

## PERCENTAGE COMPOSITION OF HYDRATES

Reminder – Goggles must be worn at all times in the lab!

### PRE-LAB DISCUSSION:

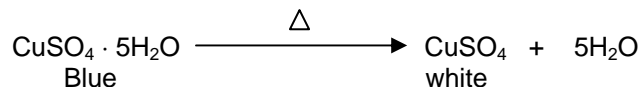
**Hydrates** are ionic compounds (salts) that have a definite amount of water as part of their structure. This “water of hydration” is released as vapor when the hydrate is heated. The remaining solid is known as the **anhydrous salt**. The general reaction for heating a hydrate is:



The  $\Delta$  sign means that heat is applied. The percent of water in a hydrate can be found experimentally by accurately determining the mass of the hydrate and the mass of the anhydrous salt. The difference in mass is due to the water lost by the hydrate. The percent of water in the original hydrate can be calculated easily:

$$\% \text{H}_2\text{O} = \frac{\text{Mass of water}}{\text{Mass of hydrate}} \times 100$$

In this experiment, a hydrate of copper (II) sulfate ( $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ ) will be studied. The change from copper (II) sulfate pentahydrate to anhydrous copper (II) sulfate is accompanied by a change in color.



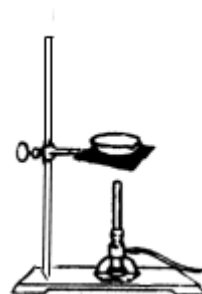
This investigation should aid in the understanding of the composition of hydrates, simple decomposition reactions, and the Law of Definite Composition.

### PURPOSE:

Determine the percent of water in a hydrate.

### PROCEDURE:

1. Clean and dry your evaporating dish.
2. Prepare your ring stand set-up as shown in the diagram at the right.
3. Place your empty evaporating dish on the wire gauze and heat the dish with the hottest flame for 3 minutes. This is done to be sure that the evaporating dish is absolutely dry.
4. Using crucible tongs, remove the dish from the apparatus. Place it on a pressed fiber pad and allow it to cool for several minutes.
5. Using a balance, find the mass of the cooled evaporating dish. Record this mass in the Observations and Data section. Never weigh an object when it is hot because heat waves tend to be circular and upward (convective), which tends to make objects appear to weigh less.
6. With the evaporating dish on the balance, measure into it exactly 2.000 grams of copper(II) sulfate penta-hydrate. Be sure the spatula is very clean to avoid contamination. Record the mass of the dish and the hydrate in the Data section.
7. Place the evaporating dish and the hydrate on the wire gauze. Gently heat the dish by moving the burner back and forth around the base. Increase the heat gradually. Avoid any popping and spattering.
8. Heat strongly for 5 minutes or until all of the blue color has disappeared. During the heating, a glass stirring rod may be used to “spread” the solid and break up larger portions of the hydrate. Be sure not to pick up any of the solid on the stirring rod. If the edges of the solid appear to be turning brown, remove the heat momentarily and resume heating with a cooler flame.
9. Allow the evaporating dish to cool for two minutes. Immediately find the mass of the dish plus the anhydrous salt, and record the mass in the data section. The dish must be weighed before the compound reabsorbs water from the atmosphere.
10. When you have finished weighing the dish and salt, place the dish back on the counter and squirt some distilled water onto the anhydrous salt. Record any change in appearance in the Data section.
11. When you have finished, the anhydrous salt can be thrown into the waste containers, and your evaporating dish washed.



## RESULTS:

### Data

Remember to record masses to **three** decimal places

1. Mass of evaporating dish \_\_\_\_\_ g
2. Mass of dish + hydrate \_\_\_\_\_ g
3. Mass of dish + anhydrous salt \_\_\_\_\_ g

### CALCULATIONS Remember to show all of your work.

1. Calculate the mass of water lost from the hydrate.
2. Find the percent of water lost from the original hydrate (remember that percentage is “the part divided by the whole, multiplied by 100”).
3. Calculate the Theoretical yield: This is where we find out how well you did. Theoretical yield is the yield you should have gotten if you had done everything perfect.
  - a. Using the periodic table, add up the weight of the five water molecules
  - b. Next, add up the weight of the entire compound, including the five water molecules.
  - c. Theoretical percent of water (“the part that is water, divided by the weight of the whole compound, multiplied by 100”):
4. Error Calculation: To find your error, take the difference between the Theoretical yield and your actual yield. Your result should be expressed as a positive number (absolute error – absolute value).
5. Percent Error: To find your percentage error, follow the following formula. For high school, anything under 10% error is great. In college, you will be graded on the % error, and they expect it be within 2 – 3%.

$$\text{Percent error} = (\text{your error/theoretical yield}) \times 100.$$