Chem 11 Name: _____

FORMULA OF A HYDRATE LAB

Unit 2: The Mole

Introduction:

Many salts that have been crystallized from a water solution appear to be dry, but when they are heated, large amounts of water are given off. The crystals often change colour when the water is released. This suggests that water is a part of their crystal structure. These compounds are called hydrates. When these compounds are heated strongly in a crucible, the water is driven off, leaving an anhydrous compound. In this experiment, you will be given an unknown hydrate and asked to find the percent of water in the hydrate. This calculation will help you to determine the empirical (chemical) formula of the hydrate.

When your sample of copper sulphate hydrate is heated, the compound decomposes into copper sulphate and water.
However, if the sample is heated too strongly (above 600°C) then the copper sulphate will decompose into copper (II) oxide and sulphur trioxide gas.

Purpose:

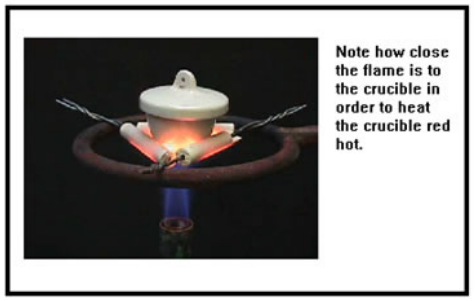
You should be able to write a purpose, based on the information presented in the Introductory information above.

Materials:

Safety goggles Bunsen burner Crucible and cover Crucible tongs Electronic Balance Lab stand and ring clamp Clay triangle Pipette / dropper Waste container (at the front of the classroom)	5.00 g of hydrate $CuSO_4 \cdot \mathbf{x}H_2O$ Water

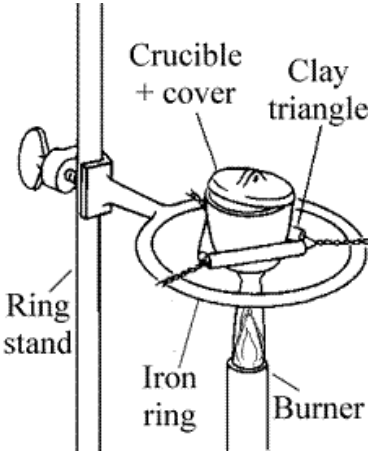
SAFETY CONSIDERATIONS

Any students working without goggles on will be asked to stop their labwork immediately.



Handle Crucible carefully with Crucible tongs. Do NOT touch crucible with your bare hands, as it will be **RED HOT!**

Equipment set-up:



Procedure:

1. Record the mass of a clean dry crucible.
2. You will be given a sample into your crucible so that is one-fourth to one-third full. This is about 5 g of hydrate. Record the exact mass of the crucible and hydrate.
3. Set up the equipment as shown on the previous page. **USE EXTREME CAUTION!** Light and adjust the Bunsen burner to have a proper blue flame.
4. Place the crucible on the triangle and begin heating. Gradually increase the heat until the bottom of the crucible is a dull red. Maintain this temperature for approximately 5 minutes. Record any observations as the hydrate is heated. **If the contents inside the crucible start to turn yellow you are heating to too strongly. Reduce the heat!!!**
5. Turn off the burner and allow the crucible to cool COMPLETELY (for 5 minutes or more). Handle the crucible with tongs. This is to prevent burning yourself, as well as to prevent the transfer of oils and moisture from your hands to the crucible and sample. Record the mass of the cooled crucible and contents.
6. Reheat the crucible for another 1 to 2 minutes to make sure that all of the water is completely driven off. (Your observations will signal when your sample is completely dried.) Turn off the Bunsen burner and allow the crucible to cool COMPLETELY (5 minutes or more). Record the mass again.
7. **If the mass that you determined in step 5 does not agree with the mass you have recorded in step 6 (to within ± 0.03g) continue the heating / mass – determination process. (Repeat Step 6 as many times as necessary, to ensure that your sample is completely dried, yet not turning yellow or burnt black).
8. Once your masses agree to within ± 0.03g and the crucible is completely cooled, add a few drops of water to the crucible. Note any changes in the substance.
9. Return the crucible and contents to the teacher at the front of the room. **DO NOT** throw any of your substances into the sink or into the garbage!!!! Put all other equipment away.

OBSERVATIONS:

DATA:

Be sure to report all data and calculations with the proper number of sig figs, uncertainties, and proper units

Mass of empty crucible	
Mass of crucible plus hydrate	
Mass after first heating	
Mass after second heating	
Mass after third heating (if necessary)	

CALCULATIONS:

Be sure to show all of your calculation steps very clearly in your lab report.

PART I: Mass of Water in a sample of Hydrate:

Mass of Hydrate: _____

Mass of Anhydrous Salt: _____

Mass of Water: _____

PART II: Ratio of Moles of H_2O to moles of Anhydrous Salt:

1) Using the Mass of water produced (see PART I), find the moles of water.

2) Using the Mass of Anhydrous $CuSO_4$ salt produced (see PART I), find the moles of the anhydrous $CuSO_4$.

3) Calculate the percentage (by mass) of water in your sample.

PART III: Simplest Ratio and Empirical Formula:

1) Using your two calculations from PART II, write a formula in this format:

X mole $CuSO_4$ • **Y** mole H_2O

2) Reduce your X:Y ratio to the simplest possible ratio, by dividing both X and Y by whichever is the smallest number (X or Y)

for example, if someone finds the ratio: 12 : 24

Then the simplest ratio can be found by: $\frac{12}{12} : \frac{24}{12} = 1 : 2$

QUESTIONS:

1. Write a balanced chemical equation for the dehydration of the copper sulphate hydrate. What type of change occurred in this lab? Physical or Chemical? How do you know?
2. If you did not heat the hydrate long enough, how would this affect the empirical formula that you found in Part III, #2? Be **very specific** in your answer.
3. If you heated the copper sulphate for too long at too high of a temperature, it may have decomposed further. Write a balanced equation for this decomposition reaction. If this reaction happened, how would this have affected the empirical formula that you found in Part III, #2? Be **very specific** in your answer.
4. What does anhydrous mean? Which chemical in our lab calculations is anhydrous? Be **very specific** in your answer.

DISCUSSION:

1) **SOURCES OF ERROR.** Aim to report at least 2 sources of error. Use your lab report format as a guide to completing this section correctly. You may also want to draw from some of the answers to the questions above, to complete this section correctly and thoroughly.
2) **PERCENT ERROR.** The accepted value for the moles of water is 5.00. Calculate your percent error. Use your lab report format as a guide to completing this section correctly.
3) **RELEVANT THEORY.** Draw on your knowledge of Unit 2 concepts so far, as well as some of the information presented in this lab handout, to thoroughly present (and elaborate on) the related theories and concepts that were employed in this lab. Be careful to follow the required format that is detailed in your lab report format.

CONCLUSION. Write an appropriate concluding sentence.