EGA: Composition of a Hydrate

The elements hydrogen and carbon combine to form thousands of compounds called hydrocarbons. The formulas of these compounds include CH_4 (methane), C_3H_8 (propane), and C_2H_2 (acetylene).

The simplest whole number ratio of particles of elements in a particle of a compound is called the empirical formula. In this experiment, you will gather evidence that will allow you to calculate the percent composition (barium chloride and water) in the hydrate and then later on, the percent barium and chlorine in the barium chloride. From this data, you will be able to predict the empirical formula of the hydrate.

MATERIALS:

- crucible with cover
- ring stand
- iron ring
- clay triangle
- bunsen burner
- balance
- 50-mL graduated cylinder
- 2- 150-mL beakers
- hot hands
- crucible tongs
- funnel
- filter paper
- distilled water
- lab coat
- goggles
- gloves
- barium chloride hydrate
- 3M $H_2SO_{4(aq)}$ (sulfuric acid)

SAFETY:

If mine are on, yours are on. You do not need gloves for part 1.

Lab coats, goggles, hair back and up, no loose clothing

Use appropriate equipment and care—hot labware and cold labware look the same.

Reminders: Please read but do not include in report sheets.

Chemical:

Wear gloves. Immediately inform your teacher of any chemical spill or accident. If a chemical gets on your skin, rinse the chemical off in the sink with copious amounts of water. If a chemical gets in your eyes, use the eyewash station. If enough chemical gets on you to soak through your lab coat, use the shower.

Bunsen Burner and Fire

Be careful to check the temperature of all surfaces before touching them while using a Bunsen burner or hot plate. Immediately inform your teacher of any fire related accident and shut off your gas valve, if it is on. Be aware of where the fire blanket, fire extinguisher, shower, and emergency gas shut off valve are located around the room.

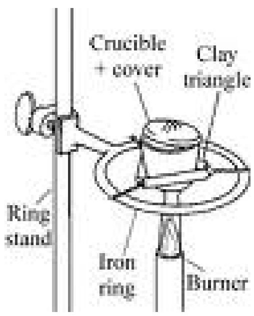
Glassware

Check all glassware for cracks and sharp edges. Immediately inform your teacher of any broken glass. Do not handle broken glass; this is a job for your teacher.

PROCEDURE:

PART 1:

1. Determine the mass of the empty crucible with the cover. Record the mass.
2. Add the contents of the container of barium chloride hydrate to the crucible.
3. Determine the mass of crucible, cover and the hydrated salt. Record the mass.
4. Remove the cover and place the crucible on a clay triangle.



5. Heat the sample slowly for 10 minutes. Then increase the heat until no further change in the salt is apparent. At this point, the salt will appear to be more powdery than crystalline. You may want to use a stirring rod to break up any clumps in the solid.

6. Cover the crucible. Use the tongs to place the crucible in the dessicator or on the base of the iron ring stand to cool.

7. When the crucible has cooled sufficiently, use the crucible tongs to place the crucible on the balance. (The oil from your hands will add to the mass and is a potential source of error if the balances were more precise.) Record the mass of the crucible, cover and salt.

8. Remove the cover, return the crucible to the clay triangle and reheat it for at least 5 minutes. Cover the crucible and allow it to cool, and determine the mass of the crucible, cover and salt again.

9. Continue this process until a constant mass is obtained.

Suggested Data Table Format:

Masses of Materials

		Mass
a	mass of crucible and cover	
b	mass of crucible, cover and salt	
c	mass of crucible, cover and anhydrous salt (1)	
d	mass of crucible cover and anhydrous salt (2)	
e	mass of crucible cover and anhydrous salt (3)	
f	mass of crucible cover and anhydrous salt (4)	
g	mass of crucible cover and anhydrous salt (5)	
h	mass of filter paper	
i	mass of filter paper and precipitate	

PROCESSING THE DATA: Remember to always show all your work in an orderly manner so that anyone reading through your calculations knows where your numbers are coming from and what they "mean".

Part 1:

1. Calculate the percentage composition of water **and** barium chloride in the compound.
2. Calculate the mass ratio of barium chloride to water for the compound.

The ***percent error*** is a way to measure how close a value is to the true value or accepted value.

$$\text{percent error} = \frac{(\textit{experimental value} - \textit{accepted value})}{(\textit{accepted value})} \times 100$$

3. Given that the accepted mass ratio of barium chloride to water is 5.79 g barium chloride/g water, calculate your percent error.

4. Propose probable sources of error that are consistent with the direction of your error.

(*A –% error indicates your value is too low, a +% error indicates your value is too high.*)

PART 2:

10. Transfer the anhydrous salt to a beaker and dissolve the salt in a minimum of 25 mL of distilled water.

11. Add 10.0 mL of 3 M sulfuric acid. Use caution using the acid. Avoid contact with skin—wear gloves.

12. Stir the contents of the beaker thoroughly.

13. Place the beaker on a hot plate **in the fume hood** and heat to boiling. While contents are heating, the other partner should determine the mass of a clean piece of properly folded and labeled filter paper.

15. Set up the funnel using the Erlenmeyer flask as the funnel support.

16. Using beaker tongs,  remove the hot beaker from the hot plate and filter the precipitate from the solution.

17. Allow the filter paper to dry overnight.

18. Determine and record the mass of the dried filter paper and the precipitate.

19. Give the dried filter paper and precipitate to your teacher.

Part 2 Data:

a	mass of filter paper	
b	mass of filter paper and precipitate	

Results Part 1 and Part 2:

a	mass of hydrate	
b	mass of anhydrous salt	
c	mass of water lost	
d	moles of water lost	
e	mass of precipitate	
f	moles of precipitate	
g	moles of barium ions	
h	mass of barium ions	
i	mass of chloride ions	
j	moles of chloride ions	

Part 2:

1. Calculate the moles of water lost by the hydrate.
2. Calculate the mass of barium sulfate ($BaSO_4$) precipitated in part 2.
3. Calculate the moles of barium sulfate ($BaSO_4$).
4. Determine the number of moles of barium ions in the barium sulfate. Assume that 1 mole of barium sulfate = 1 mole of barium ions)
5. Calculate the mass of barium ions in the precipitate. Assume the mass of barium is equal to the mass of the barium ions (electrons have a negligible mass).
6. Calculate the mass of chloride ions (equal to the mass of chlorine atoms) in the original sample.
7. Calculate the moles of chloride ions in the original sample.
8. List the moles of:
   a. barium ions: ____________
   b. chloride ions: ____________
   c. H_2O molecules ____________

9. Determine the lowest whole number ratio of barium ions : chloride ions : water molecules for the hydrated salt.

10. What is the empirical formula of the hydrated barium chloride salt? (Remember the proper way to write the formula of a hydrate.)

11. Cite possible sources of error in the experiment. Be sure your sources of error are in agreement with the direction of you error.