Experiment 4
Formula of a Hydrated Salt
Introduction

Sometimes salts combine chemically with water and form hydrates in which a definite number of water molecules combine with the ions of a salt to form a crystal. Although chemically bound, this water of hydration maintains its characteristic composition in much the same manner as radicals do. For this reason we do not write $H_2ONa_2SO_{14}$, but we write $Na_2SO_4 \cdot 10H_2O$. The dot means that each SO_4^{2-} ion and every two Na^+ ions are associated with 10 molecules of water. Some salts have more than one hydrate; i.e., sodium sulfate forms $Na_2SO_4 \cdot 10H_2O$ and $Na_2SO_4 \cdot 7H_2O$. Hydrates are usually not very stable and all the water may be removed from the hydrated crystal by heating, leaving the anhydrous salt behind.

Many hydrates lose their water of hydration without heating when they are exposed to dry air. These substances are said to be efflorescent. Some salts, which may or may not be hydrates, absorb water from the air until a concentrated solution of the salt is formed. Such salts are deliquescent. They are good drying agents and are very soluble in water. Some anhydrous salts such as $CaCl_2$ may absorb enough water from the air to first form the hydrated crystal and then absorb additional water to form a solution. Many materials such as silk, wool, hair, and tobacco pick up water vapor from the air but do not absorb enough to form a solution. Such materials are hygroscopic.

In this experiment a hydrated salt will be heated to constant weight, removing the water of hydration. The loss of weight will be the weight of water present in the original salt. From the weight of the water in the sample, the molecular weight of water, the weight of the anhydrous salt, and the formula of the anhydrous salt (which your instructor will give to you), the percent of water in the hydrate and the number of moles of water associated with one mole of the anhydrous salt will be calculated.

Procedure

Obtain a sample of an unknown from your instructor. Weigh a clean, dry evaporating dish to the nearest 0.01 gram. Empty the contents of the test tube into the evaporating dish and weigh again.

Place the dish and contents on a wire screen and heat with a low flame. (This is necessary to keep from losing any of the solid). Gradually increase the heat after it appears that most of the water has been removed. After heating the dish and contents for about 15 minutes, let it cool and weigh. Reheat the dish and contents for about 5 minutes with a full flame to drive off any water that remains. Cool and weigh again. If there was a loss of weight between the first and second weighing, the salt was not dry the first time and the process should be repeated until a constant weight is obtained.

Calculate the percent of water in the hydrate. Check your results with your instructor and obtain the correct percent of water and the formula of the anhydrous salt. Calculate the formula of the hydrated salt.

Experiment 4   **Name** _____

Formula of a Hydrated Salt

Data and Report Sheet

Sample number. . . . . ._____

Weight of dish and sample before heating   _____g

Weight of dish   _____g

Weight of sample   _____g

Weight of dish and sample after first heating   _____g

Weight of dish and sample after heating to constant weight _____g

Weight of water in sample   _____g

Percent of water in sample   _____%
     Calculations:

Formula of anhydrous salt .... ._____

Moles of water in sample (use data above) . . . . _____moles

Calculations:

Weight of anhydrous salt in sample (use data above).. . . . . _____g

Moles of anhydrous salt in sample. . . . . _____ moles

Calculations:

Formula of hydrated salt. . . .. _____ . _____H_2O

Calculations:

Problems:

1. What is the percent of oxygen in $Al_2(SO_4)_3$?   _____

2. What is the percent of water in $K_2SO_4 \cdot 10 \, H_2O$? _____

3. 10.00 grams of a sample of hydrated $PtCl_4$ are heated and lose 3.00 grams of water. How many moles of water are combined with each mole of $PtCl_4$?

                                              _____

4. Analysis of a sample of hydrated salt shows that it contains 4.86g Mg, 6.20g P, 11.20g O, and 5.40g H_2O. What is the formula of the hydrated salt?