CAC, IB Chemistry
Experiment: Percent Composition of a Copper Chloride Hydrate

Clothing
This experiment requires proper safety attire, including close-toed shoes, long pants, and goggles. If you are not properly attired, you will have to come back to perform the experiment during your free time.

Introduction
Elements combine in definite ratios to form compounds. This is known as the The Law of Definite Proportions. In this lab, you will investigate the element ratios found within a chemical compound using chemical reactions and differences in chemical and physical properties of that compound from its constituent elements. From the data obtained in this experiment you will then be able to determine the chemical formula of the compound.

Learning Objectives *After completing this exercise, you should be able to:*

- Use new equipment in the laboratory.
- Perform chemical reactions, isolating products with little loss.
- Experimentally determine the mass of components in a complete formula.
- Use experimentally determined masses to calculate the empirical formula for an unknown compound.

General Rule: It is important to begin to learn to make observations of chemicals from the beginning to the end of an experiment. You should be making notes about the appearance of substances before, during, and after the reactions. Include observations such as color change, gas formation or odors that result from your chemical reactions.

NOTEBOOK REQUIREMENTS

Before coming to lab, you must have these parts of your lab notes prepared:

- Title
- Partner
- Purpose
- Un-Balanced chemical equations describing the reactions performed in Part I and Part II. (Use x, y & a instead of the stoichiometric coefficients)
- Data table

PROCEDURE

Part One: Dehydration of $Cu_xCl_y \cdot aH_2O$

1. Remove the beaker from the oven and place it on the benchtop to cool for 10 minutes.
2. Weigh the dry and cooled beaker on an electronic centigram balance. Record the mass.

Technique Alert: *NEVER weigh hot glassware. Heat interferes with the electronic components of the balance giving you inaccurate mass results. You can determine if your beaker is cool or not by making a "tent" with your hands around the beaker. If you do not feel heat radiating from the beaker, it is cool enough to weigh.*

3. Place *about* 1 gram of the unknown copper chloride hydrate into the beaker. Break up any sizeable chunks with the sharp end of a spatula. Record the exact mass. *You do not have to have exactly 1 gram; simply record the exact mass of the sample + beaker*.

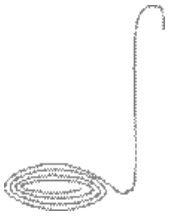
4. Place the beaker on a hotplate on the lowest heat setting and heat it **GENTLY**. If you smell chlorine or a burning smell, or if your sample begins "popping", stop heating and ask for help.

Technique Alert: *Slow and steady wins the race here! The sample will begin to change color quickly, but it may take a long time for the entire sample to dehydrate. Take your time! If you burn your sample, you will have to start over, and that will take much more time.*

5. Continue gently heating until all the crystals have completely changed color. Using tongs, slowly roll and tap the beaker on the bench top (padded with a towel) to move the crystals around. If any of the originally colored crystals remain, continue the heating process. The sample will not look 'wet' or 'burnt.' Once all the crystals have changed color, heat gently for an additional *2 minutes*.
6. Transfer the beaker to the benchtop to cool in preparation for weighing.
7. Weigh the cooled beaker and contents. Record this mass. Ask the teacher to observe your sample before moving on.
8. You need to be sure that all the water has been driven of the sample. Return the beaker to the hotplate and heat GENTLY again for an additional 2-3 minutes. Move the beaker to the benchtop to cool. Re-weigh the sample when cooled. If the two masses agree within 0.02 grams you may proceed. If not, repeat the reheating until your masses agree within 0.02 grams. Record the mass.

Part Two: Determination of the Mass of Copper

1. Add about 10-20 mL of distilled water to the beaker.
2. Swirl the beaker gently to dissolve any solids; crush up any hard crystals with your glass stirring rod. If needed, add more water to reach roughly the 15-mL mark.
3. Obtain 30 cm of aluminum wire (~0.40 g) – these are precut for you.
4. Form the wire into a loose, flat spiral that lies on the bottom of the beaker. Leave enough on one end to form a hook to hang on the side of the beaker.


Wire Coil

5. Place the wire in the beaker so that the coil is immersed in the liquid and hanging from the lip of the beaker. The only part of the wire not submerged in the liquid is the handle.
6. Label the beaker with your names and cover it with parafilm. Allow it to sit in the fume hood until the next class meeting.
7. After at least 30 minutes (and up to several days) has elapsed, add ~5 drops of 6M HCl into the beaker to dissolve any insoluble aluminum salts and clear up the solution.
8. Measure and record the exact mass of a piece of filter paper with a watch glass.
9. Set up a glass funnel in a conical flask and fit it with the pre-weighed filter paper, folded into a cone. Moisten the paper with distilled water.
10. Using a glass stirring rod with a rubber tip (called a "rubber policeman"), dislodge the solid copper from the wire as completely as you can into the same beaker containing the solution. Be careful not to break the wire.
11. Lift the Al wire from the solution and rinse any remaining copper off with distilled water from a wash bottle. You may need to add a drop or two of HCl onto the wire. Remove the wire and put it aside.
12. Decant the solution (not the solid) onto the filter paper in the funnel (*Decant* means to pour off the liquid leaving the solid behind).

13. In the beaker, wash the copper metal left behind with small portions of distilled water (1–3mL), and decant the solution (not the solid) into the Buchner funnel.
14. Break up any large clumps of copper with your stirring rod in the beaker; wash the copper again, decant and filter.
15. Finally transfer *the copper* and last washing to the filter paper.
16. Wash any remaining copper into the funnel with your wash bottle (use your rubber policeman to help). *All of the copper should be transferred to the filter paper.*
17. Rinse the copper on the paper one final time with water and allow the water to drain out.
18. Add ~10 mL of 95% ethanol to the funnel, covering the copper. Allow it to drain through.
19. Using forceps, carefully transfer the wet filter paper + copper to your pre-weighed watch glass. Unfold and spread out the paper. Place in the ~50°C oven for 30 minutes. Remove the watch glass from the oven, allow it to cool for 5 minutes, and then weigh it.
9. Place the watch glass back in the oven for 5 minutes, allow it to cool again for 5 minutes. If the two masses agree within 0.02 grams you may proceed. If not, repeat the reheating until your masses agree within 0.02 grams. Record the mass.
20. Dispose of the liquid filtrate in the filter flask in an appropriate waste container in the hood.
21. Dispose of the solid copper in the labeled waste container in the hood.

Analysis

In your lab notes, compute the following. Clearly label each computation and show all of your work, including units. Round each answer to the correct number of significant figures:

- Mass of initial $Cu_xCl_y \bullet aH_2O$ sample
- Mass of Cu_xCl_y sample
- Mass of H_2O lost
- Mass of elemental Cu
- Mass of Cl
- Moles of H_2O
- Moles of Cu
- Moles of Cl
- Value of x
- Value of y
- Value of a

Conclusion

Write your conclusion in paragraph form. Include final balanced equations for each reaction that you performed, including your best guess at stoichiometric ratios. State your final uncertainty values. Address any systematic sources of error that may have led your results to be less than perfect.