LeChatelier's Principle

name:

Laboratory investigation

hour:

Part 1: $H^+_{(aq)} + Blue^-_{(aq)} \Leftrightarrow Yellow_{(aq)}$

1. Pour about 5mL of deionized water into a test tube. Add two or three drops of bromthymol blue to the water and mix. Then add 5 drops of 0.1M HCl and stir. This will increase the [H+]. Observe the color of the solution. Now, drop by drop, add 0.1M NaOH to the solution, mixing after each drop. (*Because the OH- ions from the NaOH react with the H+ ions from the acid, adding the NaOH removes H+ from the system*.) Note any color change that occurs. Continue to add the NaOH solution until no further color change occurs. Save this solution for step 2.

2. To the solution from step 1 add 0.1M HCl, drop by drop, until the solution changes color again, mixing well. Note that by changing the conditions in the equilibrium system, we can easily force the reaction to go in either direction, converting the indicator from one form to the other.

3. Using the solution obtained in 2, prepare, by addition of the proper reagent, a solution in which the concentrations of $Blue^-$ and Yellow appear to be equal. What should the color should be?

Part 2: $Cu^{2+}_{(aq)} + 4\ NH_{3(aq)} \Leftrightarrow Cu[NH_3]_4{}^{2+}_{(aq)}$

Pale blue — deep blue

1. Pour 5mL of 0.1M Cu^{2+} solution into a test tube. Convert the Cu^{2+} ion to the copper complex ion by adding in 6M NH_3 solution drop by drop. At first the solution wiil appear to be a cloudy blue color – keep adding the ammonia until a deep blue solution is obtained. Stir gently to complete mixing.

2. When you have obtained the copper complex ion in solution, convert it back to the Cu^{2+} ion by adding dropwise 3M HCl. The HCl added neutralizes the NH_3, which is a base, and decreases the concentration of the NH_3.

Part 3: $Co(H_2O)_6{}^{2+}_{(aq)} + 2\ Cl^-_{(aq)} \Leftrightarrow Co(H_2O)_4Cl_{2(aq)} + 2\ H_2O$

pink — blue

1. Prepare a solution of $Co(H_2O)_4Cl_2$ by dissolving 0.1g $CoCl_2$ in 10mL of 6M HCl in a 100mL beaker.

2. Add water to the beaker until the color changes.

3. When the color change appears to be complete put the beaker on a hot plate and heat the solution until the color changes. Record your observations.

4. Take the beaker off the hot plate and let it cool on the on the lab bench. Note any changes that occur. Suggest two additional ways that the solution might be made to turn blue. Call your teacher over to test your ideas.

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	procedure	observations
Part 1 Step 1		
Step 2		
Step 3		
Part 2 Step 1		
Step 2		
Part 3 Step 1		
Step 2		
Step 3		
Step 4(a)		
Step 4(b)		

Questions

1. In part 1, step 1, **<u>as NaOH is slowly added</u>**:

   a) What happens to the color of the solution?

   b) Does the solution go through a state whare appreciable amounts of both $Blue^-$ and Yellow are present? Explain your reasoning…

   c) What happens to [H+]? to [Yellow]? To [$Blue^-$]?

2. In part 1, step 2, apply LcChatelier's principle to explain your observations of the behavior of the solution on addition of 0.1M HCl.

3. (a) In part 2, step 2, apply LcChatelier's principle to explain your observations of the behavior of the solution on addition of 3M HCl.

   (b) Is the conversion of Cu^{2+} to $Cu[NH_3]_4^{2+}$ reversible? Explain…

4. (a) In part 3, step 2, use LeChatelier's principle to explain what happened upon the addition of water…

   (b) Is the reaction in part 3 reversible? Exothermic? Explain your reasoning…

   (c) Explain your observations in step 4(a).

   (d) Explain your observations in step 4(b).