

CH 223 Spring 2026:

“Unknown Chloride”

Lab Instructions

Step One:

Get a printed copy of this lab! You will need a printed (hard copy) version of pages I-1-2 through I-1-11 to complete this lab. If you do not turn in a printed copy of the lab, there will be a 2-point deduction.

Step Two:

Watch the video introduction for this lab **here:** <http://mhchem.org/v/1.htm>

The video introduction will help prepare you for the lab and assist you in completing the work before turning it in to the instructor.

Also **complete the PreLab questions** before starting the lab.

Step Three:

Bring the printed copy of the lab with you on Monday, March 30 (section L1) or Wednesday, April 1 (section L2). During lab in room AC 2507, you will use these sheets (with the valuable instructions!) to gather data, all of which will be recorded in the printed pages below.

Step Four:

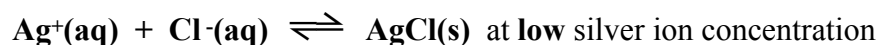
Complete the lab work and calculations on your own, then **turn it in** (pages I-1-5 through I-1-11 *only* to avoid a point penalty) **at the beginning of recitation to the instructor on Monday, May 4 (section L1) or Wednesday, May 6 (section L2.)** The graded lab will be returned to you the following week during recitation.

If you have any questions regarding this assignment, please email (mike.russell@mhcc.edu) the instructor! Good luck on this assignment!

Determination of an Unknown Chloride

The determination of a soluble chloride salt concentration is a classic titrametric analysis. A titration involves delivering a measured amount of a solution whose concentration is known accurately (the **titrant**) into a solution whose concentration is not known (the **titrate**). The purpose of the titration is to determine the number of moles of titrate present. When the reaction is complete, some physical change is observed, indicating the **endpoint** of the titration. The endpoint of a titration occurs when stoichiometric ratios of reactants are present and must be determined accurately.

In the titration in this lab, a dilute solution of silver nitrate with a known concentration acts as the titrant. It is added to a salt solution with an unknown amount of chloride, i.e. the titrate. Silver chloride, a white insoluble solid will precipitate from the solution. In order to detect when all the AgCl has been precipitated, another reagent is used as an **indicator**. The indicator in this lab, potassium chromate, is yellow and reacts with silver ions to form a bright orange silver chromate precipitate. This solid is slightly more soluble than the silver chloride so it does not form until essentially all the chloride has precipitated from the solution.



All standard solutions must first be standardized using a **primary standard** because of potential evaporation. A primary standard is a solid that is stable and does not pick up water. The primary standard in this experiment is purified sodium chloride.

In this lab you will perform six titrations. In the first three titrations you will use a known amount of a pure NaCl sample to determine the exact concentration of an approximate 0.05 M silver nitrate solution. The endpoint is the first permanent orange-red color of Ag₂CrO₄. From this information one can determine the concentration of the AgNO₃. The last three titrations will allow you to find the percentage of chloride in your salt when used in conjunction with the average silver nitrate concentration.

Note: Silver is a heavy metal toxin and should never be flushed down the drain. Dispose of all silver waste (silver nitrate and silver chloride) in the waste bottles provided.

PROCEDURE:

Part A: *Standardizing the Silver Nitrate Solution*

1. Clean a 50 mL buret with soap and water, then rinse well with water.
2. Fill your buret with silver nitrate from an amber bottle. To prevent contamination, **never** add anything to the amber bottle. Fill the buret to the 0.00 mL mark with the AgNO_3 solution. Drain 5 mL from the buret into a beaker (to remove air bubbles) and fill to 0.00 mL again. *Note:* AgNO_3 is the only solution that will be placed in your buret! Also, do not dispose of AgNO_3 in the sink – place this heavy metal in a waste container.
3. Use an analytical balance to weigh three 0.1000 - 0.1200 gram samples of purified NaCl. Record exact mass.
4. Add about 50 mL of distilled water to each sample in a 125 mL Erlenmeyer flask (or larger) to dissolve the NaCl sample. Add about three drops of indicator (K_2CrO_4).
5. Titrate with 0.05 M AgNO_3 solution as you continually swirl the flask to a lovely peach end point. As you add the silver nitrate solution initially in short bursts you will see the orange-red color form and disappear as the solution is swirled. As you approach the end point (which should be between 20-40 mL) the color should begin to persist. At this point you should be adding the solution dropwise. Read the buret to the nearest 0.01 mL. Stop when the sample has a permanent faint peach color.
6. **Repeat** the titration with the second **and** third samples.

Part B: *Determination of Percent Chloride*

1. Obtain an unknown chloride salt and record the ID number in your lab notes. Use an analytical balance to weigh **three** 0.1000 - 0.1200 gram samples.
 2. To **each** sample add 50 mL of distilled water and 3 drops of K_2CrO_4 indicator solution in an Erlenmeyer flask. Titrate each sample with the standardized silver nitrate solution as in part A.
 3. When done, place excess AgNO_3 in the waste container and rinse the buret with water before leaving the lab.
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CALCULATIONS: See the "Calculations" handout (next page)

For Part A, calculate the **molarity** of the silver nitrate solution ($[\text{AgNO}_3]$) for each titration. Calculate the Parts Per Thousand (PPT) for $[\text{AgNO}_3]$ using the "Parts Per Thousand" handout in the "Lab Notes" of the Companion (or here: <http://mhchem.org/ppt>). If your PPT is greater than 30 for the three trials, consider omitting a deviant molarity value to improve your PPT.

Calculations for Part A: Determining the molarity of the silver nitrate solution

$$[\text{AgNO}_3] = \underset{\substack{\uparrow \\ \text{about } 0.1 \text{ g}}}{? \text{ g NaCl sample}} * \underset{\substack{\uparrow \\ \text{molar mass NaCl}}}{\left(\frac{1 \text{ mol NaCl}}{? \text{ g NaCl}} \right)} * \left(\frac{1 \text{ mol AgNO}_3}{1 \text{ mol NaCl}} \right) * \underset{\substack{\uparrow \\ \text{volume AgNO}_3 \text{ titrated (20-40 mL)}}}{\left(\frac{10^3 \text{ mL/L}}{? \text{ mL AgNO}_3} \right)}$$

For Part B, calculate the **percent chloride** of your unknown sample. (Note: Use the **average molarity** of AgNO_3 as determined in part A.) Average your three percent chloride values and find the PPT for the %Cl values. As in Part A, if one trial is quite different from the other two, report data from all three trials, then only average two trials to get an improved Parts Per Thousand value.

Calculations for Part B: Determining the percent chloride of your unknown sample

$$\% \text{Cl} = \underset{\substack{\uparrow \\ \text{volume AgNO}_3 \text{ titrated}}}{\left(\frac{? \text{ mL AgNO}_3}{10^3 \text{ mL/L}} \right)} * \underset{\substack{\uparrow \\ \text{average AgNO}_3 \text{ (M) from part A}}}{[? \text{ AgNO}_3]} * \left(\frac{1 \text{ mol Cl}^{-1}}{1 \text{ mol AgNO}_3} \right) * \left(\frac{35.453 \text{ g Cl}^{-1}}{1 \text{ mol Cl}^{-1}} \right) * \underset{\substack{\uparrow \\ \text{g unknown (about } 0.1 \text{ g)}}}{\left(\frac{100\%}{? \text{ g sample}} \right)}$$

Determination of an Unknown Chloride

All masses should be recorded to 0.0001 g and volumes to 0.01 mL

YOUR NAME: _____ **LAB PARTNER(s):** _____
first AND last names!

DATA: Part A

NaCl sample #1 (g): _____

NaCl sample #2 (g): _____

Volume buret (initial, mL): _____

Volume buret (initial, mL): _____

Volume buret (final, mL): _____

Volume buret (final, mL): _____

Volume AgNO₃ used for sample #1 (mL): _____

Volume AgNO₃ used for sample #2 (mL): _____

NaCl sample #3 (g): _____

Volume buret (initial, mL): _____

Volume buret (final, mL): _____

Volume AgNO₃ used for sample #3 (mL): _____

Lab Notes and Observations:

DATA: *Part B*

Unknown Sample ID = _____

Unknown sample #1 (g): _____

Unknown sample #2 (g): _____

Volume buret (initial, mL): _____

Volume buret (initial, mL): _____

Volume buret (final, mL): _____

Volume buret (final, mL): _____

Volume AgNO₃ used for sample #1 (mL): _____

Volume AgNO₃ used for sample #2 (mL): _____

Unknown sample #3 (g): _____

Volume buret (initial, mL): _____

Volume buret (final, mL): _____

Volume AgNO₃ used for sample #3 (mL): _____

Lab Notes and Observations:

Part A Calculations: *Determination of an Unknown Chloride*

Show all work, use significant figures and circle the final answer for full credit.

Use the space below to **calculate three values for the molarity of the AgNO_3 solution**. The lab video (<http://mhchem.org/w/7.htm>) offers help with this calculation, but use your own data, not the data provided in the video. *Show all work! Watch significant figures!*

Using the three calculated values of $[\text{AgNO}_3]$ from above, calculate the **average concentration** of AgNO_3 , the **average deviation** of your molarity calculations and the precision in **parts per thousand**. (The parts per thousand handout can be found here: <http://mhchem.org/ppt>)

Part B Calculations: Determination of an Unknown Chloride

Show all work, use significant figures and circle the final answer for full credit.

Use the space below to **calculate three values for the %Cl of your unknown sample**. The lab video (<http://mhchem.org/w/7.htm>) offers help with this calculation, but use your own data, not the data provided in the video. *Show all work! Watch significant figures!*

Using the three calculated values of %Cl from above, calculate the **average %Cl**, the **average deviation** of your %Cl calculations and the precision in **parts per thousand**. (ppt handout: <http://mhchem.org/ppt>)

Part C Postlab Questions: *Determination of an Unknown Chloride*

Show all work, use significant figures and circle the final answer for full credit.

1. 35.46 mL of a silver nitrate solution was used to reach the chromate end point with a 50 mL solution containing 0.1165 g of pure NaCl. What is the molarity of the AgNO_3 solution?
2. How many mL of the silver nitrate solution used in question 1 above will react with 0.2595 g of BaCl_2 dissolved in 50 mL of water? *Hint:* start by writing a balanced precipitation reaction between BaCl_2 and AgNO_3 .
3. A solid chloride sample weighing 0.09969 g required 18.25 mL of 0.05205 M AgNO_3 to reach the chromate end point. What is the % chloride in this sample?

Part C Postlab Questions: *Determination of an Unknown Chloride - continued*

Show all work, use significant figures and circle the final answer for full credit.

4. How would the following hypothetical errors affect the calculated % chloride (increase, decrease or no change)? Explain.

- a. The pure sodium chloride was left open in the scale room and absorbed moisture.

This will **increase** **decrease** **not change** the percent chloride. (*circle one*)

Explain your answer:

- b. The calculated molarity of the silver nitrate solution was 5% too high.

This will **increase** **decrease** **not change** the percent chloride. (*circle one*)

Explain your answer:

- c. Two mL of AgNO_3 are added beyond the chromate end in titrating the unknown chloride.

This will **increase** **decrease** **not change** the percent chloride. (*circle one*)

Explain your answer:

Unknown Chloride PreLab Questions

Ideally you will complete these before performing the lab.

Include the completed PreLab Questions when you turn in your lab report.

1. In Part A, silver nitrate and sodium chloride react to make silver chloride and sodium nitrate. Write a balanced molecular equation and net ionic equation for this reaction, showing all states of matter.

Balanced molecular equation:

Balanced net ionic reaction:

2. What is the stoichiometric ratio between the silver and chloride ions? (use the net ionic reaction to answer this question.)
3. What is the indicator used in this lab? Give the name and the chemical formula for the indicator.
4. In Part B, silver nitrate will be used once more, but will the unknown necessarily be sodium chloride? Explain briefly.
5. In this lab, what chemical will have a yellow color?
6. In this lab, what chemical will have an orange color?
7. If your unknown compound in Part B were to be sodium chloride, calculate the expected percent chloride for this compound.
8. Should you expect a percent chloride answer larger than 100%? Explain briefly.
9. A low parts per thousand value shows a high accuracy for this lab. **True** **False** *Circle one, and explain your answer below.*

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