EXPERIMENT 3

THE SYNTHESIS OF COPPER SULFIDE

When heated together, copper and sulfur combine to form a sulfide of copper. In this assignment, you will heat a known mass of copper with excess sulfur in a covered crucible to produce the nonvolatile copper sulfide. The excess sulfur vaporizes to form gaseous sulfur, which escapes from the crucible. When the hot sulfur gas reaches the air, it reacts with oxygen to produce gaseous oxides of sulfur (mainly sulfur dioxide, SO\(_2\)). Thus only the copper sulfide remains in the crucible.

From the measured mass of the product and the mass of copper used, you may determine the mass of sulfur in the product. Then you will use the known masses of the copper and sulfur and their atomic masses to calculate the simplest formula of the copper sulfide.

EXPERIMENT: Place a wire triangle on your ring stand and put a clean crucible in it. Adjust the support ring so that the bottom of the crucible is about 6 cm above the top of the Bunsen burner. Do not heat or weigh the cover. Adjust the burner until the flame is at its hottest. Heat the crucible with your bunsen burner until the bottom of the crucible is a bright red. After five minutes of heating allow the crucible to cool on the triangle (about 15 minutes). While the crucible cools, obtain a piece of copper wire (already cut), clean the wire with a piece of steel wool and weigh the wire to the nearest mg (0.001g). Record the mass of the copper wire in your notebook. Coil the wire and place it into the bottom of your cool crucible. Using your tongs transfer the crucible containing the wire coil to the balance and record the mass of the crucible and wire to the nearest mg.

Add just enough powdered sulfur to cover the coil of copper, but do not make the crucible more than half full of sulfur. Place a crucible cover slightly askew on the top of the crucible, and very slowly heat the crucible on a wire triangle IN THE HOOD. UNDER NO CIRCUMSTANCES SHOULD YOU HEAT THE MIXTURE AT YOUR LAB BENCH, THE GASES GIVEN OFF ARE POISONOUS! Never remove the cover while the crucible is hot. As the sulfur escapes it will burn in the atmosphere to produce a blue flame. When the sulfur ceases to burn along the edge of the crucible heat the crucible strongly for 3 to 4 minutes. Allow the crucible to cool for 15 minutes and then reweigh the crucible with its contents (but without the cover) to the nearest mg. Record this mass.

To insure that all of the copper has reacted, add a little more sulfur to the crucible and reheat the mixture as directed above. Reweigh the product and record this mass. Continue this process until two consecutive weighings agree within 10 mg (0.010g). Use your last mass as the total mass. Be sure to use the same balance for all of your weighings.
CALCULATIONS

Record in your data table the following information:

1) Mass of the copper
2) Mass of crucible and copper
3) Mass of crucible and product after each heating
4) Mass of sulfur in product (subtract (2) from (3))

Calculate the moles of copper used from (1). Calculate the moles of sulfur in the final product from (4). Record these values in the table (Watch out for significant figures!). Calculate the moles of copper per mole of sulfur in the final product. Report the formula of the copper sulfide as your result. You should have 3 significant figures. **DO NOT ROUND YOUR CALCULATED RATIO TO ONE DIGIT WHEN REPORTING THE FORMULA OF YOUR PRODUCT.**
THE SYNTHESIS OF COPPER SULFIDE
(WORKSHEET)

OBJECTIVE: To synthesize and calculate the simplest formula of a sulfide of copper.

PROCEDURE:

DATA:

<table>
<thead>
<tr>
<th></th>
<th>mass (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass of copper</td>
<td></td>
</tr>
<tr>
<td>Mass of crucible and copper</td>
<td></td>
</tr>
<tr>
<td>1st heating</td>
<td></td>
</tr>
<tr>
<td>2nd heating</td>
<td></td>
</tr>
<tr>
<td>3rd heating</td>
<td></td>
</tr>
<tr>
<td>4th heating</td>
<td></td>
</tr>
<tr>
<td>5th heating</td>
<td></td>
</tr>
<tr>
<td>Mass of sulfur in product</td>
<td></td>
</tr>
</tbody>
</table>

OBSERVATIONS: Include observations about the product color and texture

1) 

2)
CALCULATIONS:

Mass of Sulfur

Moles of Copper:

Moles of Sulfur:

Mole ratio of copper to sulfur:

\[ \text{______ moles copper} / \text{______ moles sulfur} \]

Ratio = \[ \text{______} : 1 \]
RESULTS:

The simplest formula for copper sulfide is: Cu________S
(Do not round off to a whole number)

CONCLUSION:

SOURCES OF ERROR:
QUESTIONS
[Show all Work]

1) Round the formula of your compound to the nearest whole numbers (for example, Cu_{1.65}S becomes Cu_2S) and then write the reaction of copper and sulfur to produce copper sulfide. Interpret this reaction in terms of, a) atoms and molecules, b) moles, and c) grams.

2) What conclusions can you draw from each of the following observations?
   a) The properties of the product differ from the properties of either copper or sulfur.
   b) The mass of the product did not increase when additional sulfur was added and the crucible and contents were reheated.

3) Iron pyrite has the formula FeS_2. Calculate the percent by mass of sulfur in this compound.
4) A sample of zinc sulfide contains 0.563 g of zinc and 0.276 g of sulfur. How many moles of zinc are there in the sample? How many moles of sulfur. What is the simplest formula of zinc sulfide?

5) The formula of silver sulfide is Ag\textsubscript{2}S. How many grams of sulfur are required to convert 1.00 g of silver to silver sulfide?

6) The formula of a compound of an unknown metal (M) is M\textsubscript{3}S\textsubscript{4}. It contains 23.4\% sulfur by mass. Calculate the atomic mass of M. (Hint: Assume 100 grams of M\textsubscript{3}S\textsubscript{4})