3 The Formula of Copper Sulfide

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- Make precise measurements of mass with an analytical balance.
- Determine the copper/sulfur mass ratio and the copper/sulfur mole ratio for a copper sulfide produced by direct combination of the elements.
- Use these data to determine the simplest formula of the compound.
- Verify that the law of constant composition is valid for the compound.

DISCUSSION

Copper forms two sulfides, Cu_2S and CuS. In this experiment you will make a sulfide of copper by heating a known amount of copper with variable amounts of sulfur. During the heating, copper will directly combine with sulfur to form a sulfide. By subtracting the mass of the copper used from the mass of the compound formed, you can find the mass of the combined sulfur. From the masses of copper and sulfur, the moles of each element, you can calculate the mole ratio and the empirical formula. You can then decide which sulfide has been formed, or whether a mixture of the two has been produced.

The Law of Constant Composition asserts that if different mixtures of the same elements are reacted under the same conditions, they will yield the same compound with the same empirical formula. By performing the experiment with two different amounts of the sulfur, you will be able to verify or dispute this law.

PROCEDURE

1. Place a crucible and cover in a triangular wire holder supported by an iron ring and ring stand. Adjust a bunsen burner to provide maximum heat (blue flame with sharp inner cone). Heat the crucible gently at first and then strongly for two minutes. The bottom of the crucible may glow red hot. This heating drives off any moisture or impurities that would change the mass of the crucible during the next heating. Allow the crucible and cover to cool for 5 minutes before weighing. *DO NOT* weigh hot objects on the balances because it can damage the delicate mechanisms and it will give incorrect masses. Use crucible tongs to handle the crucible even when it is cool. The tongs will keep the crucible from absorbing oil and moisture from your fingers. Measure the mass of the crucible and cover to the nearest milligram (0.001 *g*).

2. Add about 200 *mg* of copper powder to the crucible. To obtain this amount quickly and approximately, set the copper syringe at 0.15 *cc*, and press it into the copper powder once or twice. Then eject the tamped powder into the crucible. Determine the mass of the crucible, cover, and copper.

Similarly, set the sulfur syringe at 0.2 *cc* to add approximately 200 *mg* of sulfur to the crucible. (It is not necessary to measure the mass of crucible, cover, copper and sulfur since not all of this sulfur will react with the copper.)

Heat the crucible, cover and contents with your burner in the hood. Heat them carefully for a few seconds and then strongly for 2 minutes. The excess sulfur, which does not react with the copper, combines with oxygen in the air and departs the crucible as sulfur

dioxide. Remove the crucible from the ring stand and allow the crucible to cool for 5 minutes.

3. When the crucible has cooled, determine the mass of the crucible, cover, and contents.

Discard the contents of the crucible, clean the crucible, and repeat Steps 1-3 with a second sample. This time use about 200 *mg* of copper but only about ***100*** *mg* of sulfur (set the sulfur syringe at 0.1 *cc*.)

4. Calculate the mass of copper used.

5. Calculate the moles of copper used.

6. Determine the mass of the copper sulfide that formed.

7. Find the mass of sulfur that *combined* with the copper.

8. Calculate the number of moles of sulfur that combined.

9. Find the copper-to-sulfur mass ratio in the compound (write down a decimal value). Compare this to the ratio of atomic weights of the two elements.

10. Calculate the copper-to-sulfur mole ratio (write down a decimal value).

11. Determine the empirical formula of the compound.

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Name _____
Partner _____
Section _____Locker ____
Instructor _____

Enter the data or answer the questions *according to the corresponding step in the procedure*

	Trial #1	**Trial #2**
1. Mass of empty crucible and cover		
2. Mass of crucible, cover, and copper		
3. Mass of crucible, cover, and compound		
4. Mass of copper used		
5. Moles of copper used		
6. Mass of compound formed		
7. Mass of sulfur combined		
8. Moles of sulfur combined		
9. Copper/sulfur mass ratio		
10. Copper/sulfur mole ratio		
11. Empirical formula of copper sulfide		

CALCULATIONS

APPLICATION OF PRINCIPLES

1. Why is the copper/sulfur mass ratio different from the mole ratio?

2. How well do your data support the law of constant composition? Can your experiment prove or disprove that law?

3. What are the experimental limits of your measurements? What are sources of possible error?

4. If 52.2 *g* of bismuth react under certain conditions with 10.0 *g* of oxygen, what is the empirical formula of the bismuth oxide formed?

5. 59.9 *g* of titanium metal react completely with 40.1 *g* of sulfur. What is the empirical formula of the titanium sulfide?