The Empirical Formula of a Compound

Introduction

The **empirical formula** of a compound gives the simplest whole number ratio of atoms (or moles of atoms) in a compound. According to Ebbing, it is "the formula of a substance written with the smallest integer (whole number) subscripts." The **molecular formula** may be the same as the empirical formula, or a multiple of the empirical formula. For ionic compounds, the empirical formula is the same as the molecular formula. For molecular substances, the empirical formula and molecular formula are often different. In this case, knowing the molecular weight as well as the empirical formula will allow you to find the correct molecular formula. For example, acetylene and benzene both have the empirical formula CH. CH has a weight of 13 g/mol. The molecular weight for acetylene is 26 g/mol, so it must contain twice the number of atoms. Thus its molecular formula is C_2H_2. The molecular weight for benzene is 78 g/mole, so its molecular formula must be C_6H_6.

Today in lab, you will react a known amount of magnesium metal with hydrochloric acid, producing the ionic compound magnesium chloride. Since the product consists solely of magnesium and chlorine, you can determine the mass of chlorine that is present in the product. Then, knowing the mass of magnesium and mass of chlorine, you can determine the ratio of moles in the product and thus the empirical formula.

Procedure

1. Take a piece of magnesium ribbon that weighs approximately 0.2 g. Clean the surface of the ribbon with sandpaper or steel wool to remove any tarnish.

2. Place an evaporating dish on top of a watch glass. Determine the combined mass.

3. Add the polished magnesium ribbon to the evaporating dish. Determine the combined mass of the magnesium, watch glass, and evaporating dish.

4. Slowly add about 10 mL of 3.0 M HCl to the magnesium in the evaporating dish. Note your observations during the reaction. After reaction is complete, there should be no visible pieces of magnesium in the dish. If magnesium metal remains, add a few more drops of HCl until reaction is complete. **Caution:** Do this step under the hood.

5. Cover the evaporating dish with the watch glass, leaving room for steam to escape.

5. Gently heat the evaporating dish on a hot plate until only a dry solid remains. Make sure that the underside of the watch glass is dry also. **Caution:** Keep the hot plate and sample under the hood during the drying procedure.

6. Remove the dish and watch glass from the hot plate and allow to cool for about ~~10~~ 5 minutes. Weigh the cooled dish, magnesium chloride, and watch glass.

Empirical Formula of a Compound (Magnesium Chloride)
REPORT FORM

Name _____

Date _____

Pre-Laboratory Questions and Exercises
Due before lab and/or during wait time. Answer in the space provided.

1. a) How many moles of copper atoms are in 150 g of copper metal?

b) How many copper atoms are in this amount of copper?

2. Write the empirical formula for the following compounds containing,

a) 0.0200 mole of Al and 0.0600 mole of Cl.

b) 0.0800 mole of Ba, 0.0800 mole of S, and 0.320 mole of O.

3. When 0.424 g of iron powder is burned in an oxygen atmosphere, 0.606 g of a reddish brown oxide is obtained. Determine the empirical formula of the oxide.

4. What safety precautions are cited in this experiment?

DATA:

1. Mass of empty evaporating dish _____ g

2. Mass of evaporating dish and magnesium _____ g

3. Mass of magnesium _____ g

4. Mass of evaporating dish and magnesium chloride
First weighing _____ g
(after heating and cooling)
Second weighing _____ g

(if necessary) Third weighing _____ g

(if necessary) Fourth weighing _____ g

5. Mass of magnesium chloride _____ g

6. Mass of chlorine in magnesium chloride _____ g

7. Moles of magnesium (show your calculation) _____ mol

8. Moles of chlorine (show your calculation) _____ mol

9. Moles of magnesium (3 sig. figures) _____
(show your calculation)

10. Moles of chlorine (3 sig. figures) _____
(show your calculation)

11. Your experimental empirical formula of magnesium chloride _____
(with whole number subscripts)

12. True (known) empirical formula of magnesium chloride _____

Post-Laboratory Questions and Exercises
Due after completing the lab. Answer in the space provided.

1. Why was an evaporating dish more suitable for this lab procedure, rather than using a beaker?

2. How would your experimental formula of magnesium chloride "MgClx" have been affected if your product was not dried completely before weighing it? Would "x" be too high or two low? Explain mathematically.

3. When 6.25 grams of pure iron are allowed to react with oxygen, a black oxide forms. If the product weighs 8.15 g, what is the empirical formula of the oxide?

4. A compound of nitrogen and oxygen is 30.46% by mass N and 69.54% by mass O. The molar mass if the compound was determined to be 92 g/mol.

a) What is the empirical formula of the compound?

b) What is the molecular formula of the compound?