# Experiment Eleven

## The Formula of a Hydrate

### Procedure

This experiment is divided into three sections from which sections 1 and 2 should be done simultaneously in order to use time efficiently.

### Part 1 Determining the water of hydration of a compound.

Heat a nickel or porcelain crucible in order to remove any moisture present. Your heating set up should look similar to that in Figure 1.

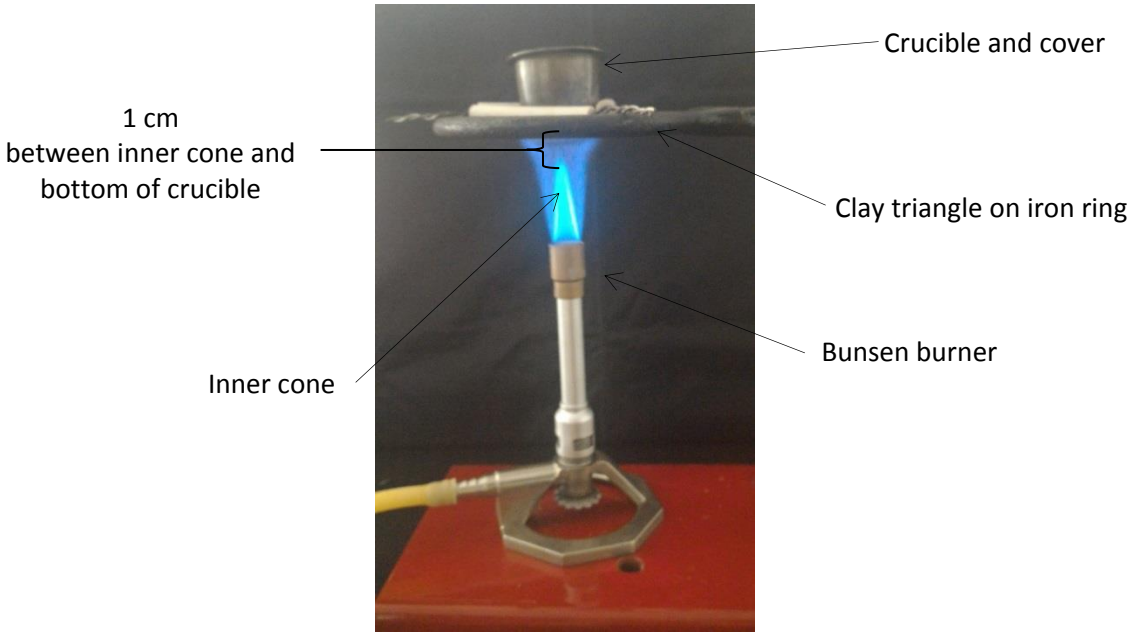


Figure 1. Heating setup for a crucible.

Heat the crucible using the hottest flame. This is achieved by adjusting the burner so the tip of the inner cone of the flame is about 1 cm below the bottom of the crucible. The crucible should be heated until redness and then allowed to cool down on a wire gauze with ceramic center as in Figure 2. DO NOT HANDLE THE HOT CRUCIBLE WITH YOUR FINGERS! USE CRUCIBLE TONGS TO HANDLE A HOT CRUCIBLE OR ANY RED HOT ITEM! The appropriate way of handling your hot crucible is displayed in Figure 3.

After your crucible and its lid have cooled down to room temperature, weigh them using an analytical balance. DO NOT WEIGH YOUR CRUCIBLE AND LID IF THEY ARE STILL HOT OR WARM! Record the mass in your notebook.

Figure 2. Cooling a crucible on a wire.

Figure 3. How to handle a hot crucible.

Ask your instructor for an unknown solid hydrate and record the unknown number. Place the unknown in your crucible and reweigh it with the lid on. Place the crucible with its lid on back on the clay triangle and heat it gently for five minutes. After five minutes, take the lid and maintain it slight open over the crucible as in Figure 4, and heat it to redness for another fifteen minutes. To accomplish this, you need to heat the crucible as you did when you were removing its moisture.

Figure 4. Crucible with its lid ajar.

This allows for the water to evaporate. After the fifteen minutes of heating the crucible to redness, turn of your Bunsen burner and close the crucible. Allow it to cool down to room temperature. Weigh on an analytical balance your sample, crucible and lid after they have cooled down. DO NOT WEIGH YOUR SAMPLE, CRUCIBLE AND LID IF THEY ARE STILL HOT OR WARM! You will obtain a wrong experimental mass. Repeat the heating procedure to ensure the compound has lost all its water and reweigh. Calculate the formula for your hydrate. The unknown hydrate may be one of the compounds in Table 1.

| Compound | Molecular Formula |
|---|---|
| Magnesium sulfate heptahydrate | $MgSO_4 \cdot 7\ H_2O$ |
| Nickel (II) sulfate pentahydrate | $NiSO_4 \cdot 6\ H_2O$ |
| Copper (II) sulfate hexahydrate | $CuSO_4 \cdot 5\ H_2O$ |
| Managenese (II) chloride tetrahydrate | $MnCl_2 \cdot 4\ H_2O$ |
| Sodium acetate trihydrate | $NaCOOCH_3 \cdot 3\ H_2O$ |
| Calcium sulfate dihydrate | $CaSO_4 \cdot 2\ H_2O$ |
| Lithium sulfate monohydrate | $LiSO_4 \cdot H_2O$ |

Table 1. Identity of Unknown Hydrates

## Part 2 Determining which compounds are hygroscopic and which are efflorescent

Remember this part can be done while you are doing Part one of the experiment.

Take a clean and dry watch glass and place a few crystals of calcium chloride on it and rapidly weigh the sample. Repeat this procedure for zinc sulfate heptahydrate and iron (III) chloride. Let your three samples sit for an hour on your bench. After an hour has passed reweigh your samples and record the weight. What has happened to each of your samples? Did their appearance change? Do their initial and final weights differ? If your sample increased weight, this is because it picked up water from the moisture in the air. A compound that does this is considered hygroscopic. If your sample did not change in weight it is considered efflorescent. Which of your experimental compounds where hygroscopic and which were efflorescent? Record your observations.

## Part 3 Determining which compounds are hydrates.

Take a small amount of amount of copper (II) sulfate (a tip full of a spatula should be enough), and place it in a clean and dry test tube. Gently heat the sample for one minute using the Bunsen burner (Figure 5) . MAKE SURE THE OPENING OF YOUR TEST TUBE IS NOT POINTING IN THE DIRECTION OF ANOTHER PERSON. Observe and record what happens. Did droplets form on the side of the test tube after it was heated? If your answer is yes, the compound is a hydrate. The droplets observed are water. This is one of the properties of a hydrate. Compare the color of the compound before heating to what it looks afterwards. Record all your observations. Another property of a hydrate is that it dissolves in water. Wait for your sample to cool down and then add a couple of milliliters of water to your sample. Did it dissolve? If it did we have confirmation that your compound is a hydrate. Write down your observations in your notebook. What can you conclude about a hydrate? Repeat this procedure with sodium chloride and calcium carbonate, and magnesium sulfate.

Figure 5. Heating a sample in a test tube.