Overview:

Epsom salt (aka magnesium sulfate) is a combination of MgSO\(_4\) and H\(_2\)O. Many ionic compounds incorporate a fixed number of water molecules into their crystal structures. These are called hydrates. Heat can be used to dehydrate a hydrated salt causing the H\(_2\)O molecules to evaporate and produce an anhydrous salt which often will appear different than its hydrate.

When expressing the formula for a hydrate, it is necessary to notate the fixed number of H\(_2\)O molecules. A large dot is placed between the formula and the H\(_2\)O molecules following the formula for the ionic compound.

For example: CuSO\(_4\) • 5 H\(_2\)O is the formula for copper sulfate. This formula indicates that for every 1 mole of CuSO\(_4\), 5 moles of H\(_2\)O are present.

Purpose: 1) Dehydrate Epsom salt using chemistry procedures and determine the amount of water it contains 2) Use your math skills to determine the mole ratio, or how many moles of H\(_2\)O there are compared to moles of MgSO\(_4\) (Epsom salt) 3) Compare your lab determined mole ratio to the real mole ratio on the box of Epsom salt.

Materials:

- Bunsen burner
- Wire screen (or triangle)
- Scale
- Ring stand w/ ring
- Evaporating dish (or crucible)
- Tongs
- Epsom salt (MgSO\(_4\))

Procedure:

1. Put on your goggles. Secure the iron ring on the ring stand a couple of inches above the height of the burner. Place the triangle/ screen on the ring.

2. Place clean crucible or evaporating dish on the set-up. Light the burner and heat for a couple of minutes to make certain container is thoroughly dry. Turn off burner and cool the container for several minutes until it is comfortable to touch. Record the mass of the dry container.

3. Add about 5 grams of Epsom salt to the container. Record the mass of the container and Epsom salt.

4. Place the container back on the set-up and heat gently with hot flame until the water has been released from the hydrate. This will require about 5 minutes. (see illustration)

5. When no more H\(_2\)O appears to be coming from the hydrate, turn off the burner and cool for several minutes until container is comfortable to the touch. Record the mass of the container and salt.

6. If time allows, reheat the container with salt, cool and find the mass again. If the two final masses agree, you can be confident that you have indeed released all of the H\(_2\)O. If not, continue the heating and cooling as directed in this lab to make sure all the water is released.

7. Put your excess Epsom salt into the trash can and carefully clean out your crucible. All other lab materials need to be ready for the next class.
Data / Observations:

<table>
<thead>
<tr>
<th>Mass of Epsom Salt before and after heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mass of a clean, dry, empty container</td>
</tr>
<tr>
<td>2. Mass of container &amp; hydrated salt (before heating)</td>
</tr>
<tr>
<td>3a. Mass of container &amp; anhydrous salt (after heating 1st time)</td>
</tr>
<tr>
<td>3b. Mass of container &amp; anhydrous salt (2nd time) *repeat until no change in mass</td>
</tr>
<tr>
<td>3c. Mass of container &amp; anhydrous salt (3rd time) *repeat until no change in mass</td>
</tr>
</tbody>
</table>

Calculations / Analysis (must show work):
1. a. Determine mass (g) of H$_2$O lost from your salt (how much did you “cook out?”): Using your data table, determine the numbers to subtract in order to figure out mass (g) H$_2$O.

   b. Determine mass (g) of the anhydrous MgSO$_4$ used in this lab (just the anhydrous salt- not the molar mass). Using your data table, calculate the mass of the anhydrous MgSO$_4$ used.

2. a. Calculate how many moles of H$_2$O were dehydrated from your salt. Use dimensional analysis to covert your grams of H$_2$O (found in 1a) to moles of H$_2$O.

   b. Calculate how many moles of MgSO$_4$ salt. Use dimensional analysis to covert your grams of MgSO$_4$ (found in 1b) to moles of MgSO$_4$.

3. a. Determine the mole ratio of H$_2$O molecules to MgSO$_4$ particles. Divide the moles of H$_2$O (calculated in 2a) by the moles of MgSO$_4$ (calculated in 2b) to determine the ratio of moles of H$_2$O to moles of salt (moles H$_2$O / moles MgSO$_4$). Round your answer to the nearest small whole number.

   b. Write the correct formula for your hydrate using the ratios $1\text{MgSO}_4$•____H$_2$O (use your answer from #3 to fill in the blank).

Questions for Discussion:
1. Copper Nitrate is a hydrate with the following formula: Cu(NO$_3$)$_2$ • 3 H$_2$O. What is the ratio between moles of copper nitrate and moles of water in this hydrate?

2. Why might you need to reheat the salt several times before getting the final mass of the salt?

3. Assume your salt sample released 4.5 grams of water. How many moles of water were in your sample? (Yes, you must use your calculator and dimensional analysis!)

Conclusion: Write a 3-4 sentence paragraph describing the purpose of this lab and your results.