NAME: HONORS CHEMISTRY

SECTION: Lab: Percent Water in a Hydrate

Hydrates are salts that, when they formed, included water molecules within their chemical structure. Not all chemicals form hydrates. Different chemicals tend to form hydrates with different numbers of water molecules. The ratio of water to moles of the compound can be determined experimentally by heating to remove the water to create an **anhydrous** compound.

When you make a new compound in the laboratory, you need to determine its formula. One of the first steps in doing this is to find the relative amounts of the elements in the compound. These relative amounts are expressed as the percent composition—the percent, by mass, of each element in a compound.

The percent by mass of an element in a compound is the number of grams of the element divided by the grams of the compound, multiplied by 100%:

$$\% \text{ mass of element E} = \frac{\text{grams of element E}}{\text{grams of compound}} \times 100\%$$

The percent composition of a compound has as many percent values as there are elements in the compound. These percentages must add up to 100%.

In this lab, you will experimentally determine the percent water in an unknown hydrate and use this data to identify your hydrate.

Objective

- Use percent composition data to identify an unknown hydrate

Materials

Safety goggles
Utility clamp
Spatula
Ring stand
Test tube clamp
Wire gauze
Balance
Test tube
Bunsen burner
Unknown hydrate A, B or C

Safety

Always wear safety goggles when working in the lab. When working with open flames, tie back hair and loose clothing. Do not touch hot equipment. Remember, hot glass looks cold! Copper(II) sulfate pentahydrate is a skin and respiratory irritant. Zinc sulfate heptahydrate is a skin and mucous membrane irritant.

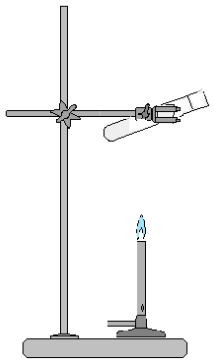
Roles

Project Manager _____

Quality Control Manager _____

Materials Manager _____

Figure 1



Procedure

1. Read through the entire procedure and create an appropriate data table in your notebook.
2. Set up a ring stand with a utility clamp attached high enough for the lit Bunsen burner to move underneath, as shown in Figure 1.

3. Measure and record the mass of an empty test tube to the nearest 0.01 g.
4. Use a spatula to transfer about 2 g of hydrate to the test tube. Record the letter of your unknown hydrate: A, B, or C.
5. Observe and record the color and appearance of your unknown hydrate.
6. Measure and record the mass of the test tube and hydrate to the nearest 0.01 g.
7. Hold the test tube almost horizontally with a test tube clamp.
8. Gently tap the test tube until the hydrate is spread out over the lower third of the tube.
9. Slide the test tube into the utility clamp so that the test tube is suspended almost horizontally, with the open end slightly elevated. Make sure that the open end of the test tube is pointed away from everybody at the lab table.
10. Light and adjust the Bunsen burner.
11. "Sweep" the bottom of the test tube with the top portion of the burner flame.
12. Continue "sweeping" the flame along the lower third of the test tube. Occasionally sweep over the top of the test tube until no more water vapor escapes from the tube and there are no more changes in the appearance of the hydrate (~5-15 minutes).
13. Turn off the Bunsen burner and let the tube cool for a few minutes.
14. Use the test tube clamp to remove the tube from the utility clamp and carefully set the tube on a piece of wire gauze. Allow the tube to cool for 10 minutes or until it no longer radiates heat.
15. Measure and record the mass of the tube and its contents after heating to the nearest 0.01 g.
16. Observe and record the color and appearance of the contents after heating.

Calculate the following: (Be sure to show all your work in the lab report. Follow significant figure rules!)

- The original mass of the hydrate
- The mass of the water lost upon heating
- The percent water in the hydrate

Analyze and Apply Show all of your work!

1. When you heated the salt in the lab, was this a chemical change or a physical change? What evidence supports your answer?
2. Your unknown is one of the following hydrates:

   $CuSO_4 \bullet 5H_2O$
   $MnCl_2 \bullet 4H_2O$
   $ZnSO_4 \bullet 7H_2O$

   For each of the above hydrates, calculate the following:
   a. The gfm (molar mass) of the total compound
   b. The combined mass of the water molecules only
   c. % water in the hydrate
3. Write out the complete names for each of the above hydrates.
4. Compare the experimental % water of your hydrate to the calculated percent water of the hydrates from question 1. What do you think is the identity of your hydrate? Explain how you arrived at your answer.
5. Assume that you have correctly identified the unknown. Calculate the percent error in your experiment.

Conclusion:
In your conclusion, *restate your findings* and identify major sources of error in this experiment.