EMPIRICAL FORMULA OF A HYDRATE LAB

Many salts crystallized from water solutions appear to be perfectly dry, yet when heated, they liberate large quantities of water. The crystals change form, even color, as the water is driven off. Such compounds are called **hydrates**. The number of moles of water present per mole of anhydrous salt (salt minus water of crystallization) is usually a whole number. One example is the hydrate of copper (II) sulfate. Its blue crystals look and feel dry. Yet each mole of hydrate contains 5 moles of water. Its formula is $CuSO_4 \cdot 5\ H_2O$. The dot between the $CuSO_4$ and the 5 H_2O does NOT mean multiplication. It indicates that 5 water molecules are bound to the other atoms. The molar mass of $CuSO_4 \cdot 5\ H_2O$ is 249.6 g/mole.

In this experiment, you will determine the empirical formula of a hydrate. You will do so by heating the hydrate to drive off the water. You will measure the mass of the water driven off the hydrate by heating it and you will measure the mass of the anhydrous salt that remains. By calculating the number of moles of water driven off and the number of moles of anhydrous salt remaining, you will be able to find the empirical formula of the hydrate.

Materials

3 - 5.25" glass test tubes
ring stand, wire gauze, iron ring, & burner
hydrated salt
wood splint spatula for transferring solid to test tubes

Procedure

PUT YOUR GOGGLES & APRON ON NOW!

1. Obtain and label three dry test tubes #1, #2, and #3. Weigh the test tubes to the nearest 0.01 g. Record these data on the data table below. Remember to zero the balance each time you use it. Also remember to use the same balance throughout the experiment.

2. Add 0.5 - 0.8 g of the hydrate to each of the test tubes. Do not pack the crystals.

3. Reweigh the three test tubes and record the masses, again to the nearest 0.01 g.

4. Lay the test tubes on the square wire gauze. Turn the corners of the wire gauze up slightly so the test tubes do not roll off. You must be able to heat the entire length of the test tube with the burner to drive off all the water of hydration. Place the wire gauze and the three test tubes on the iron ring and heat the three samples gently and evenly along their entire lengths.

5. Heat the test tubes by gently waving the burner flame back and forth underneath the wire gauze. Record any observations you make during the heating process.

6. Heat for approximately 5 minutes. Allow the test tubes to cool before handling. This may take several minutes. (Remember that the glass is very hot even though it may appear to be cool.)

7. Weigh the three samples and record the data.

8. Reheat the three samples for an additional five minutes, cool, and reweigh until the mass of the anhydrous salt and test tube is constant. What does "anhydrous" mean?

DATA TABLE

		Trial 1	Trial 2	Trial 3
1	mass of empty test tube (g)			
2	mass of hydrate & test tube (g)			
3	mass after 1st heating (g)			
4	mass after 2nd heating (g)			
5	constant mass of anhydrous salt & test tube (final mass, g)			
6	mass of water driven off (g)			
7	# of moles of water			
8	molar mass of anhydrous salt (_______________)			
9	grams of anhydrous salt (g)			
10	moles of anhydrous salt			
11	mole ratio of H_2O to anhydrous salt			
12	Empirical formula of hydrate - experimental			
13	Empirical formula of hydrate - theoretical			

Calculations
Show **all** calculations necessary to calculate the empirical formula for the hydrated salt. You have to show your work for only one trial.

Grading
To receive full credit, the data table must be filled in completely and correctly for all three trials. You must include a sample calculation sheet along with your data table.

**CRITERIA IN ORDER TO RECEIVE CREDIT FOR THIS ASSIGNMENT:
* All numbers are clear & legible.
* All numbers are labeled with their correct units.
* Calculations are shown in detail.
* Calculations are shown in a neat and logical order.
* No messy cross-outs or eraser marks.

* Failure to follow these criteria will result in your having to re-submit your lab. It will be considered a late grade when you re-submit.

THIS LAB IS DUE ON:

Writing Formulas Assignment

PURPOSE:

~ Practice writing formulas for compounds given the name of the compound
~ See how common these compounds are in our everyday lives

ASSIGNMENT:

~ Find ingredient labels (NOT "Nutrition Facts") of different items
~ Find names of compounds that you know how to write the formula for
~ Cut out, copy, scan, or cut and paste the label you found the name(s) on
~ Tape, glue, or staple the label onto a regular-sized piece of paper (8 ½" x 11")
~ Underline or highlight the name of the compound on the label, if possible.
~ Write the formula for the compound next to the label.

REQUIREMENTS:

~ Only write the formula for a compound one time each on this assignment – even if you find the compound on several different labels.
~ You can use as few or as many labels as you need to get your required number of compounds.
~ You MUST have the label or a copy of each label included when you hand in the assignment.
~ Please number your compounds so it is easier for me to grade.

~ Standard level classes – total of 10 DIFFERENT compounds

EXAMPLE:

Chicken, Chicken By-Product Meal, Corn Meal, Brewers Rice, Chicken Fat (preserved with mixed Tocopherols, a source of Vitamin E), Ground Whole Grain Sorghum, Dried Beet Pulp, Fish Meal, Chicken Flavor, Dried Egg Product, Fish Oil (preserved with mixed Tocopherols, a source of Vitamin E), Brewers Dried Yeast, Potassium Chloride, Salt, Fructooligosaccharides, Monosodium Phosphate, Choline Chloride, Minerals (Ferrous Sulfate, Zinc Oxide, Manganese Sulfate, Copper Sulfate, Manganous Oxide, Potassium Iodide, Cobalt Carbonate), Vitamin E Supplement, DL-Methionine, Calcium Carbonate, Vitamins (Ascorbic Acid, Vitamin A Acetate, Calcium Pantothenate, Biotin, Thiamine Mononitrate (source of vitamin B1), Vitamin B12 Supplement, Niacin, Riboflavin Supplement (source of vitamin B2), Inositol, Pyridoxine Hydrochloride (source of vitamin B6), Vitamin D3 Supplement, Folic Acid), Rosemary Extract.

~ "Monosodium Phosphate" should be just sodium phosphate (No Greek prefixes when there is a metal in the compound!) Na^{+1} PO_4^{-3} Formula = Na_3PO_4
NOTE: Be sure not to repeat this compound even if you see it listed as "disodium phosphate", "trisodium phosphate", or "sodium phosphate"
~ Notice that I did not highlight "Choline Chloride", "Thiamine Mononitrate", or "Pyrodoxine Hydrochloride" in green. THAT'S BECAUSE WE DIDN'T LEARN HOW TO WRITE THE FORMULAS FOR THOSE COMPOUNDS! This assignment is not meant for you to look up the formulas on the internet – it is meant for you to practice what you learned in class!
~ There are many acceptable compounds on this label. I have highlighted these compounds in green. Not all are addressed in these directions.
~ Some labels may incorrectly use transition metals in compounds. For example, the label above says "Copper Sulfate". That is incorrect because it does not tell the oxidation number of copper. Use the Periodic Table given in class to find the most common oxidation number of the transition metal and use that.

CAVEATS:

~ Be sure to read the entire name of the compound - from one comma to the next. There will be ingredients listed like "sodium aluminum phosphate" or "calcium disodium EDTA". Neither of these is acceptable for this assignment.

~ There are some polyatomic ions that we haven't learned or used, but will be acceptable to use. These polyatomic ions include: silicate, molybdate, selenate, and selenite.*

EXTRA NOTE:

~ It seems that pet food, nutritional drinks, and vitamins have many acceptable compounds in them. You may want to look to these types of items to start.

~ This assignment is due at the beginning of the class period on ______________________________.

You will be working by yourself on this project. This project will be worth 40 points.

* These polyatomic ions follow the same pattern as other elements in the same group. For example, "silicate" implies that silicon is in the polyatomic ion. Well, silicon is in the same group as carbon, and therefore it behaves like carbon. We know that there is a polyatomic ion called carbonate, and it has the formula CO_3^{-2}. It would stand to reason that silicate would be SiO_3^{-2}. Follow this example if you decide to use molybdate, selenate, or selenite.