Formula of a Hydrate

Name____________________________

Introduction to Hydrates

Many ionic compounds have water molecules incorporated into their crystal structures. Such compounds are called hydrates. An ionic compound without any water locked inside its crystal structure is called an anhydrate. To emphasize the presence of discrete water molecules in the chemical structure, the formula of all hydrates shows the water of hydration separated from the rest of the chemical formula by a dot. The dot does not mean "multiply by", it means "loosely attached to." A coefficient before the H_2O indicates the number of water molecules inside the compound for each anhydrate unit.

Two examples are:

- sodium acetate trihydrate $NaC_2H_3O_2 \bullet 3\ H_2O$ (1 mole of salt (or anhydrate) for every 3 moles of water)
- iron (III) phosphate tetrahydrate $FePO_4 \bullet 4\ H_2O$ (1 mole of salt for every four moles of water)

PRE-LAD - Do this on this page (in pencil) before coming to class. *Show your work in the space. NWNCNK*

1. On a separate sheet make a Data/Results table - In your Google Lab Sheet please.
2. Calculate the *theoretical* percentage of water in iron(III) phosphate tetrahydrate.
3. If a student measured 9.72 g of a sodium carbonate hydrate and 3.61 g of sodium carbonate anhydrate (without the water attached)
   a. calculate the mass of water removed from this hydrate during heating.
   b. Calculate the moles of water removed during heating.
   c. Calculate the moles of the anhydrate that resulted from this heating.
   d. From your calculation in b & c, determine the whole number ratio of moles of water/moles of anhydrate.
4. In the lab a student measured 13.30 g of a barium chloride hydrate and after heating, the anhydrate weighed 11.16 g,
   a. calculate the *experimental* percent of water in this hydrate.
   b. Later you were told that this compound is a dihydrate, calculate the *theoretical* percent of in this hydrate.
   c. Do you suppose the error source for the experimental trial was caused by salt popping out of the dish, or not heating to dryness? Justify.

Materials

At the Lab bench shared by 2 groups

- vial of copper(II) sulfate hydrate ×2 (~5 g)
- evaporating dish ×2
- tongs & scoop ×2
- ring stand, ring, & burner ×2
- tap water wash bottle ×2
- lighter or matches
- tile for cooling evaporating dish

Procedure - In this LAD the salt (or anhydrate) part of the hydrate that you are testing is *copper(II) sulfate*.

A. Measure the mass of a clean dry evaporating dish

B. After using the tare button, put all of the hydrate into the evaporating dish and measure the mass of the hydrate. (It doesn't matter what mass, but whatever amount you use, you need to record the exact amount.)

C. Place the evaporating dish over the burner and heat the hydrate gently for 5 minutes, then strongly for about 10 minutes, or until the color change is complete.
Observation: Do you see any of the water leaving?

D. Allow the dish to cool and measure the mass of the dish and its anhydrate contents.

E. Heat as many more times as necessary to be sure you have heated to a constant mass. (We are hopeful for only two heatings.)

Process the Data - Part A - *Go to the web site: Unit F LAD 6F1 page to enter the data requested.*

In this LAD the salt (or anhydrate) part of the hydrate that you tested was *copper(II) sulfate*.
At the top of your data table, write the chemical formula for the salt part of the hydrate in this LAD.

1. Calculate the mass of the water that was removed during the heating.
2. Convert the mass of water from #1 to moles of water.
3. Calculate the mass of the anhydrate.
4. Convert the mass of anhydrate from #3 to moles of anhydrate.
5. Calculate the mole ratio of moles of water to moles of anhydrate. (water/anhydrate)
6. Use the information from the ratio in #5 to write the formula for this hydrate in the format as shown in the examples above.

Process the Data - Part B

An alternative method of analyzing the data with mass percentages (include this in your data table)

7. Use calculation #1 from above to calculate the *experimental* % water in the hydrate.
8. After having seen the class data and having established the known formula for the compound, use the formula to calculate the *theoretical* % water in the hydrate.
9. Go to the web site: Chapter 6 LAD 6.1 page to enter the data requested.

LAD F1 (pg 3 of 3) Formula of a Hydrate

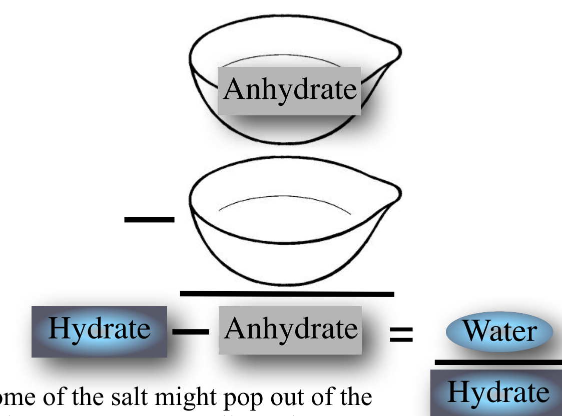
Post-LAD Questions

1. List two reasons as to why is it important to wait until the dish cools before weighing?
(Do NOT answer that we are waiting for all of the water to leave. If it didn't leave while heating…it's not going to leave while cooling.)

2. Did you observe any water escaping during the heating process? Why can or can't you see it?

3. Are there any visual changes to the salt as it changes from a hydrate to an anhydrate? What are those changes?

4. If you had a flame that was not adjusted properly with enough air, the methane may not completely combust. Incomplete combustion caused the formation of soot (unburned carbon) which may stick to the bottom of the evaporating dish. Would this source of error cause your percentage of water in the hydrate appear too small, too large, or have no effect? *Be sure and state how this error would affect your measurements and follow those changes completely through the calculations.*



5. If your flame was too hot at the very beginning of the heating process, some of the salt might pop out of the dish. Would this source of error cause your percentage of water in the hydrate appear too small, too large, or have no effect? *Be sure and state how this error would affect your measurements and follow those changes completely through the calculations.*