



Chemistry

Name: _____

Section _____ HYDRATE COMPOSITION LAB Date: _____

Composition of a Hydrate

Lab #20

Pre-Lab Discussion:

Many substances incorporate water molecules into their crystal lattice. One such compound is barium chloride which has two water molecules for every formula unit of the salt. The formula for barium chloride dihydrate is $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$, where the dot in the formula indicates two water molecules bonded to the BaCl_2 . Blue copper (II) sulfate crystals also include water bonded into the crystal lattice. Heating can remove the water molecules as indicated by a change to an ashen gray color. In this experiment, you will determine the number of water molecules in copper sulfate crystals by measuring the mass of the hydrate before and after heating and then using the equation:

$$\text{Percent H}_2\text{O} = \frac{\text{mass of evaporated H}_2\text{O}}{\text{mass of hydrate}} \times 100$$

Research Questions:

How can the percent of water in copper(II) sulfate hydrate be determined?

Materials:

| | | | |
|------------------|----------------|--------------------|----------------|
| balance | ring stand | iron ring | clay triangle |
| scoopula | crucible tongs | striker | Tirrill burner |
| evaporating dish | ceramic pad | copper(II) sulfate | |

Safety Notes:

Caution: You must wear goggles and aprons during this lab.

Caution: the evaporating dish will be EXTREMELY hot and will cause severe burns if touched before cooling for 7 minutes.

Warning: placing even a slightly warm object on a balance will give an incorrect mass; if the object is too hot it can ruin the balance.

Method:

1. Set up the ring stand, ring, and triangle as shown. Obtain the instructor's approval before continuing.
2. Obtain a clean, dry evaporating dish. Heat the empty dish as instructed for 5 minutes.
3. Allow the dish to cool for 2 minutes on the ring and triangle.
4. *Using crucible tongs*, remove the evaporating dish to the ceramic pad and cool for 8 more minutes.
5. Weigh and record the mass of the empty dish.
6. Obtain an approximately 3 g sample of copper(II) sulfate hydrate sample from the instructor. Working over a sink, transfer the sample to the evaporating dish. Weigh the evaporating dish and sample and record the mass on the data table.
7. Place the dish and sample on the same heating apparatus used in Step 2. Warm the dish and sample by waving a burner flame under the dish for about one minute. *If you hear any popping sounds or see the sample turning any color besides a light gray, you are heating too strongly. Remove the flame and wait about 15 seconds before resuming heat.*

8. After warming the dish and sample, heat for 10 more minutes using a very low burner flame. *Again, any color changes besides light gray indicate too strong a heat.*
9. Allow the dish to cool for 2 minutes on the ring and triangle.
10. *Using crucible tongs*, remove the evaporating dish to the ceramic pad and cool for 8 more minutes.
11. Weigh and record the mass of the evaporating dish and the dried sample (1).
12. Repeat from step 7 heating for 5 minutes instead of 10 minutes. Record dried mass (2).
13. Clean up your lab area and put equipment away. The dried sample can go in the trash.

Data Collection and Processing:

| Data Table | | |
|--|-------------|-----|
| Mass of the empty evaporating dish | (a) | g |
| Mass of the dish and CuSO ₄ hydrate crystals | (b) | g |
| Mass of the dish and dried CuSO ₄ crystals (1) | (c) | g |
| Mass of the dish and dried CuSO ₄ crystals (2) | (d) | g |
| Mass of dried CuSO ₄ crystals | (d - a) | g |
| Mass of water of hydration | (b - d) | g |
| Percent water in CuSO ₄ hydrate | (Calc. #1) | % |
| Moles H ₂ O | (Calc. #2a) | mol |
| Moles CuSO ₄ | (Calc. #2b) | mol |
| Value of <i>x</i> in CuSO ₄ • <i>x</i> H ₂ O | (Calc. #2c) | |

Calculations:

1. Calculate the percent water by mass. [Show all work, units, and substitutions.]

$$\text{Percent H}_2\text{O} = \frac{\text{mass of evaporated H}_2\text{O}}{\text{mass of hydrate}} \times 100$$

2. The gfm of CuSO₄ is 159.61 g/mol and the gfm of H₂O is 18.02 g/mol. Calculate:

a. Moles H₂O:

b. Moles CuSO₄:

c. Value of *x* in CuSO₄•*x*H₂O (moles H₂O / moles CuSO₄)

Conclusions and Evaluations:

1. The accepted value for the percentage of water in copper(II) sulfate crystals is 36%. Calculate your percent error. [Show all work, units, and substitutions.]

2. Give two reasons why the evaporating dish must be cool before measuring its mass.

3. Why did we measure the mass of the anhydrous salt as soon as it was cool (instead of waiting till the next day, for example)?

4. Explain how the results of the entire class support the Law of Definite Composition.

5. Explain why we repeated Steps 7 – 10 and also the advantage of doing this.

Applications:

1. What did YOU (personally) learn?

2. By whom and how can any idea, principle, or activity in this lab be used in the real world? Remember, the *principle* comes from this lab but the *example* comes from the real world.
