Experiment: Determination of Empirical Formula

Introduction

In this experiment you will be determining the empirical formula of silver chloride by weighing the silver chloride produced when a known mass of silver metal is dissolved in nitric acid solution and then reacted with hydrochloric acid solution.

Experiment Summary

You will dissolve an accurately weighed piece of silver metal in nitric acid solution:

$Ag\ (s) + 2\ HNO_3\ (aq) \rightarrow AgNO_3\ (aq) + H_2O\ (l) + NO_2\ (g)$

Net-ionic equation:_____

Notice that silver, like copper, gold and other inactive metals, does not produce H_2 (g) when it reacts with a strong acid. Instead, a poisonous yellow-brown gas, nitrogen dioxide, is produced. Silver nitrate, another product of the reaction, can stain your skin.

After the silver has dissolved, you will add hydrochloric acid solution to precipitate silver ions as silver chloride.

$AgNO_3\ (aq) + HCl\ (aq) \rightarrow AgCl\ (s) + HNO_3\ (aq)$

Net ionic equation: _____

You will then dry and weigh the silver chloride.

Using the masses of silver and silver chloride, you will calculate the experimental mole ratio of silver to chloride (the empirical formula) in silver chloride, as well as the percent by mass silver in silver chloride.

Procedure:

A. Wash your evaporating dish with tap water and do a final rinse with distilled water. Dry the dish with paper towel. Get some evaporating dish tongs from the community drawer. Use these and not your hands to handle your evaporating dish throughout the experiment. Make sure to practice handling the evaporating dish with the evaporating dish tongs before proceeding with the experiment. Prepare your evaporating dish for heating by placing it on a clay triangle on a ring that is attached to a ring stand. Make sure your Bunsen burner is close enough to the bottom of the evaporating dish to let you heat the dish strongly.

B. Dry to a constant mass as follows: Heat the dish strongly with a blue flame (air hole on Bunsen Burner completely open) for several minutes. Allow the dish to cool on a wire gauze to room temperature. Take the evaporating dish, the report sheet and your pen to the weighing room. Weigh the evaporating dish to the nearest 0.1 mg and record this on your report sheet as the mass of the dish in column 1. Return to the lab and again heat the evaporating dish strongly and allow it to

cool. Return to the weighing room, weigh the dish and record this reading in column 2. Compare two readings. If they differ by 5 mg or more, the evaporating dish may not be dry. You will, therefore, heat the dish a third time, allow it to cool, weigh it and record its mass in column 3. Compare readings 2 and 3. If they differ by more than 5 mg then you must dry some more. If 2 consecutive readings differ by less than 5 mg you may assume the dish is dry. (Be sure to use the same balance for all weighings.)

C. Take your evaporating dish and the report sheet of this lab experiment to your instructor to get approval of your data and a piece of silver. Take the dish plus silver and your pen and lab report to the weighing room and weigh the dish plus silver to the nearest 0.1 mg. Record this on your report sheet.

D. For this portion of the experiment you will work with the ***fume hood fan on***. Place your evaporating dish plus silver under the fume hood. Your instructor will add approximately 2.4 ml of Dil (6 M) HNO_3 to the silver in the dish. Dil HNO_3 is a strong acid. Use extreme caution when working with Dil HNO_3.

Caution: Both, nitric acid solution and the produced NO_2 gas, are extremely corrosive and damaging to skin and eyes. NO_2 is damaging to the respiratory system if inhaled.

You may need to warm the dish slightly if the reaction is slow to start. Make sure the solution does not spill or spatter during the reaction. The reaction is complete when no more NO_2 gas is being produced and the silver is completely dissolved. (There may be a few specks left in the dish because of contaminants in your silver sample.)

E. Add approximately 1.8 ml of dilute(6M) HCl to the solution in the evaporating dish. ***Caution: HCl is damaging to skin; handle carefully***. A white silver chloride precipitate will form. Allow the precipitate to settle and then test for completeness of precipitation by adding a drop of dil HCl to the clear solution above the precipitate to see if any more forms. If more precipitate forms, add a few ml more HCl. If no more precipitate forms precipitation is complete. Allow the precipitate to settle. Then use your medicine dropper to draw off as much of the clear liquid as possible without removing any silver chloride precipitate along with it.*

* ***This might be a good place to stop for today.*** Use a pencil to write your name on the etched part of a 250 ml beaker. Place the evaporating dish on the beaker and store it under the fume hood.

F. Set up a steam bath for use in drying the precipitate. Fill a 250 ml beaker about 2/3 full of tap water. Use the Bunsen Burner to heat the water to boiling by placing the beaker on a wire gauze on a ring attached to a ring stand. Transfer the beaker to a hot plate placed under the fume hood. Place the evaporating dish with precipitate on the top of the beaker of boiling water.

G. Dry the silver chloride precipitate to a constant mass as follows: Heat the evaporating dish on the steam bath to dry the precipitate. When the precipitate appears to be dry, remove the dish

from the bath, dry the bottom of the dish with a paper towel, and allow the dish and the precipitate to cool to room temperature. Take the evaporating dish, your pen and report sheet of this lab experiment to the weighing room. Weigh the dish and contents to the nearest 0.1 mg and record this on your report sheet as the mass of dish plus silver chloride in column 1. Return to the lab and again heat the dish and contents over the steam bath and allow to cool. Return to the weighing room, weigh the dish and contents and record this reading in column 2. Compare the two readings. If they differ by 5 mg or more, the silver chloride may not be dry. You will, therefore, heat the dish and contents a third time, allow it to cool, weigh it and record its mass in column 3. Compare readings 2 and 3. If they differ by more than 5 mg then you must dry some more. If two consecutive readings differ by less than 5 mg, you may assume that the silver chloride is dry. (You may notice that a lavender color appears on top of your silver chloride precipitate as you dry it. This is finely divided silver.)
Note: Do not heat the dish containing the silver chloride with a direct flame. The flame would be hot enough to melt and decompose the dried silver chloride precipitate.

H. When you have completed the experiment, have the instructor approve and initial your data, and then **dispose of the silver chloride in the special waste container provided for its disposal**. It will help if you add a few drops of water to the evaporating dish to loosen up the silver chloride, and then scrape it off with a spatula into the waste container. Do not throw it in the trash.

Calculation:

Perform the calculations indicated on your report sheet, giving setups of calculations as requested. Be sure your setups are complete and include all units. Check and recheck your significant figures.

Please use the following molar masses for silver and chlorine:
Silver= 107.9 g/mole
Chlorine= 35.45 g/mole

Report Sheet

Empirical Formula

Name_____
Last First

Instructor's initial_____

DATA:

Mass of Dish	_____g	_____g	_____g
			_____ Data Approval
Mass of Dish + silver	_____g		
Mass of Dish+Silver chloride	_____g	_____g	_____g
			_____ Data Approval

CALCULATIONS:

Mass of silver
Setup:

_____g

Mass of silver chloride
Setup:

_____g

Mass of chlorine
Setup:

_____g

Experimental empirical formula of silver chloride
Setup:

_____

Experimental percent by mass silver in silver chloride
Setup:

_____%

Theoretical percent by mass silver in silver chloride
Setup:

_____%

Percent error in your percent by mass silver
Setup:

_____%

Exercise:

1. Throughout the experiment you were careful to handle the evaporating dish only with the evaporating dish tongs. What effect would handling the dish with your hands have on the dish?

2. Some possible sources of experimental error are listed below. Tell whether the error would make your experimental % by mass silver **too high**, **too low**, or would have **no effect** on your results. (Hint: make yourself a complete setup of calculations.)

1. Weighing the empty dish while it is still hot. _____

2. Splattering of the silver chloride precipitate during drying. _____

3. Using a balance whose zero point is actually 1.5 mg too high _____

4. Splattering of the solution during the dissolving of the Ag in acid. _____

5. Silver chloride precipitate not completely dry. _____

6. Incomplete precipitation of the silver chloride. _____

7. Contaminants in the silver sample. _____