

Determining the Formula of a Hydrated Crystal

PROBLEM

What are the proportions of water to salt in a hydrated crystal?

INTRODUCTION

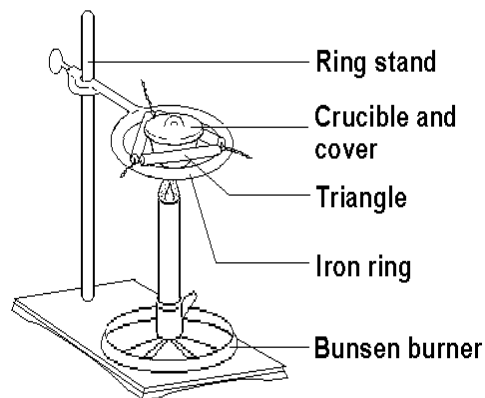
Hydrated crystals are solid solutions containing ions of salt and molecules of water. As solutions of some salts evaporate and crystals begin to form, attractions between the ions and the water molecules pull the water into the crystal structure. When this happens, the water of crystallization or hydration is taken up in definite proportions to the ions. Heating the hydrated crystals drives the water out of the crystal, resulting in the formation of an anhydrous powder. In this laboratory investigation, you will measure the mass of a hydrated crystal. Then you will dehydrate the crystal and measure the mass of the anhydrous salt for comparison to determine the percentage of water in the hydrated crystal. Finally, you will use your knowledge of stoichiometry to determine the formula of the hydrated crystal.

MATERIALS (per group)

Balance; Bunsen burner; crucible and cover; hydrated crystal (copper II sulfate, barium chloride, magnesium sulfate, etc.); ring stand and iron ring; safety goggles; scoop; tongs; triangle; wire gauze

PROCEDURE

1. Put on safety goggles. *CAUTION: Wear safety goggles whenever you use the Bunsen burner.* Set up a ring stand with a triangle and a clean crucible as shown in the diagram at the right. Light the Bunsen burner with a striker. Adjust the flame so the tip of the cone is under the crucible. Heat the crucible for two to three minutes to be sure it is completely dry.
2. Using tongs, remove the crucible from the heat in two steps, first the cover and then the crucible itself. Set the crucible and cover aside on a wire gauze to cool.
3. When the crucible and cover are cool, measure their combined mass with a balance. Record the mass of the crucible and cover in the data table on the next page.
4. Add about 3-5 grams of hydrated crystal to the crucible. Measure the exact mass of the crucible, cover, and hydrated crystal. Record the mass of the crucible, cover and hydrated crystal in the data table on the next page. Determine the exact mass of the hydrated crystal and record the result.
5. Place the crucible, cover, and contents in the triangle and begin heating to dryness. Begin heating, gently at first, for a few minutes. Then continue heating strongly for ten minutes.
6. Set the crucible, cover and contents aside on a wire gauze to cool. When they are cool, measure their combined mass with a balance. Record the mass for the first heating in the data table.
7. Place the crucible, cover, and contents back in the triangle and heat strongly for five minutes. Then set the crucible, cover and hydrated crystal aside on a wire gauze to cool. When they are cool, measure their combined mass with a balance. Record the mass in the data table on the next page.



8. If the mass of the crucible, cover, and contents is different than it was for the previous heating, repeat step 7 until the mass is constant. Then calculate the mass of the anhydrous crystal, the mass of the water driven off, and the percentage of water in the hydrated crystal. Record the results in the data table below.
9. Obtain the accepted value for the percentage of water in the hydrated crystal from your teacher and do an error analysis.
10. Determine the empirical formula of the hydrated salt (mole ratio of anhydrous salt to water) using methods of stoichiometry.

OBSERVATIONS

1. Mass of empty crucible and cover _____
2. Mass of crucible, cover, and hydrated salt _____
3. Mass of hydrated salt _____
4. Mass of crucible, cover, and anhydrous salt after
 - [a] first heating _____
 - [b] second heating _____
 - [c] third heating _____
 - [d] final heating _____
5. Mass of anhydrous salt _____
6. Mass of water _____
7. Percentage of water _____
8. Theoretical percentage of water (from teacher) _____
9. Error analysis
 - [a] Absolute error _____
 - [b] Percentage error _____

10. Stoichiometry

ANHYDROUS SALT	WATER
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- | | | | |
|-----|---------------------------|-------|-------|
| [a] | Formula of | _____ | _____ |
| [b] | Formula mass of | _____ | _____ |
| [c] | Moles of | _____ | _____ |
| [d] | Mole ratio of | _____ | _____ |

11. Formula for hydrated salt (salt•xH₂O) _____

CONCLUSIONS

1. What are the likely sources of error in this investigation? _____

2. What is the purpose of multiple heatings? _____
