Measuring the Percent Water in Hydrates

Objective: To measure the percent composition of water in hydrates *like* copper sulfate pentahydrate ($CuSO_4 \bullet 5H_2O$).

To practice percent composition calculations using lab data.

Introduction: Hydrates are ionic compounds that have water molecules attached to them with special, coordinate bonds. These water molecules are part of the ionic compound and are part of what determines its properties.

Unlike normal bonds, these coordinate bonds are easily broken. Most hydrates can have the water removed by simply heating them.

$$CuSO_4 \bullet 5H_2O \rightarrow CuSO_4 + 5H_2O$$

This dehydration reaction turns the hydrate into a new form, called an **anhydrate**. Since this compound has different bonds, it has different properties like changes in color.

Safety: The hydrates that you are working with in this experiment are **all safe to handle**. You should still avoid direct skin contact, and wash your hands in case it happens.

You will need to wear goggles throughout the experiment because you will be heating chemicals, which always increases the risk of something unexpected happening.

You will be working with Bunsen burners that are capable of **generating heat in excess of 2000°C**. Super hot! Always be wary of the flame, extinguish when not in use, and remember that **hot glassware does not look different than cool glassware**. When heating chemicals in a Bunsen burner flame in a test tube always **point the opening at a 45° angle away from other people**, and **hold the test tube with a test tube clamp, not your fingers.**

Procedure: Select one of the hydrate compounds from the lab table in the back of the room. Before making any measurements:

- Copy the formula of your hydrate from the container
- Determine the *percent water* in your hydrate using the formula below. This calculation should be very similar to the work we have done in class.

$$\%H_2O = \frac{mass\ of\ ALL\ H_2O\ molecules}{molar\ mass\ of\ compound} \times 100$$

You will need to devise a procedure for how to actually measure the percent composition of water in your sample. Here are some things to consider:

1. You should **use approximately 1 g of any of the hydrates** available in the back of the room.
2. Your experiment should be conducted in a **medium-sized glass test tube**. When heating the test tube, you should hold it with a test tube clamp.
3. You can remove the water from your hydrate by heating it in a test tube over a Bunsen burner flame
4. It is unlikely that you will be able to capture the water that is released during your reaction. You will need to find another way to measure the amount of water lost.
5. It will be very difficult to remove your sample from the test tubes after heating it. If you try you will lose a lot of your anhydrate in the process, leading to a large margin of error. You should start your experiment by recording the weight of a clean,dry test tube.
6. You CANNOT measure the mass of anything HOT! This will result in bad data AND melting my balances!! Very expensive mistake!
7. Record all of your data in a data table in your notebook, and include your calcs as well.
8. Share your data and results with the class on the shared data table. We will use this data to explore some new statistics tools as well as some tricks with spreadsheets!

Once you have devised a procedure, check it with me FIRST. Once you are cleared, get to work! Try to collect all of your data before the end of the period and get it reported online!

Once done with your work, share your data ONLINE in this spreadsheet. You will need this shared data to complete the work below! If you lab group is done early and there is not any shared data available yet, move onto other work and come back to finish this lab in a later class.

What to Turn In:

1. An **objective sentence** for your report, written in your own words, specific to the chemicals that you are using in your experiment.
2. A **data table** containing ALL of the data you collected in your experiment.
3. **ALL of the calculations** showing how you calculated the percent composition of the water in your hydrate.
4. **A separate data table** showing the results of ALL the other groups who calculate the percent composition of water for the same hydrate as you.
5. A calculation of the % composition of water in your hydrate **from the actual formula of the hydrate**. This calculation is similar to what you did in the HW, and is described in the procedure above. This is the expected outcome of your experiment, and should be close to the average you calculated from class data.
6. Data analysis calculations showing:
    a. The average % composition of water in your hydrate from ALL groups
    b. The % error of your average % composition from the expected % composition, calculated from the actual formula