

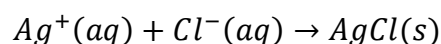
# Experiment 19

## Determination of Chloride

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### Overview

In this experiment, you will determine the percent by mass chloride in a sample that is a mixture of NaCl (FW: 58.44 g/mol) and MgCl<sub>2</sub> (FW: 95.21 g/mol). You will also be able to determine the percent NaCl by mass of your sample. Your determination will be based on the mass of AgCl (FW: 143.32 g/mol) you collect as a precipitate from a portion of your sample which you dissolve in water. The **net ionic reaction** for the precipitation reaction is



### Experimental Description

Oftentimes, it is necessary to determine the mass of one component in a mixture. This experiment will illustrate a possible approach to this problem. Specifically, you will determine the percent by mass NaCl in a mixture of NaCl and MgCl<sub>2</sub>.

You will do this by precipitating all of the chloride in the sample as AgCl. You will then take advantage of the fact that NaCl has one Cl<sup>-</sup> ion per formula unit, whereas MgCl<sub>2</sub> has two. This approach requires setting up two equations with two unknowns. It will be convenient to define the unknowns as the number of moles of NaCl and MgCl<sub>2</sub> in the sample respectively.

If  $x$  represents the number of moles of NaCl, and  $y$  represents the number of moles of MgCl<sub>2</sub> in the sample, the total mass of the sample is given by

$$m_{sample} = x(FW_{NaCl}) + y(FW_{MgCl_2})$$

The second equation comes from the number of moles of chloride in the sample. This will be equal to the number of moles of AgCl precipitated, so long as sufficient AgNO<sub>3</sub> is used. Expressed in terms of the number of moles of NaCl and MgCl<sub>2</sub> as expressed above, this becomes

$$n_{AgCl} = x + 2y$$

Thus, the mass of AgCl obtained should be given by

$$m_{AgCl} = (x + 2y)(FW_{AgCl})$$

Solving these two equations will provide all of the information needed to complete the calculations for this experiment.

**Example:** Cristobol dissolves 0.1192 g of unknown mixture of NaCl and MgCl<sub>2</sub> in 50 mL of water in a 100 mL beaker. He adds 25.5 mL of 0.100 M AgNO<sub>3</sub> to precipitate the Cl<sup>-</sup>. He then filters and dries the precipitate. The mass of precipitate he acquires is 0.3283 g. What is the percent by mass NaCl in his unknown?

**Solution:** Let  $x$  represent the number of moles of NaCl in the unknown, and  $y$  represent the number of moles of MgCl<sub>2</sub>. The mass of silver chloride obtained is given by

$$m_{AgCl} = 0.3283 \text{ g} = (x + 2y) \left( 143.32 \frac{\text{g}}{\text{mol}} \right)$$

Solving this for  $y$  yields

$$y = \frac{1}{2} \left( \frac{0.3283 \text{ g}}{143.32 \frac{\text{g}}{\text{mol}}} - x \right) = 0.0011453 \text{ mol} - \frac{x}{2}$$

We still need a second equation in order to find both  $x$  and  $y$ . That second equation can come from the mass of the initial sample:

$$m_{\text{sample}} = 0.1192 \text{ g} = x \left( \frac{58.44 \text{ g}}{\text{mol}} \right) + y \left( \frac{95.21 \text{ g}}{\text{mol}} \right)$$

Inserting the results from the first equation into the second yields

$$0.1192 \text{ g} = x \left( \frac{58.44 \text{ g}}{\text{mol}} \right) + \left[ 0.0011453 \text{ mol} - \frac{x}{2} \right] \left( \frac{95.21 \text{ g}}{\text{mol}} \right)$$

Solving this expression for  $x$  reveals

$$x = 0.001107 \text{ mol}$$

The mass of NaCl in the original sample is then given by

$$\%_{NaCl} = \frac{(0.001107 \text{ mol}) \left( \frac{58.44 \text{ g}}{\text{mol}} \right)}{0.1192 \text{ g}} \cdot 100\% = 54.27\%$$

## Equipment

The equipment list is forthcoming.

## Procedure

1. Dissolve approximately 0.1 g of your unknown sample in about 50 mL water in a 100 mL beaker.
2. Add enough 0.1 M AgCl to ensure that you will precipitate all of the Cl<sup>-</sup> in your sample. (You calculated this amount in your prelaboratory assignment.)
3. Filter and dry the AgCl(s) which you obtain in step 2.

## Vocabulary and Concepts

net ionic reaction..... 1

## Pre-Laboratory Assignment – Determination of Chloride

Name \_\_\_\_\_ Section \_\_\_\_\_

Consider Sam's experiment in which they use 1.2852 g of unknown.

1. Assuming all 1.2852 g of the unknown is NaCl, perform the following calculations.
  - a. Calculate the number of moles of  $\text{Cl}^-$  in the sample.
  - b. Calculate the minimum volume of 0.100 M  $\text{AgNO}_3$  needed to precipitate all of the chloride.
2. Assuming all of the 1.2852 g of the sample are  $\text{MgCl}_2$ , perform the following calculations.
  - a. Calculate the number of moles of  $\text{Cl}^-$  in the sample.
  - b. Calculate the minimum volume of 0.100 M  $\text{AgNO}_3$  needed to precipitate all of the chloride.
3. In order to ensure that you precipitate all of the chloride in the 1.2852 g sample which is a mixture of NaCl and  $\text{MgCl}_2$ , how many mL of 0.100 M  $\text{AgNO}_3$  solution should you use?

## Report Sheet - Determination of Chloride

Name \_\_\_\_\_ Date \_\_\_\_\_

Lab Partner(s) \_\_\_\_\_

<b>Data</b>	
Chlorine	35.45 g/mol
NaCl	58.44 g/mol
MgCl <sub>2</sub>	95.21 g/mol
AgCl	143.32 g/mol
Volume 0.100 M AgNO <sub>3</sub> Used	
Mass of sample of unknown	
Mass of AgCl recovered	
Moles of Cl <sup>-</sup>	
Mass of Cl <sup>-</sup>	
% by mass Cl <sup>-</sup> in unknown	
Moles of NaCl in sample	
Mass NaCl in sample	
% by mass NaCl in unknown	

### Sample Calculations: