

# Experiment 10. LeChâtelier's Principle; Buffers

**Experimental  
Procedure**

**Lab 406**

# Overview

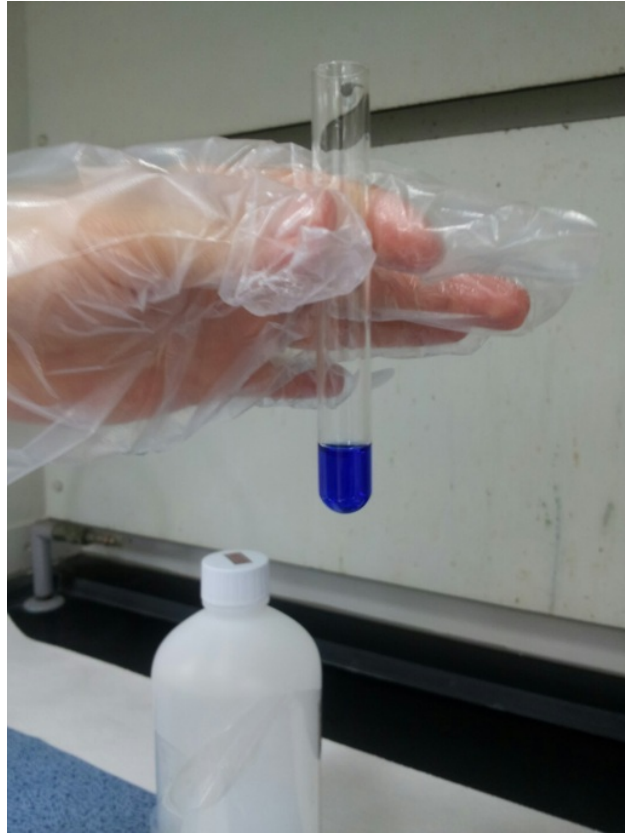
A large number of qualitative tests and observations are performed. The effects that concentration changes and temperature changes have on a system at equilibrium are observed and interpreted using LeChâtelier's principle. The functioning of a buffer system and the effect of a common ion on equilibria are observed.

Perform this experiment with a partner. At each circled superscript **(1-21)** in the procedure, stop and record your observation on the Report Sheet. Discuss your observation with your lab partner and TA. Account for the changes in appearance of the solution after each addition in terms of LeChâtelier's principle.

## A. Metal-Ammonia Ions

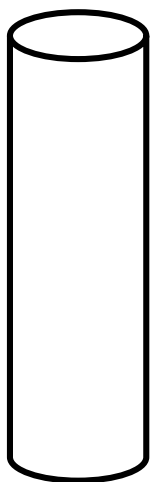
**1. FORMATION OF METAL-AMMONIA IONS.** Place ~ 1 mL (<20 drops) of 0.1 M  $\text{CuSO}_4$  (or  $\text{NiCl}_2$ ) in a small, clean test tube. <sup>(1)</sup> Add drops of conc  $\text{NH}_3$  (Caution: strong odor, do not inhale) until a color change occurs and the solution is clear (not colorless). <sup>(2)</sup>

**2. SHIFT OF EQUILIBRIUM.** Add drops of 1 M  $\text{HCl}$  until the color again changes. <sup>(3)</sup>



## *B. Multiple Equilibria with the Silver Ion*

**1. SILVER CARBONATE EQUILIBRIUM.** *In a 150-mm test tube add ~ ½ mL ( $\leq 10$  drops) of 0.01 M  $\text{AgNO}_3$  to ~ 1/2 mL of 0.1 M  $\text{Na}_2\text{CO}_3$ . (4) Add drops of 6 M  $\text{HNO}_3$  (Caution: 6 M  $\text{HNO}_3$  reacts with the skin!) to the precipitate until evidence of a chemical change occurs. (5)*



- 1-1) ~0.5 mL of 0.1 M  $\text{Na}_2\text{CO}_3$
- 1-2) ~0.5 mL ( $\leq 10$  drops) 0.01 M  $\text{AgNO}_3$
- 1-3) Add drops of 6 M  $\text{HNO}_3$  until a chemical change occurs.

- 2-1) ~ 5 drops of 0.1 M  $\text{HCl}$
- 2-2) Add drops of conc  $\text{NH}_3$  until evidence of a chemical change occurs. (At this point, the solution should be “Clear and colorless.”)
- 2-3) Reacidify with 6 M  $\text{HNO}_3$ .
- 2-4) Add excess conc  $\text{NH}_3$ .

3-1) Add drops of 0.1 M  $\text{KI}$

4-1) Add drops of 0.1 M  $\text{Na}_2\text{S}$  until evidence of chemical change has occurred.

**2. SILVER CHLORIDE EQUILIBRIUM.** To the clear solution from **PART B.1**, add ~ 5 drops of 0.1 M HCl.<sup>(6)</sup> Add drops of conc  $\text{NH}_3$  (Caution! Avoid breathing vapors and avoid skin contact) until evidence of a chemical change.<sup>(7)</sup> [At this point, the solution should be “clear and colorless.”] Reacidify the solution with 6 M  $\text{HNO}_3$  (Caution!) and record your observations.<sup>(8)</sup> What happens if excess conc  $\text{NH}_3$  is again added? Try it.<sup>(9)</sup>

**3. SILVER IODIDE EQUILIBRIUM.** After trying it, add drops of 0.1 M KI.<sup>(10)</sup>

**4. SILVER SULFIDE EQUILIBRIUM.** To the mixture from **PART B.3**, add drops of 0.1 M  $\text{Na}_2\text{S}$  until evidence of chemical change has occurred.<sup>(11)</sup>





## C. A Buffer System

**1. PREPARATION OF BUFFERED AND UNBUFFERED SYSTEMS.** *Transfer 10 mL of 0.10 M  $\text{CH}_3\text{COOH}$  to A1 and A2 of labeled 50-mL beaker. Use a pH meter to determine the pH of the solution. <sup>(12)</sup> Now add 10 mL of 0.10 M  $\text{NaCH}_3\text{CO}_2$  to each beaker. <sup>(13)</sup> Measure the pH of the solution. <sup>(14)</sup>*

Place 20 mL of distilled water into beaker B1 and B2 of labeled 50-mL beaker. Measure the pH of the distilled water.

	1	2
A	Buffer + HCl	Buffer + NaOH
B	H <sub>2</sub> O + HCl	H <sub>2</sub> O + NaOH

**2. EFFECT OF STRONG ACID.** Add 5 mL of 0.10 M HCl to A1 and B1 beaker, estimate the pH, and record each pH change.<sup>(15)</sup>

**3. EFFECT OF STRONG BASE.** Add 5 mL of 0.10 M NaOH to A2 and B2 beaker, estimate the pH, and record each pH change.<sup>(16)</sup>

**4. EFFECT OF A BUFFER SYSTEM.** Explain the observed pH change for a buffered system (as compared with an unbuffered system) when a strong acid or strong base is added to it.<sup>(17)</sup>

**D.  $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$ ,  $[\text{CoCl}_4]^{2-}$   
Equilibrium (Common-Ion effect)**

**1. EFFECT OF CONCENTRATED HCl.** *Place about 10 drops of 1.0 M  $\text{CoCl}_2$  in a 75-mm test tube.<sup>(18)</sup> Add drops of conc HCl (Caution: Avoid inhalation and skin contact) until a color change occurs.<sup>(20)</sup> Slowly add water to the system and stir.<sup>(20)</sup>*





*Equilibrium (Temperature effect)*

**1. WHAT DOES HEAT DO?** *Place about 1.0 mL of  $\text{CoCl}_2$  in a 75-mm test tube into the boiling water bath. Compare the color of the hot solution with that of the original cool solution. (21)*

## *Disposal for Parts A, C, D, and E:*

*Dispose of the waste solutions in the Waste Salt Solutions container*

## *CLEANUP:*

*Rinse the test tubes twice with tap water and discard in the Waste Salt Solutions container. Do two final rinses with deionized water and discard in the sinks*



## Two Buffer Calibration (Vernier)



## First Calibration Point

1. Choose **Calibrate** from the **Experiment menu** and select the sensor you want to calibrate with a touch pen.
2. Click **Calibrate Now** to begin the calibration process.
3. Rinse the pH Sensor with distilled water and gently wipe it out with a paper towel. And place it into a buffer of pH 4.01.
4. Type "4.01" in the **Edit box** as the pH value. Swirl the beaker containing the buffer solution gently, wait until the voltage stabilizes, then click **Keep** to record the calibration point.

## Second Calibration Point

1. Rinse the pH Sensor with distilled water, and place it into a buffer of pH 7.00.
2. Type "7.00" in the **Edit box** as the pH value for the second calibration point. Swirl the beaker containing the buffer gently and **wait until the voltage stabilizes**. Click **Keep**, then click **OK**. This completes the calibration.





- Rinse the electrode with distilled water and place it in the sample to be measured.*
- Rinse the electrode with distilled water again and try another sample.*

## ■ Maintenance and Storage of pH Meter



- *Short-term storage (up to 24 hours): Place the electrode in pH-4 or pH-7 buffer solution.*
  - *Long-term storage (more than 24 hours): Store the electrode in a buffer pH-4 or KCl storage solution in the storage bottle.*
- (When you are finished making measurements, rinse the tip of the electrode with distilled water. Slide the cap onto the electrode body, then screw the cap onto the storage bottle.)*