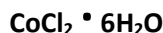


## LAB: Percent Composition of Hydrated Crystals

Crystalline compounds that retain water during evaporation are referred to as being **hydrated** or are said to contain water of hydration. The ratio of moles of water to moles of compound is a small whole number. The formula for the hydrated compound Cobalt (II) chloride hexahydrate is:



For every one formula unit of  $\text{CoCl}_2$  there are six molecules of water. The amount of water in a hydrate can be determined experimentally by heating the compound and driving the water off. The compound with the water removed is known as **anhydrous**.

The molar mass of  $\text{CoCl}_2$  is 129.83 g/mol

The molar mass of  $\text{H}_2\text{O}$  is 18.02 g/mol and the molar mass of  $6\text{H}_2\text{O}$  is  $(6)(18.02 \text{ g/mol}) = 108.12 \text{ g/mol}$

The molar mass of  $\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$  is 237.95 g/mol (The 6 in front of the  $\text{H}_2\text{O}$  needs to be taken into account!)

Therefore, the percent (by mass) of  $\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$  that is water would be found by taking the molar mass of the water in the formula and dividing it by the total molar mass of the entire compound:

$$\% \text{ Water} = \frac{\text{molar mass of } \text{H}_2\text{O in Compound}}{\text{molar mass of Compound}} \times 100\% = \frac{108.12}{237.95} = 45.4 \% \text{ H}_2\text{O}$$

Similarly, the percent (by mass) of  $\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$  that is  $\text{CoCl}_2$  would be found by taking the molar mass of the  $\text{CoCl}_2$  in the formula and dividing it by the total molar mass of the entire compound:

$$\% \text{ CoCl}_2 = \frac{\text{molar mass of } \text{CoCl}_2 \text{ in Compound}}{\text{molar mass of Compound}} \times 100\% = \frac{129.83}{237.95} = 54.6 \% \text{ CoCl}_2$$

### PRELAB QUESTIONS:

1) For each of the following compounds, write out the correct formula and calculate the percent composition of each compound (i.e. what percent is water? AND what percent is the anhydrous compound?).

A) Magnesium sulfate heptahydrate

B) Manganese sulfate monohydrate

C) Copper (II) sulfate pentahydrate

D) Copper (II) chloride dihydrate

## Pre-LAB Continued

**Your Hydrated Crystal formula for the lab:  $\text{NiSO}_4 \cdot 6\text{H}_2\text{O}$ . Complete the following calculations**

1) Calculate the total molar mass of the **entire formula** (remember to use the number in front of the  $\text{H}_2\text{O}$ ).

2) Calculate the molar mass of just the **water** in the formula (Use the multiple in front of the  $\text{H}_2\text{O}$ ).

3) Calculate the % composition of water in the Hydrated Crystal. This represents the **THEORETICAL % water** in the crystal.

$$\left( \frac{\text{Molar Mass of Water}}{\text{Total Molar Mass of Compound}} \right) \times 100\% = \text{percent composition of water}$$

In this activity, you will heat a given amount of the hydrate  **$\text{NiSO}_4 \cdot 6\text{H}_2\text{O}$**  to determine the percentage of water in the compound. You will measure the mass of the hydrate before heating and measure the mass of the anhydrous left over after heating. The water will leave the test tube and evaporate into the air. By using the law of conservation of mass, you will be able to calculate the mass of the water that was lost through evaporation.

## Procedure

1) Measure the mass of an empty DRY test tube.

2) Obtain a sample of hydrated crystal from your instructor. Place the crystals in the test tube and measure the mass of the crystals and test tube. (***This is the HYDRATED CRYSTAL.***)

3) Using the test tube clamp and a Bunsen burner, heat the test tube and crystals to remove the water. You should see water leaving the test tube (or condensing at the tip). Heat all of the area of the test tube to remove ALL of the water.

4) Measure the test tube and crystals after heating. Heat a 2<sup>nd</sup> or 3<sup>rd</sup> time to be sure all of the water has been removed. The remaining crystals should be the ***ANHYDROUS CRYSTAL.***

5) Repeat the procedure for a 2<sup>nd</sup> trial.

**DATA TABLE:**

|                                                                          | <b>Trial 1</b> | <b>Trial 2</b> |
|--------------------------------------------------------------------------|----------------|----------------|
| Mass of empty test tube                                                  |                |                |
| Mass of <b>HYDRATED</b> crystal & test tube                              |                |                |
| Mass of <b>ANHYDROUS</b> crystals & test tube<br>1 <sup>st</sup> heating |                |                |
| 2 <sup>nd</sup> heating                                                  |                |                |
| Final mass (of anhydrous crystals & test tube)                           |                |                |

**DATA ANALYSIS / Calculations:**

Show work for all calculations. *Equation/Substitution/Answer*

1) Calculate the Mass of **HYDRATED** crystal **before** heating for each trial.

**Trial 1**

**Trial 2**

2) Calculate Mass of **anhydrous** crystals **after** final heating for each trial. *Use the final mass value for this calculation.*

**Trial 1**

**Trial 2**

3) Calculate the Mass of **water lost** from the hydrated crystals for each trial.

**Trial 1**

**Trial 2**

4) Calculate the **Experimental** % composition of water in the hydrated crystals for each trial.

**Trial 1**

**Trial 2**

5) Calculate the **Average experimental % water** in the hydrate from the 2 trials.

*(over for final calculation & conclusion!)*

6) Calculate the % Error of the **average % water** in hydrate compared to the **actual / theoretical % composition of water**. (*Theoretical %: you calculated this on page 2 of this lab!*).

$$\%error = \frac{|experimental \% - theoretical \%|}{theoretical \%} \times 100$$

**CONCLUSION:**

What are some possible sources of error for the % Water in the hydrate? **Explain how these errors affect data instead of simply listing the errors.**

**\*\***(Simply listing sources of error will not be worth full credit – Remember: ***Claim/Evidence/Reasoning***)