Name: ____

Chemistry 103 Laboratory
University of Massachusetts, Boston

WATER OF HYDRATION

PRELAB ASSIGNMENT

The following problem is similar to the calculation that you will do in lab based on your own experimental data. After reading the experiment, do the calculations and fill in the five blanks.

A sample of solid magnesium sulfate hydrate $MgSO_4 \cdot xH_2O$ is carried through an experimental procedure similar to the one that you will be doing in lab. Part of the data sheet is as follows:

Mass of hydrate	3.6975 g
Mass of anhydrate	1.8059 g
Mass of water lost	
Moles of water lost	
Moles of anhydrate ($MgSO_4$)	
Moles H_2O / moles $MgSO_4$ (written with proper significant figures)	
The integer x in the formula $MgSO_4 \cdot xH_2O$	

There are some solid ionic compounds that have water molecules bound inside the crystal lattice in a definite proportion to the ionic compound itself. One example is copper (II) sulfate pentahydrate which has the formula $CuSO_4 \cdot 5H_2O$. This compound consists of Cu^{2+} copper ions, SO_4^{2-} sulfate ions and H_2O molecules. For each copper ion in the crystal there is one sulfate ion and five water molecules. These proportions can also be stated as follows: for each mole of Cu^{2+} there is one mole of SO_4^{2-} and five of H_2O. Compounds such as this are called "hydrates" because of the presence of the water molecules. In many cases the water molecules are removed, the remaining compound is called "anhydrous", meaning "without water". The formula for anhydrous copper (II) sulfate is simply $CuSO_4$.

In this experiment you will be given the hydrate of barium chloride and will be asked to determine the number of moles of water in the crystal bound to each mole of $BaCl_2$. In other words, if the formula for hydrated barium chloride is $BaCl_2 \cdot xH_2O$, you are asked to determine x, i.e. the number of moles of water molecules bonded to each mole of barium chloride. You can expect that the number x is a small integer, not less than 1 and not more than 15.

IN THE LABORATORY

1. Obtain a crucible and a cover. Scrape out any loose solid that you find, and wash out the crucible. Set up a heating apparatus with a ring pipe-stem triangle as demonstrated in the lab.

The first objective is to dry out the crucible and cover by intense heating over a flame. Even though the crucible appears to be dry there is water adsorbed on its surfaces.

2. Set the crucible on the triangle and set on the crucible cover in such a way that vapors can escape while heating. See the demonstration.

3. Light your Bunsen burner and adjust the gas and air controls so as to obtain a hot flame as indicated by a light blue cone at the top of the barrel. Heat both the crucible and the cover for about five minutes.

4. Shut off the gas and allow the crucible and cover to cool in place on the triangle. After the crucible and cover have cooled to room temperature, carry them to the balance room with a paper towel. Avoid touching the crucible or the cover with your hands because the skin oils deposited will add to their weight.

5. Use an analytical balance to weigh both the crucible and cover and record their weight to 4 decimal places on the data sheet. IF THE CRUCIBLE IS STILL WARM, THIS MASS WILL BE TOO LOW.

Obtain a sample of roughly 2 to 4 grams of $BaCl_2 \cdot xH_2O$ (to be called the "hydrate") in the crucible by the following preweighing method.

6. Place the dry crucible and cover side-by-side on the pan of a triple-beam balance.

7. Move the beam riders to a sum of 2 grams plus the known mass of the crucible and cover. Because the riders are set to a mass greater than the mass of crucible plus cover, the beam indicator will be lower than horizontal.

8. Very carefully and gradually add hydrate to the open crucible until the beam indicator rises slightly above horizontal. Now the crucible contains slightly more than 2 grams of hydrate.

9. Restore the riders to zero and remove the crucible and cover.

10. Weigh the crucible, cover and hydrate on the same analytical balance as before and record the mass on the data sheet.

Subtract the mass of crucible and cover from the mass of crucible, cover and solid. If the difference is not between 2 and 4 grams, figure out what you did wrong, return to the triple beam balance and obtain the proper weight of solid.

11. Again place the crucible on the triangle and position the cover to allow water vapor to escape.

12. Adjust the burner to obtain a cool flame by turning down the barrel, reducing the air in the flame. The flame should not have a light blue cone above the barrel. Begin heating very gently to avoid spattering.

13. After about five minutes increase the intensity of the flame so that the bottom of the crucible glows slightly. IF YOU SEE SMOKE OR SPARKS COMING FROM THE CRUCIBLE, YOUR FLAME IS TOO HOT. Continue heating for about ten minutes.

14. Allow the crucible to cool in place to room temperature, then weigh it together with its cover and record the mass on the first blank at step 14 on the data sheet.

At this point we do not know whether or not all the water has been driven off from the hydrate. The only way to know is to heat it again with intense heat as was done above. If all the water is gone, the weight after this second heating will be close to the previous weight.

15. Reheat the crucible, cover and solid for at least ten minutes*. When it has cooled down, weigh again and record the mass on the second blank. If the two masses are within 0.005 grams, we can assume that all (or enough) of the water has been driven off. However, if the two masses differ by more than about 0.005 grams, you must reheat for ten more minutes and reweigh a third time.

*During the second heating and cooling, it would be a good idea to use scratch paper to carry out the calculations for finding x using your first mass from step 14. If you do not understand these calculations, consult your instructor or teaching assistant.

The term "anhydrate" refers to anhydrous $BaCl_2$.

16. This completes the experimental work. Scrape the solid from your crucible into a waste-paper basket and put away all equipment that you used.

Name ______________________________ Lab Section ______________________________
Partner(s) ___________________________

Water of Hydration

Data

The following atomic weights will be useful.

Hydrogen	1.00794 g/mol
Oxygen	15.9994 g/mol
Chlorine	35.4527 g/mol
Barium	137.327 g/mol

Use enough significant figures in your molecular weights so that the precision of your results is not limited by the molecular weights.

Mass of crucible and cover				From 5.
Mass of crucible, cover and hydrate				From 10.
Mass of hydrate				
Mass of crucible, cover and solid after 3 successive heating steps (Circle the smallest mass and use that value below)				From 14 and 15.
Mass of anhydrate				
Mass of water lost				
Moles of water lost				mol
Moles of anhydrate ($BaCl_2$)				
Moles H_2O/moles $BaCl_2$ (written with proper significant figures)				
The integer x in the formula $BaCl_2 \cdot x\ H_2O$				