

Determining the Formula of a Hydrate

Overview

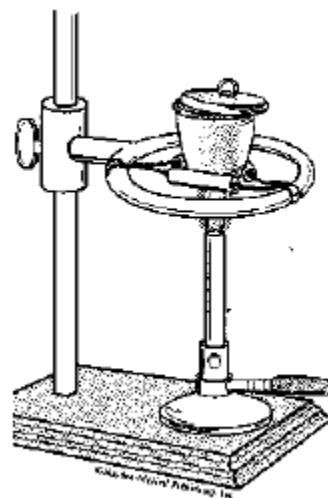
The label on a bottle of hydrated copper (II) sulfate has been torn and the formula is unknown. Your task is to determine the exact formula of the hydrate ($\text{CuSO}_4 \cdot x\text{H}_2\text{O}$). Heating measured portions of a hydrated salt results in dehydration of that salt.

Procedure

To do this analysis, you and your classmates should divide into groups to design experiments, to run several experiments, and to collect data. Some of you will decide to perform specific experimental runs using different masses of the hydrated salt while others may choose to replicate data. Each person should conduct the experiment at least once. As a group, you should decide what information to tabulate on the board.

Suggestions for running the experiment:

1. Set up your ring stand as shown.
2. Weigh a clean, dry crucible and its lid.
3. Adjust the height of your ring so that the bottom of the crucible rests at the top of the inner blue flame.
4. With the crucible lid on top of the crucible but slightly ajar, heat the empty crucible and lid for two minutes. Allow to cool to room temperature. Obtain the exact mass.
5. Repeat the heating, cooling, and weighing step. This technique is called "heating to constant mass."
6. Now place the sample of hydrated salt in the crucible and obtain the mass. Record both the mass and your qualitative observations.
7. With the lid ajar, heat the salt so that it completely dehydrates. Use crucible tongs to monitor the progress of your reaction. Record your qualitative observations.
8. When you have heated your sample enough to dehydrate it, turn off the burner, place the lid firmly over the crucible so water cannot reenter the vessel and allow the crucible and its contents to cool to room temperature. Use crucible tongs to handle the crucible and lid.
9. After the crucible has cooled to room temperature, determine the mass of the product.
10. Heat to a constant mass. Repeat the heating and cooling until the mass of your product is within 1% of the previous mass. Record all masses and qualitative observations in your notebook.
11. Dispose of the products in the labeled beaker in the lab. Wash all *cool* equipment thoroughly and clean your lab station.



Analysis

How can you determine the composition and chemical name of the hydrated salt?

Evaluate your tabulated results with your classmates. You may find it useful to consider the following questions as you conduct your class discussion:

1. What can we learn from the mass of the product, anhydrous copper (II) sulfate? For example:
 - a. How much copper (II) sulfate was in the reactant?
 - b. How do we know this and why is it important?
 - c. What happened to the mass of the salt as the reaction progressed? Why?
 - d. How is the Law of Conservation of Mass involved?
2. How do your results compare with those of your classmates?
3. What claim can you make about composition of the hydrated salt you used as a reactant? How does your evidence support your claim?
4. Working with your classmates, write a balanced chemical equation that represents with the hydrated salt is heated to produce an anhydrous salt. Is this a chemical reaction or physical process?