



Quantitative Determination of the Empirical Formula for a Metal Sulfate Hydrate Compound*

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**2000
Lesson
#14
*FIRST DRAFT**

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Suggestions for Teachers

Purpose:

The purpose of this experiment is to determine quantitatively the empirical formula for a metal sulfate hydrate compound.

Objective:

- Students will be able to carry out a guided inquiry investigation.
- Students will be comfortable handling and manipulating evaporating dishes and watch glass covers.
- Students will become more comfortable safely using a Bunsen burner.
- Students will obtain more practice using an electronic balance and accurately massing substances.
- Student will obtain more practice in quantitative experimentation (significant digit manipulation as well).
- Students will get more practice in writing across the curriculum.

Materials:

Compound A	$\text{BaSO}_4 \cdot 7\text{H}_2\text{O}$
Compound B	$\text{BaSO}_4 \cdot 5\text{H}_2\text{O}$
Compound C	$\text{BaSO}_4 \cdot 5\text{H}_2\text{O}$
Compound D	$\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$

- Beaker (250 ml or 400 ml)
- Evaporating dish
- Watch Glass Cover
- Goggles
- Apron
- Bunsen burner
- Ring stand
- Ring
- Wire gauze
- Forceps
- Flint
- Dessicator
- Electronic balance
- Nichrome wire loop

Lab/Lesson

Here's the Story:

Douglas and Arthur are employed by TruGreen Chemical Company. Arthur has been employed there for 6 years and Douglas for 6 months. Arthur is the manager for shipping and receiving and Douglas is a “gofer”/“scut” worker. Arthur and Douglas have known one another for years.

Packages A, B, C, and D arrive on Friday (delivered by UPS) at 4:55 PM (quitting time is 5:00 PM). Douglas (who has an extremely hot date) is perturbed by this late delivery on a Friday! He decides to stash the packages on the side of the loading dock until Monday morning. It rains from early Saturday morning until late Sunday evening. Douglas arrives to work Monday morning only to find that the labels on packages A, B, C, and D did not have permanent color markings! All he can make out on the packages is that they are all metal sulfate hydrates. Packages A, B, C, and D are going to be needed by TruGreen Chemical Company on Thursday morning for an extremely important experiment. Douglas will be on the unemployment line if he cannot re-label these packages. In a panic he runs to his friend Arthur and relates his story of woe! Arthur calms him and tells him that he knows of some extremely bright and ambitious students in Washington, DC at Benjamin Banneker High School who might be willing to take on the task of identifying these compounds.

Your task in this guided inquiry investigation is to determine the empirical formula of the metal sulfate hydrate compounds. Each pair of you will receive vials B and vials C and D. Each vial contains a hydrate. The guide is as follows: Please see “Teacher Notes” at the end of this document. Please feel free to offer suggestions or alterations to the guide, but as always please get an affirmation from me prior to altering the guide. Remember the guide is just a series of suggestions for accomplishing your task. I strongly encourage you to make your own suggestions.

Helpful Hints:

- Make sure your evaporating dish fits firmly inside your beaker that you selected.
- Keep accurate records of your vials.
- Develop a method using the materials given to determine the metal in the metal sulfate hydrate.
- Determine the formulas for the hydrates.
- Please pay strict attention to significant digits rules in your calculations.

Assessment:

You may create a scientific poster or a lab report to communicate your results. As usual, please include:

1. Title
2. Names of researchers involved in the project
3. A statement of the problem
4. The materials used
5. The methods used
6. The results (include tables, etc. here)
7. Finally your conclusions (Teachers should provide a sample rubric at this point)

Reference:

This lab is adapted from a lab by Merrill, copyright 1984.

Teacher Notes:

- Teachers should determine an appropriate stopping point for students. A suggested stopping point is that the evaporating dish and cover can be stored in the dessicator overnight.
- Teachers should also take care to discuss safety features specific to this lab with students. I would strongly suggest guiding students to using a ring attached to a ring stand to secure the beaker with hot water. Also review the standard safety issues of using a Bunsen burner.
- Teachers should also guide students to a discussion of how to heat the evaporating dish with a hot plate or Bunsen burner. I would suggest heating slowly at first and then gradually increasing the heat to avoid spattering of the product.
- Teachers should also make sure that students are comfortable in converting from grams to moles, and the methods for determining an empirical formula. I also would review flame tests by discussing fireworks displays with students. Flinn Scientific has an excellent (and inexpensive) lab unit on metal flame tests.

Teachers should also share their rubrics with students before hand and make sure that students are knowledgeable about the assessment scheme.