

**SAFETY PRECAUTIONS**

Wear safety goggles at all times.

Never leave flame unattended.

Do not touch hot objects. They look the same as cold objects.

Handle hot crucibles with crucible tongs. Hot porcelain looks the same as cold porcelain.

Always place hot crucibles on wire screen.

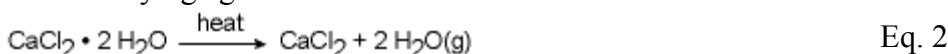
**OBJECTIVES/OVERVIEW**

In this experiment you will determine the percent water in a hydrate.

A hydrate is a solid that contains water in its crystalline lattice. Alum,  $\text{KAl}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$  and plaster of Paris,  $\text{CaSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$  are examples of hydrates. The water molecules occupy regular lattice positions and are present in simple stoichiometric ratios. The theoretical percentage of water present in a hydrate can be easily calculated by dividing the mass of water per mol of hydrate by the molar mass (including water) of the hydrate (Equation 1).

$$\text{Theoretical percent H}_2\text{O} = \frac{\text{mass H}_2\text{O per mol hydrate}}{\text{molar mass}} \times 100 \quad \text{Eq. 1}$$

The water of hydration can often be driven off by mild heating leading to the anhydrous (without water) form of the substance as illustrated in Equation 2. The anhydrous forms of many solids are used as drying agents.



The percentage of water of hydration in a given material can be experimentally determined by heating a weighed sample of the substance to drive off the water and reweighing to determine the mass of water lost. The mass loss divided by the mass of the original sample, multiplied by 100 (Equation 3) will give the percentage of water in the hydrate.

$$\text{Experimental percent H}_2\text{O} = \frac{\text{mass loss}}{\text{sample mass}} \times 100 \quad \text{Eq. 3}$$

**PROCEDURES**

1. Clean a crucible and cover using soap, water and a test tube brush. Rinse with water and dry with a paper towel.

2. Set up a ring stand with a ring and place a Bunsen burner under the ring. Adjust the height of the ring to about 2 inches above the top of the Bunsen burner. Place a clay triangle on the ring. Then carefully light the Bunsen burner.

3. Using crucible tongs, place the crucible with the lid on the clay triangle and heat intensely for 5 minutes to dry the crucible.

4. Remove the crucible and cover and place on a wire screen for at least 10 minutes to cool.

5. When cool, use crucible tongs and transfer the crucible and cover to the balance. Weigh and record the mass to 2 decimal places on the data page. NOTE: Using crucible tongs prevents mass inaccuracies due to contamination of the crucibles and lids with oil and moisture from the skin.

6. Using weigh paper, measure out slightly more than one gram of the sample hydrate. Pour the hydrate into the crucible, replace the cover and weigh again. Record the mass, and then calculate the mass of the sample hydrate.

**Gravimetric Determination of Water of Hydration** Names \_\_\_\_\_

7. With the cover off, place the crucible with sample on a clay triangle. Heat with a Bunsen burner using a low flame for five minutes. NOTE: The low flame prevents spattering of the sample during dehydration.

8. Gradually increase the temperature of the flame until you are using a medium flame and continue heating for an additional ten minutes. **CAUTION: DO NOT ALLOW CRUCIBLE OR SAMPLE TO BECOME RED HOT SINCE UNDESIREED SAMPLE DECOMPOSITION MAY OCCUR.**

9. Immediately place the lid on the crucible, and allow the crucible to cool for at least 10 minutes (or until cool). Make sure you leave the cover on to prevent rehydration from the air.

10. Weigh the crucible and cover and record the mass to 2 decimal places on the data page.

11. Record your results and calculations in the data table.

12. Clean out your crucible in the sink.

**CALCULATIONS/SET-UPS**

Mass of sample	mass of crucible, lid and sample - mass of crucible and lid
Mass of water lost	mass of crucible, lid and sample before drying - mass of crucible, lid and sample after final drying
Percent of water in sample	Experimental percent H <sub>2</sub> O = $\frac{\text{mass of water lost}}{\text{mass of sample}} \times 100$

### DATA TABLE

1. Mass of Empty crucible and cover (grams)	
2. Mass of Crucible with sample and cover (grams)	
3. Calculated Mass of Sample (grams) (#2 - #1)	
4. Mass of Crucible and cover after removal of hydrates (grams)	
5. Calculated Mass of water lost (grams) (#2-#4)	
6. Percent of Water in Sample $\frac{\#5}{\#3} \times 100$	

Bring this data table to the instructor to get the accepted value for this experiment.

Accepted value \_\_\_\_\_

Calculate the percentage error using the following formula:

$$\% \text{ error} = \frac{(\% \text{ of water in sample (\#6)} - \text{Accepted Value (above)})}{\text{Accepted Value}} \times 100$$

Box your answer below.