Name _____ Period _____ Date _____

Copper Metal from Malachite Earth Resources

The lab was taken from the following reference. The entire article is available to read if you wish.
Yee, G., Eddleton, J., and Johnson, C. (December 2004). Copper Metal from Malachite circa 4000 B.C.E. Journal of Chemical Education, Vol. 81 No. 12, pgs. 1777-1779. Retrieved from www.JCE.DivCHED.org.

This lab extracts the copper from an ore with the mineral malachite, basically copper carbonate hydroxide $Cu_2CO_3(OH)_2$, as people may have done it, more primitively, at the beginning of the copper age, about 4000 B.C.E. We are using malachite jewelry beads. The malachite is changed to solid (s) copper (II) oxide and two other products that are released as gases (g): carbon dioxide and water. (Copper can form two different ions, Cu^{1+} and Cu^{2+}. The (II) indicates the Cu^{2+} ion.) The following is the chemical equation showing the reactant or starting material on the left of the arrow and the products on the right of the arrow.

$$Cu_2CO_3(OH)_{2(s)} \rightarrow 2CuO_{(s)} + CO_{2(g)} + H_2O_{(g)}$$

The copper (II) oxide, CuO, is heated with carbon, C, to reduce the copper oxide to copper metal, Cu, as shown in the following chemical equation:

$$2CuO_{(s)} + C_{(s)} \rightarrow 2Cu_{(s)} + CO_{2(g)}$$

Step One: Weigh out five small (2mm diameter) beads (work in groups of three). Record weight.

Step Two: Roasting.
The beads are placed in a crucible and the crucible is covered with a lid and placed in a ceramic triangle on a ring stand. A Bunsen burner is used to roast the sample for 15 min. The height of the ring should be adjusted such that the tip of the inner blue cone of the Bunsen burner is touching the bottom of the crucible. *Caution: at the beginning of the heating, the sample can sometimes behave like popcorn and jump out of the crucible as the hot gases escape, so it must be covered.*

Step Three: Cool and Weigh. After this period, the heat is removed and the crucible is allowed to cool for 10 min, yielding copper(II) oxide. Note that the bead is brittle at this point, so extra care should be taken when handling it. The sample is reweighed and the mass of the CuO is recorded. Record Weight.

Step Four: Reduction.
About 1/4 of a charcoal briquette is placed into a folded paper towel and finely crushed with a hammer. The roasted CuO sample is returned to the crucible. The crucible is filled with crushed charcoal to within 1/4 inch of the top and tapped gently to help settle the contents. The crucible is covered and heated on the Bunsen burner for 20 - 45 min (longer time better). *Caution: carbon monoxide gas might be produced.*

Step Five: Cool, Clean, and Weigh. The heat is removed and the crucible is allowed to cool, covered, for 10 min. The excess charcoal is removed and the copper metal isolated by spreading it out in the paper pan. If the sample appears red and chalky, it has not been reacted fully and should be reacted further. The product can be brushed to dislodge any charcoal particles adhering to the metal. Wiping the bead on a paper towel also works to remove the weakly adherent carbon layer. Throw the carbon ash into the recycle bag. The product is weighed.

Step Six: Calculations
(1) Find the weight of malachite by adding up the atomic weights of all the atoms in the formula. Find the weight of copper in the malachite formula. Calculate the percent weight of copper (theoretical %). (2) Find the percent weight of copper you extracted from your malachite beads (experimental %). (3) Find the percent error and discuss what could cause the error. (4) Repeat for copper oxide.

Step Seven: Characterization.

Find the density of your final product and compare to the density of copper. Hit the bead with a hammer and see if it is malleable (Caution: be sure to wear your safety goggles). Test with a conductivity meter to see if the bead conducts electricity.

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COPPER FROM MALACHITE PRE-LAB

Read the entire handout containing the background and lab procedure. Answer the following questions.

Questions	Record answers here:
1. Give the chemical name and formula for the copper compound in the green mineral Malachite.	
2. How long do you need to roast the bead?	
3. During the roasting step, the copper compound in malachite is converted into a new product. Give the chemical name and formula for the copper-containing product.	
4. What does the (II) designate in the name for CuO, copper (II) oxide? Why is it used?	
5. Besides the bead, what is added to the crucible for the reduction step?	
6. How long will the bead need to be heated for the reduction step?	
7. Give the chemical name and formula for the product of the reduction step.	
8. List the three ways that the final copper product will be characterized.	

LAB WORKSHEET (You may transfer this to a separate piece of paper if you need more room.)

Step 1: Weight of five (5) malachite beads _____

Observations:

Step 2: Observations during roasting step:

Step 3: Weight of copper oxide (CuO): _____

Observations:

Step 4: Observations during the reduction step:

Step 5: Weight of copper (Cu): _____

Observations:

Step 6:

Theoretical Calculations	Experimental Calculations
Atomic Weight of malachite:	Percent copper extracted:
Weight of copper in malachite:	Percent error:
Percent copper in malachite:	Sources of error:

Repeat Step 6 for copper oxide for extra credit.

Step 7: Density (Describe method and record measurements):

Malleability test:

Conductivity test: