Lab #4: Percent Composition of a Hydrate

Objectives:

1. To find the percent of water of a hydrate.
2. To determine the empirical formula of a hydrate.

Introduction:

Ionic compounds often separate from water solution with molecules of water incorporated into the solid. Such compounds are referred to as *hydrates*. Several examples include washing soda or sodium carbonate decahydrate ($Na_2CO_3 \cdot 10H_2O$), gypsum or calcium sulfate dihydrate ($CaSO_4 \cdot 2H_2O$) and Epsom salt ($MgSO_4 \cdot 7H_2O$). In writing the formula, a dot is used to separate the formula of the ionic compound from that of water, and is viewed as an addition sign in determining molar mass. Hydrates will lose all or part of their water of hydration when exposed to air or heated. Frequently, this dehydration is accompanied by a colour change. The remaining ionic compound is known as the *anhydrous* version of the compound.

Pre-lab: (Show all work and necessary units)

1. Calculate the molar masses of the three hydrates listed in the introduction. Show all your work.
2. Calculate the percent of the water in Epsom salt – magnesium sulfate heptahydrate.
3. How much anhydrous $MgSO_4$ would remain behind after strongly heating 25.0 g of $MgSO_4 \cdot 7H_2O$? (Hint: Use the answer from the previous question and assume all water is lost.)
4. Write the formula for copper (II) sulfate and calculate its molar mass.

Materials:

Bunsen Burner and Starter	Iron Ring	Crucible & Crucible Tongs
Rubber Hose	Ring Stand	Copper (II) Sulfate Hydrates

Procedure:

1. Setup the ring stand with iron ring and ring. Place the clay triangle over the ring to hold the crucible.
2. Measure and record the mass of a clean, dry, empty crucible.
3. Measure out 2 to 3 g of the copper (II) sulfate hydrate in the crucible. Record the mass. Place the crucible in the clay triangle.
4. Light the burner with a flame that is approximately 3 to 4 cm high (1.5 to 2 inches for the imperialist) and position the flame under the crucible so that the inside blue cone is just below the crucible. While heating, be ready to adjust the height or remove the burner in case of excess spattering.
5. Heat the hydrate for 5 to 10 minutes and allow for cooling. Take the mass of the crucible and contents and record the result in trial 1 of the observation table.
6. Repeat steps 4 and 5 until a consistent mass is obtained.
7. Record any qualitative observations (i.e. spattering, spilling, smoke).

Observations:

Mass of Crucible (empty):	
Mass of Crucible and Hydrate *Before* Heating:	
Mass of Crucible and Anhydrous *After* 1st Heating: 2nd Heating: 3rd Heating:	
Qualitative Observations:	

Analysis:

1. Calculate the mass of the water lost during the heating.
2. Determine the percent composition of water and the anhydrous in the hydrate used.
3. If the empirical formula for the hydrate is $CuSO_4 \cdot xH_2O$, find the value of x.
4. Write the complete name and formula of the hydrate based on your calculations.
5. Calculate the molar mass of the hydrate.

Evaluation:

1. The actual percentage of water in the hydrate is 36.08%. Determine the percentage error.
2. Describe two possible sources of experimental error in the procedure.
3. Describe ***and*** explain two changes you will observe or measure if the anhydrous is left on the lab bench for a few days.

Conclusion:

Summarize what you have learned from this lab.