibrium will shift in a direction that will relieve the stress. One such stress is a change of concentration of either a reactant or product.

**Objectives:**Determine how equilibrium shifts in response to changes in concentration of reactants and products.

**Special Materials:**12M HCl  
6M HCl  
0.1M FeCl3  
0.1M KSCN  
0.1M CoCl2  
Saturated NH4Cl solution  
Saturated NaCl solution  
6M NaOH solution  
NaCl (s)  
1mM FeCl3/0.5mM KSCN solution   
0.03M NH4OH/Phenolphthalein solution

**Pre-Lab:**1. What is Le Chatelier’s principle and how does it apply to chemical equilibrium?

2. In which direction will equilibrium shift if there is an increase in the concentration of a reactant?

3. In which direction will equilibrium shift if there is an increase in the concentration of a product?

**Procedure:**  
**Part A. Chloride Solutions**  
1. Add 3mL saturated NaCl solution to a test tube. Add 6 drops of 12M HCl. Record your observations.

2. Repeat with saturated NH4Cl solution.

**Part B. Iron(III) Chloride and Potassium Thiocyanate Solutions**1. Add 5mL of FeCl3/KSCN solution into each of three test tubes.  
2. To tube 1, add 1mL of 0.1M KSCN solution. Record your observations.

3. To tube 2, add 1mL of 0.1M FeCl3 solution. Record your observations.

4. Use tube 3 as a negative control. Record the color of the solution.

**Part C. Cobalt Chloride Solution**  
1. Add 2mL of 0.1M CoCl2 solution to a test tube.  
 a. Add 3mL 12M HCl. Record your observations.

b. Add water dropwise until a stable change occurs. Record your observations.

2. Add 2mL of 0.1M CoCl2 solution to each of two test tubes.  
 a. Add 1.5g NH4Cl to the first test tube.

b. Add nothing to the second test tube, which is your negative control.

c. Compare the two solutions (tube 1 vs. tube 2). Record your observations.

**Part D. Ammonia Solution**  
 1. Add 5mL of Ammonium hydroxide/Phenolphthalein solution (note: the phenolphthalein is a pH indicator – it is red when basic) into a test tube.  
 2. Add 10 drops of 6M HCl to the same test tube and stir. Record your observations.

**Analysis:**Part A:  
a. In step 1, which ion concentration change is responsible for the equilibrium shift. Write a net ionic equation, including physical state for each reactant and product, to explain what you observed. Which ion is the spectator ion?

b. In step 2, which ion concentration change is responsible for the equilibrium shift. Write a net ionic equation, including physical state for each reactant and product, to explain what you observed. Which ion is the spectator ion?

Part B:  
a. Write a net ionic equation to explain what you observed (hint: this is a double replacement reaction).

b. Which product is responsible for the color of the solution?

c. In step 2, which ion concentration change is responsible for the equilibrium shift?

d. In step 3, which ion concentration change is responsible for the equilibrium shift?

Part C:  
a. Write a net ionic equation to explain what you observed (hint: this is a double replacement reaction).

b. Which product is responsible for the new color of the solution?

c. In step 1, which ion concentration change is responsible for the equilibrium shift?

d. In step 2, which ion concentration change is responsible for the equilibrium shift?

Part D:  
a. Write a net ionic equation to explain what you observed (hint: this is a double replacement reaction)

b. Which ion concentration change is responsible for the equilibrium shift?

**Extension:**Predict the effect of adding 6M NaOH instead of 6M HCl to a saturated solution of sodium chloride. Test your prediction.

**Question:**

In the Haber process, nitrogen and hydrogen are combined to form ammonia according to the following reaction:  
N2(g) + 3H2(g) ↔ 2NH3(g)

**Explain** what effect an increase in pressure would have on the yield of ammonia. Hint: think in terms of Le Chatelier’s Principle – what change in equilibrium, to the right or left, would reduce the stress of increased pressure? **Explain why**.