Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Per\_\_\_\_\_\_\_\_\_

**Formula of a Hydrate**

**Background Information**

Some chemical compounds, especially inorganic salts, incorporate water into their crystalline structures. These salts, when they have absorbed water, are called **hydrates**. **Anhydrous salts** are salts that can form hydrates but which have had all the water driven off, usually by heat. Hydrated salts are characterized by the number of moles of water molecules per mole of salt.

The water of hydration of nickel(II) chloride (NiCl2) is six moles H2O for every one mole of NiCl2. The hydration reaction is shown below. The hydrate in this reaction is called nickel(II) chloride hexahydrate.

**NiCl2 + 6H2O 🡪 NiCl2·6H2O**

The formula of this hydrate shows the molar amount of water incorporated into the crystal structure. The dot between the salt formula and the water formula indicates that the water is part of the crystal structure. For most hydrates the amount of water included in the formula is only important when trying to measure molar amounts of the salt. You need to know the true formula weight (molar mass) in order to measure out the mass needed to give a certain number of moles. The chemical importance of the water of hydration is minimal since it can be driven off by heat or simply dissolve away if the salt is dissolved in water.

In this experiment you will remove the water of hydration from a known mass of hydrated copper sulfate by heating the compound in an evaporating dish:

**CuSO4·xH2O(s)🡪 CuSO4(s) + xH2O(g)**

By knowing the mass of the anhydrous salt and the mass of water driven off through heating, the formula of the hydrate can be determined.

**Prelab Questions**

1. Explain what a hydrate is.
2. Draw a particle diagram of each of the following:

BaCl2 •2 H2O

2 H2O

BaCl2

1. Complete the Chemical Reaction

BaCl2 •2 H2O Heat\_\_> \_\_\_\_\_\_\_\_\_\_\_\_\_ + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

And, explain how the starting mass compares to the ending mass if heated in an open container.

4. A hydrate of magnesium sulfate (MgSO4 · xH2O) has a mass of 13.52 g. This sample is heated until no water remains. The anhydrous MgSO4 has a mass of 6.60 g. Determine the formula of the hydrate.

Write a **Problem Statement** using the EDR as a guide**.**

**Data**

*Read the procedure* and use your EDR **to make a quantitative and a qualitative data table**. Make sure it includes all units and uncertainties. **The tables must be word processed** before being turned in.

**Design**

**Materials**

1 evaporating dish

tongs

1 hot plate

1 balance

Copper(II) Sulfate \* \_\_\_H2O

**Safety**

Wear goggles at all times

Keep hair and loose clothing away from flame

Evaporating dish will be hot, cool on hot pad or in sink, watch your fingers

**Procedure**

1. Heat a clean evaporating dish on the hot plate for 1 to 2 minutes. Let cool and weigh. Record evaporating dish weight.

2. If you are at an **odd number table, add approximately 1 gram** of the copper sulfate hydrate crystals to the evaporating dish, weigh and record. If you are at an **even number table, add approximately 2 grams.**

3. Heat the evaporating dish containing the hydrate on the hot plate. Adjust the hot plate setting to 4 or 5 and heat for approximately five to seven minutes. Note the color change. Let cool for approximately five minutes and weigh.

4. Reheat the evaporating dish with copper sulfate again for about five minutes, let cool and weigh. If the masses of the two weights are within 0.05 grams of each other, use the smaller mass and calculate the mass of anhydrous salt present. If the masses of the two trials are not within 0.05 grams of each other, reheat for about two minutes and weigh. Continue to reheat until the masses are within 0.05 grams of each other.

**Data Processing and Presentation**

**Calculations**– Use the following to lead you through calculations. Follow your EDR as a guide and all work must be on your own piece of paper.

1. Mass of anhydrous salt.
2. Mass of water removed by heating.
3. Molar mass of anhydrous salt (CuSO4).
4. Moles of anhydrous salt.
5. Moles of water removed by heating.
6. Ratio moles of water to moles of anhydrous salt. (Include all significant figures)
7. Whole number ratio moles of water to moles of anhydrous salt.
8. Formula of the hydrate.
9. Percent Error for empirical formula. (Use unrounded moles of H2O and whole number moles of H2O)

% error = [(theoretical value – experimental value) / theoretical value] **x 100%**

**Analysis and Conclusion Questions:**

1. Compare the *calculated* unrounded value for CuSO4 to water ratio with the theoretical value. Support with data.
2. Identify one logical source of experimental error.
3. Explain how that error affected your results (the moles of H2O calculated). Support your explanation with numbers.