Experiment 42 – Water of Hydration

**Goal:** This is a survey lab where we will observe properties of hydrates through a series of experiments and we will determine the formula of a hydrate.

Formula of a hydrate: AB·xH₂O where x is typically, but not always, a whole number.

    e.g., CaCl₂·2H₂O, Na₂SO₄·10H₂O

Consider the meaning of the formula: CaCl₂·2H₂O means there is 1 mole CaCl₂ to 2 moles H₂O.

Determining the formula of a hydrate is essentially the same as determining an empirical formula. If you know the molar ratio of the formula units to water, then you will have the hydrate formula.

The calculations in the lab book are convoluted, and unnecessarily complicated. For this lab, use the Data and Calculations page and Advanced Study Assignment provided.

**Sample Calculations**

ex. A student weighs a dry crucible and lid and finds the mass to be 23.560 g. Upon addition of a hydrate, MgSO₄·xH₂O, the crucible, lid and sample weigh 30.483 g. After heating to dryness the weight of the crucible, lid and anhydrous MgSO₄ is 27.042 g. What is x in MgSO₄·xH₂O?

\[
\text{MgSO}_4 \cdot x\text{H}_2\text{O} \quad \rightarrow \quad \text{MgSO}_4 + x\text{H}_2\text{O}
\]

(a) mass of hydrate = mass of hydrate, crucible and lid – mass of crucible and lid

\[
\text{mass of hydrate} = 30.483 \text{ g} - 23.560 \text{ g} = 6.923 \text{ g}
\]

(b) mass of anhydrite = mass of anhydrite, crucible and lid – mass of crucible and lid

\[
\text{mass of anhydrite} = 27.042 \text{ g} - 23.560 \text{ g} = 3.382 \text{ g}
\]

(c) mass of water = mass of hydrate – mass of anhydrite = 6.923 g – 3.382 g = 3.541 g H₂O

(d) Calculate molar masses of the components of the hydrate:

\[
\text{MgSO}_4 = 120.4 \text{ g/mol} \quad \text{and} \quad \text{H}_2\text{O} = 18.02 \text{ g/mol}
\]

(e) Calculate the moles of MgSO₄ in the hydrate.

\[
\frac{3.382 \text{ g MgSO}_4}{120.4 \text{ g MgSO}_4} = 0.02809 \text{ mol MgSO}_4
\]
(f) Calculate the moles of water in the hydrate.

\[
\frac{3.541 \text{ g H}_2\text{O}}{1 \text{ mol H}_2\text{O}} = \frac{0.1965 \text{ mol H}_2\text{O}}{18.02 \text{ g H}_2\text{O}}
\]

(g) Calculate the ratio of H\(_2\)O/MgSO\(_4\)

\[
x = \frac{\text{mol H}_2\text{O}}{\text{mol MgSO}_4} = \frac{0.1965 \text{ mol}}{0.02809 \text{ mol}} = 7
\]

(h) Formula of hydrate = MgSO\(_4\)·7H\(_2\)O

ASA: Use the ASA provided – not the one in the lab book.

Procedure: All of it. Use the Data/Calculation page provided – not the one in the lab book.

Waste Disposal: Dispose of all liquids and solids in Heavy Metal Inorganic waste container.