Percent Composition of Hydrates

You are a research chemist working for a company that is developing a new chemical moisture absorber and indicator. The company plans to seal the moisture absorber into a transparent, porous pouch attached to a cellophane window on the inside of packages for compact disc players. This way, moisture within the packages will be absorbed, and any package that has too much moisture can be quickly detected and dried out. Your company's efforts have focused on manganese sulfate, $MgSO_4$, which can absorb water to become a hydrate and is relatively inexpensive.

When many ionic compounds are crystallized from a water solution, they include individual water molecules as part of their crystalline structure. If the substances are heated, this water of crystallization may be driven off and leave behind the pure anhydrous form of the compound. Because the law of multiple proportions also applies to crystalline hydrates, the number of moles of water driven off per mole of the anhydrous compound should be a simple whole-number ratio. You can use this information to help you determine the formula of the hydrate.

To help your company decide whether $MgSO_4$ is the right substance for the moisture absorber and indicator, you will need to examine the hydrated and anhydrous forms of the compound and determine the following:

- the empirical formula of the hydrate, including its water of crystallization,
- if the compound is useful as an indicator when it changes from the hydrated to the anhydrous form, and
- the mass of water absorbed by the 25 g of anhydrous compound, which the company proposes to use.

Even if you can guess what the formula for the hydrate should be, carefully perform this lab so that you know how well your company's supply of $MgSO_4$ absorbs moisture.

OBJECTIVES

Demonstrate proficiency in using the balance and the Bunsen burner.

Determine that all the water has been driven from a hydrate by heating your sample to a constant mass.

Relate results to the law of conservation of mass and the law of multiple proportions.

Perform calculations by using the molar mass.

Analyze the results and determine the empirical formula of the hydrate and its percentage by mass of water.

Prelaboratory Assignment

- Read the **Introduction** and **Procedure** before you begin.
- Answer the Prelaboratory Questions.
  1. What information is necessary to determine the percentage of water in your hydrate sample?
  2. How will the water be removed from the hydrate in this experiment?
  3. A hydrate has the formula of $CaSO_4 \cdot 2H_2O$. What is the percent water in this hydrate?

MATERIALS

- balance
- Bunsen burner
- crucible and cover
- crucible tongs
- $MgSO_4$, hydrated crystals
- desiccator
- distilled water
- dropper or micropipet
- ring and pipe-stem triangle
- ring stand
- spatula
- stirring rod, glass
- weighing paper