The Determination of the Percent Water in a Compound

INTRODUCTION

The polarity of the water molecule, which makes it a great solvent for ionic compounds, causes water molecules to cling to the structure of solid substances. When this occurs, the trapped water molecules are called water of hydration and they become an integral part of the crystal structure.

There are many compounds that have a tendency to absorb water vapor from the air. These compounds are said to be *hygroscopic*, and can be used as moisture-reducing agents. Other compounds absorb such large quantities of water vapor that they will actually dissolve in their own water of hydration, a property known as *deliquescence*. They are also called *hydrates*.

In this experiment, you will test a hygroscopic ionic compound (hydrate) to determine its water of hydration. Although the water molecules are securely attached to the ionic solid that you will test, they are susceptible to removal by heat. You will gently heat a sample of the compound to drive off the water of hydration. By measuring the mass of the sample before and after heating, you can determine the amount of water in the sample and calculate its water of hydration just as you would calculate an empirical formula. You will need to calculate a possible empirical formula for each of the 6 compounds listed, using your data, and determine which is the most likely formula for the substance you used.

You will

- Carefully heat a measured sample of a hygroscopic ionic compound.
- Determine the water of hydration of the compound.

Complete the chemical formula of the compound

OBJECTIVES

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MATERIALS

crucible with cover
crucible tongs
lab burner

Spatula
balance
ring stand, ring, and clay triangle
Desiccator

one of the following compounds:
magnesium sulfate, $MgSO_4 \cdot nH_2O$
copper (II) sulfate, $CuSO_4 \cdot nH_2O$

SAFETY: Wear chemical splash goggles, aprons, closed-toed shoes. Wash hands after lab.

PROCEDURE

1. Measure and record the mass of a clean, dry crucible with cover. Obtain about 1–1.5 g of the selected compound and place it in the crucible. Use a spatula to break up any large pieces of the substance by pressing the pieces against the wall of the crucible. Measure and record the mass of the crucible, cover, and compound.

3. Set up a ring stand, ring, and clay triangle for heating the sample. Rest the crucible on the clay triangle. Tip the cover slightly so that it does not fit snugly on top of the crucible. Set up a lab burner and ignite the burner away from the crucible. Adjust the burner to get a small flame.

4. Gently heat the crucible for about ten minutes. Depending on the compound that you selected, the color of the sample may change significantly as the water of hydration is driven out of the crystals.

5. Turn off the burner. Cover the crucible and allow the sample to cool for about ten minutes.

6. When the crucible is cool enough to handle safely, measure and record the mass of the crucible, cover, and contents.

7. Heat the crucible of your sample for five more minutes, allow it to cool, and measure and record its mass.

8. Continue heating the sample for five minutes at a time, until you have two mass measurements that are within about 0.050 g of each other. If time constraints force you to complete the experiment on a second day, place the crucible in a desiccator until you can continue your work.

9. Dispose of your sample as directed.

DATA TABLE

Compound selected for analysis	
Mass of crucible and cover (g)	
Mass of crucible, cover, and hydrated sample (g)	
Mass of hydrated sample (g)	
Mass of crucible, cover, and dehydrated sample – 1st weighing (g)	
Mass of crucible, cover, and dehydrated sample – 2nd weighing (g)	
Mass of crucible, cover, and dehydrated sample – 3rd weighing (g)	
Mass of crucible, cover, and dehydrated sample – 4th weighing (g)	
Mass of dehydrated sample (g)	
Mass of water evolved (g)	

DATA ANALYSIS

Verify the proper chemical formula for the hydrate you were given (Copper (II) sulfate X-hydrate.) Show all calculations, with explanations of what you did, in your lab book. All calculations will be written in 3 steps:

- Statement telling what you are calculating
- Equation explaining how you will calculate this value
- Math, including all units

1. Calculate the initial mass of the hydrate.

2. Calculate the mass of water driven off.

3. Calculate the mass of remaining anhydrous compound.

4. Calculate the moles of water driven off.

5. Calculate the moles of anhydrous compound using your experimental mass.

6. Determine which compound you likely had.

7. . If you had not heated the sample long enough to remove all the water of hydration, how would your subsequent calculations have been affected?

CONCLUSION

State the purpose of your work in this lab. State what you learned about your compound. Cite evidence from your data and calculations to explain your conclusion.