***LAB— Honors* [20 pts]**
Empirical Formula of a Hydrate

Name _____
Lab Partner _____
Period _____ ***Date*** _____

Purpose: To determine the percent of water in $CuSO_4$ hydrate ($CuSO_4 \cdot x\ H_2O$) and the empirical formula of $CuSO_4$ hydrate.

Introduction: In any ionic crystal lattice, there are small holes between ions. If these holes are large enough, water molecules get incorporated into the crystal lattice. Water molecules are attracted to the ions in the crystal because water is a polar molecule (has a strong dipole)-- the positive and negative ends are attracted to the charged ions. Hydrated crystals appear perfectly dry, yet when heated they lose large quantities of water. You will heat your hydrate, measure the change in mass, and calculate the mass of water which had been stuck in the crystal lattice.

Materials provided: Crucible w/lid, Bunsen burner, ring stand with ring & clay triangle, crucible tongs, $CuSO_4$ hydrate, and balance

***LAB WRITE-UP**: On a separate sheet of paper, complete all parts of the lab specified below.*

Procedure: SAFETY GOGGLES MUST BE WORN!!!!!

1) Set up a ring stand with ring and clay triangle. Set up your Bunsen burner. Get tongs and a crucible.
2) When the crucible is cool enough to touch, mass the crucible (no cover) on a balance. Record mass.
3) Put enough of the blue $CuSO_4 \cdot x\ H_2O$ in the crucible to fill it ¼ to ⅓ full. Record total mass.
4) Place the crucible w/hydrate on clay triangle and heat for at least 5 minutes or until the compound turns all white.
5) Remove crucible with tongs-- put a cover on and let it cool. When cool enough to touch, determine mass of crucible w/ anhydrate. (No cover!!!) You have recorded the mass of anhydrate after the first heating. ***The timing is important here*****:** *You don't want to wait too long, because this gives the "anhydrous" crystal more time to grab water from the air. However, if you don't wait long enough, the hot crucible will create convection currents which have the effect of "buoying" up the crucible.*
6) **Clean up:** The sample can be disposed of into a trash can. Wash out your crucible, and return it to the oven for drying. Return all ring stands and rings and tongs to their proper places.

Data: [4 pts] Fill in all experimental data. UNITS!!

mass of crucible_____
mass of crucible + hydrated crystal_____
mass of hydrated crystal_____
After heating:
mass of crucible + anhydrous crystal_____
mass of anhydrous crystal_____
mass of water in hydrate_____

Calculations and Results:

a) [3 pts] Show your calculation to find the percent mass of water in the $CuSO_4$ hydrate. Label all substances and use units. **PLEASE put up your value on the board, so we can compare class values**.

b) [3 pts] Show all necessary calculations to determine the full empirical formula of the $CuSO_4$ hydrate. (HINT: Find moles of anhydrous $CuSO_4$ and moles of water. Then, divide each by the smallest value to find *x*. Round answer to 2 sig figs. Write the empirical formula.)

Post-Lab Questions:

1) [1 pt] When doing your lab, how did you ensure that you had driven off all of the water of hydration?

2) [1 pt] The accepted percent mass of water in $CuSO_4$ hydrate is _____%. The accepted empirical formula of the $CuSO_4$ hydrate is $CuSO_4 \cdot \quad H_2O$. Do your experimental results predict too much or too little water in your hydrate then the accepted amount?

3) [1 pt] If one's experimental results predicted too much water, it means that the change in mass due to heating was too great. This is typically because the mass of the anhydrous was too low. Give one good reason which would account for low anhydrous mass.

4) [1 pt] If one's experimental results predicted too little water, it means that the change in mass due to heating was too small. This is typically because the mass of anhydrous was too high. Give one good reason which would account for high anhydrous mass.

5) If *Epsom salt*, $MgSO_4 \cdot x\ H_2O$, is heated to 250°C, all the water of hydration is lost. On heating a 1.687 g sample of the hydrate, 0.824 g of anhydrous $MgSO_4$ remains.
   a) [3 pts] What is the mass percent of water in the hydrate?

   b) [3 pts] What is the empirical formula of the hydrate?