

Determination of the Empirical Formula for a Compound

In Chapter 4, the concept of the mole was used to determine the empirical formula for compounds from experimental data.

In this experiment, a measured mass of magnesium metal will be reacted with an excess of 1M HCl. The excess hydrochloric acid will be evaporated, and the mass of the magnesium chloride product will be measured. This data will be used to calculate the empirical formula for magnesium chloride.

OBJECTIVES

1. to determine the mass of magnesium chloride produced when a given mass of magnesium is reacted with an excess of 1M HCl
2. to calculate the simplest formula for the compound magnesium chloride
3. to compare the simplest formula obtained experimentally with the accepted formula
4. to analyze the cause of any unexpected experimental results

MATERIALS

Apparatus

centigram balance
beaker (150- or 250-mL)
graduated cylinder (25- or 50-mL)
ring stand and ring
hot plate (for class)
wire gauze with ceramic center
lab burner
safety goggles
lab apron
fume hood required

Reagents

magnesium metal ribbon
1M HCl

PRELAB

Answer questions 1-2 on the Report Sheet.

PROCEDURE

Part I

1. Put on your laboratory apron and safety goggles.
2. Measure the mass of a clean, dry beaker (150- or 250-mL) labeled with your name. Record the data on the Report Sheet.
3. Measure the mass of a strip of magnesium and record the data on the Report Sheet.
4. Add 50 mL of 1M HCl slowly. Record your observations on the Report Sheet.



CAUTION: Hydrochloric acid is corrosive to skin, eyes, and clothing. When handling 1M hydrochloric acid, wear safety goggles and lab apron. Wash off spills and splashes with plenty of water. Call your teacher.

5. Continue to add 1M HCl until there is an excess of HCl.
6. Put the beaker on the hot plate in the fume hood.
7. Before you leave the laboratory, wash your hands thoroughly with soap and water; use a fingernail brush to clean under your fingernails.

Part II (the following day)

1. Put on your laboratory apron and safety goggles.
2. Record your observations of the beaker contents on the Report Sheet.
3. Measure the mass of the beaker and magnesium chloride. Record the data on the Report Sheet.
4. Heat the beaker and contents for three minutes on a wire gauze with a burner and allow it to cool.
5. Measure the mass of the beaker and magnesium chloride. Record the data on the Report Sheet.
6. Repeat Steps 4 and 5 until a constant mass is obtained.
7. Wash the magnesium chloride out of the beaker into the drain.
8. Before you leave the laboratory, wash your hands thoroughly with soap and water; use a fingernail brush to clean under your fingernails.

POST LAB DISCUSSION

The mass of the reaction product can be used to calculate the number of moles of each element in the product. The mass of each element is converted to moles and the numbers compared. The ratio of moles of magnesium to moles of chlorine can be used to determine the simplest formula for the compound that was produced in the reaction.

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Name _____

Class _____ Date _____

PRELAB QUESTIONS

1. How can you tell when an excess of 1M HCl has been added to the beaker with the magnesium?

2. When 2.43 g of magnesium are reacted with an excess of hydrochloric acid, 9.52 g of magnesium chloride are obtained.
 - a. What is the mass of the chlorine in this compound? _____
 - b. Calculate the number of moles of magnesium reacted. _____
 - c. Calculate the number of moles of chlorine reacted. _____

Part I

1. Mass of beaker _____
2. Mass of magnesium metal strip _____
3. Volume of 1M HCl added _____
4. Observations (Step 4) _____

Part II

1. Observations (Step 2) _____

2. Mass of beaker and magnesium chloride after removal from the hot plate. _____
3. Mass of beaker and magnesium chloride after heating for three minutes. _____
4. Mass of beaker and magnesium chloride after heating for three minutes a second time.

5. Record the results of further heatings in the following space.
Third heating _____
Fourth heating _____
Fifth heating _____

CALCULATIONS

Express all results with the correct number of significant digits.

1. Calculate the number of moles of magnesium reacted. _____
2. Calculate the mass of magnesium chloride produced. _____
3. Calculate the mass of chlorine in the magnesium chloride. _____
4. Calculate the number of moles of chlorine in the compound. _____
5. Calculate the ratio of the number of moles of magnesium to chlorine. _____

SYNTHESIS

1. What is the empirical formula for magnesium chloride? _____

2. Compare the empirical formula with that you obtained assuming magnesium chloride is a neutral compound in which magnesium has a charge of $2+$ and chloride a charge of $1-$. _____

3. Compare your results to the class results. _____

4. Was the number of moles of chlorine that combined with one mole of magnesium that you obtained in your experiment larger or smaller than the accepted value? _____

5. a. Calculate the theoretical yield, in grams, of magnesium chloride in your experiment. _____
- b. What percent of the theoretical yield is the yield of magnesium chloride in your experiment? _____
6. If the yield is different from 100%, analyze the experiment to determine circumstances that could lead to such a result. _____

