Name _____ Date _____ Period ____

Chem 07-33 Solving Problems in Chemistry (SPIC)

Chapter 5:8 Hydrates from Lab Data

5:8 Hydrates

Some crystals form hydrates as they crystallize from water solutions. These compounds have water molecules adhering to their crystal structure. There is a fixed ratio of water molecules per formula unit. Hydrates are named using the Greek prefixes to name the quantity of water molecules.

calcium sulfate dihydrate	$CaSO_4 \cdot 2\ H_2O$
sodium sulfate decahydrate	$Na_2SO_4 \cdot 10\ H_2O$
Magnesium sulfate septhydrate	$MgSO_4 \cdot 7\ H_2O$

The raised dot indicates that the water molecules are not held tightly and can be driven off by heating the hydrate.

Example 9

In an experiment, a student gently heated a hydrated copper compound to remove the water of hydration. The following data was recorded.

Mass of the crucible, cover, and contents before heating	21.54 g before
Mass of empty crucible and cover	19.82 g container
Mass of crucible, cover, and contents after heating to constant mass	20.94 g after

A. Calculate the experimental percent of water in the compound
B. Calculate the percent error assuming that the compound is copper II sulfate pentahydrate.

Solving Process:

The mass of the original compound is found by subtracting the mass of the container from the total mass before.

$$\%\ H_2O = \frac{\text{g } H_2O \text{ removed}}{\text{g original compound}} \mid 100\ \%$$

$$= \frac{0.60 \text{ g } H_2O}{1.72 \text{ g cmpd}} \mid 100\% = 34.9\%\ H_2O/\text{cmpd}$$

To calculate the percent error, compare the experimentally determined value for the percent water with the value calculated from the formula for copper (II) sulfate pentahydrate, $CuSO_4 \cdot 5\ H_2O$. The calculated percent of water in the compound is 36.0% H_2O/compound.

$$\%\ \text{error} = \frac{|\ \text{expected} - \text{achieved}\ |}{\text{expected}} \mid 100\%$$

$$= \frac{|\ 36.0\%\ H_2O/\text{cmpd} - 34.9\%\ H_2O/\text{cmpd}\ |}{36.0\%\ H_2O/\text{cmpd}} \mid 100\%$$

$$= 3.1\%\ \text{error}$$

Practice Problems

13. Calculate the percentage of each of the following in the compound sodium sulfate decahydrate, $Na_2SO_4 \cdot 10\ H_2O$.
    a. Na b. S c. O d. H_2O

14. Calcium chloride can exist as the anhydrous compound $CaCl_2$ or in three different hydrated forms that are mono-, di-, and hexahydrates. Calculate the following.
    a. The percent calcium in each compound
    b. The percent water in each of the three hydrates

15. In a laboratory experiment, barium chloride dihydrate was heated to completely remove its water of hydration. Calculate:

a. The experimental percent of water
b. The percent of $BaCl_2$
c. The percent error

The data below was obtained in the experiment.

Empty crucible and cover	20.286 g container
Crucible, cover and contents before heating	21.673 g before
Crucible, cover, and contents after heating	21.461 g after