Chemistry 150

This one does not require a lot of preparation. The photocopied pages of the write-up is due in class on **Wednesday, March 14.**

In 1884, the French chemist and engineer Henri-Louis Le Châtelier proposed one of the central concepts of chemical equilibria. **Le Châtelier's principle** can be stated as follows:

> **If a system at equilibrium is disturbed by a change in temperature, pressure, or the concentration of one of the components, the system will shift its equilibrium position so as to counteract the effect of the disturbance.**

Le Châtelier's principle describes what happens to a system at equilibrium when something momentarily takes it away from equilibrium. For example, if a chemical system is at equilibrium and we add a substance (either a reactant or a product), the reaction will shift so as to reestablish equilibrium by consuming part of the added substance. Conversely, removal of a substance will result in the reaction moving in the direction that forms more of the substance.

In this experiment, you will be observing the results of perturbing a set of 6 different reactions. In most cases the reagents will already be made up for you, but in some cases you will need to make stock solutions.

Lab 7: What factors change the position of equilibrium?

Part 1. Purpose

Watch and record LeChatelier's Principle in action.

Part 2. Materials and methods

Chemicals list: develop list from the procedure section.

No sketch of the equipment is necessary, since no new glassware or techniques are being used.

Part 3. Procedure

There will be 6 stations for 6 reactions. You will go around to each station and the reagents will remain at the proper station.

Reaction 1:

$$NaCl\ (s) \rightleftharpoons Na^+\ (aq) + Cl^-\ (aq)$$

1. Add a few drops of conc. HCl to 2-3 mL of saturated NaCl solution and observe the result.

Reaction 2:

$$NH_4Cl\ (s) \rightleftharpoons NH_4^+\ (aq) + Cl^-\ (aq)$$

2. Add a few drops of conc. HCl to 2-3 mL of saturated NH_4Cl solution and observe the result.

Reaction 3:

$$Fe^{3+}\ (aq) + SCN^-\ (aq) \rightleftharpoons FeSCN^{2+}\ (aq)$$

3. If you are the first group at this station, prepare a <u>stock solution</u> by mixing 2 mL of 0.1M $FeCl_3$ and 0.1M KSCN in a 100 mL graduated cylinder adding H_2O to bring the volume to 100 mL. Save this stock solution for the rest of the class.

4. Take 5 mL of the stock solution and note the color. Add about 1mL of 0.1M $FeCl_3$ solution and observe the result.

5. Take 5 mL of the stock solution and note the color. Add about 1mL of 0.1M KSCN solution and observe the result.

6. Take 5 mL of the stock solution and note the color. Add 0.1M AgCl solution dropwise until almost all the color is gone. Split the solution into two test tubes including the precipitate.
    a. Add 2 mL of 0.1M KSCN dropwise to one tube and observe the result.
    b. Add 2 mL of 0.1M $FeCl_3$ dropwise to the second tube and observe the result.

Reaction 4:

$$2\ CrO_4^{2-}\ (aq) + 2\ H_3O^+\ (aq) \rightleftharpoons Cr_2O_7^{2-}\ (aq) + 3\ H_2O\ (l)$$

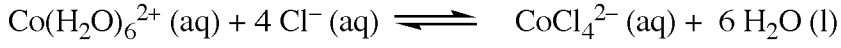
7. Add 2 drops of 6M HNO_3 to roughly 3 mL of 0.1M K_2CrO_4 solution and observe the result.

8. Add 10% NaOH solution dropwise to the solution from step 7 until the original color is restored.

9. Add 2 drops of 6M H_2SO_4 to roughly 3mL of 0.1M K_2CrO_4 solution and observe the result.

10. Add 10% NaOH solution dropwise to the solution from step 9 until the original color is restored.

Reaction 5:



$$Co(H_2O)_6^{2+}\,(aq) + 4\,Cl^-\,(aq) \rightleftharpoons CoCl_4^{2-}\,(aq) + 6\,H_2O\,(l)$$

11. Add 3 mL of conc. HCl dropwise to 2 mL (no more) of 0.1M $CoCl_2$ and observe the result.

12. Add water dropwise to the solution from step 11 until the reverse reaction is evident.

Reaction 6:

$$NH_3\,(g) + H_2O\,(l) \rightleftharpoons NH_4^+\,(aq) + OH^-\,(aq)$$

13. Prepare a stock solution by mixing 4 drops of conc. NH_4OH and 3 drops of phenolphthalein in a 100 mL graduated cylinder and adding H_2O to bring the volume to 100mL.

14. Dissolve a small amount of NH_4Cl in 5 mL of stock solution and observe the result.

15. Add a few drops of 6M HCl to about 5 mL of stock solution and observe the result.

Safety issues: Some strong acids (hydrochloric, nitric and sulfuric) and bases (ammonium hydroxide, sodium hydroxide) are being used; behave accordingly.

Waste disposal: All materials in this lab are to be treated as metals and acid waste; nothing should go down the sink. Please use the appropriately labeled beakers in the hoods to get rid of waste.

Part 4. Original data

For each reaction, set up tables listing the reaction and associated observations about gases evolved, heat given off, etc., that will allow you to complete the analysis section.

Part 5. Analysis

As a separate table, or as a column on the table in part 4, indicate to which side the reaction shifted (i.e., "reactant" side or "product" side as the equations are written).

Part 6. Group results

None.

Part 7. Questions

1. What was the purpose of adding silver chloride to the stock solution in reaction 3, step 6? Hint: writing the ionic equation may help with your explanation.

2. What was the purpose of adding the sulfuric acid in reaction 4, step 9? I mean, didn't you already demonstrate the acidification point in step 7 with the same reaction?

3. What does the concentrated acid added in reaction 6, step 15, do that affects the equilibrium of the reaction?

Part 8. Conclusion

None

Abstract

None.