Copper Conversions Lab

Name _____

Introduction

In this multi-day lab you will start with a sample of copper metal and run several successive reactions which produce different copper compounds. The last reaction will release the copper atoms as copper metal again. If your technique is perfect, you will recover all the copper atoms you started with (according to the Law of Conservation of Matter).

Procedure 1

Tare a 250 m. beaker. Add about 1.5 grams of copper turnings and record the weight accurately. Roll the copper into a loose ball and check the weight again. Get about 20 ml. of dilute nitric acid. **This acid is strong. Be careful.** Walk to one of the fume hoods or one of the vents at the lab benches along the wall. Take the copper beaker, the acid and your stirring rod.

Pour the acid over the copper. Wait a couple of minutes as the reaction starts. Make observations. As the reaction slows down, use the stirring rod to push each piece of copper off the walls of the beaker an into the acid. This reaction is done when all the copper metal has reacted. There will be some excess acid so be careful with this liquid. Put the beaker in your lab drawer until you start Procedure 2.

Data for Procedure 1

Grams of copper metal: _____

Descriptions before the reaction:

Copper: _____

Nitric acid: _____

Description during reaction: _____

_____

_____

Description after reaction: _____

_____

To the tune of
"Oh Clementine"

In a beaker in a fume hood
I put copper metal wire
When I added nitric acid
It got hot but 'twas no fire.

Orange bubble of NO2
Filled the lab with noxious smell.
Copper nitrate's blue solution
There's reaction I can tell.

Equations and calculations:

You know two things you put into the reaction. You produced blue copper(II)nitrate which dissolved in the water that was carrying the acid. The gas you saw escape was nitrogen dioxide. Some water molecules were also produced but they just mixed in with the water that was already there, so you were unable to see them. Write and balance the equation for this reaction:

What type of reaction is this? _____

You know how many grams of copper you used. How many grams of blue copper nitrate are dissolved in the liquid?

How many grams of nitrogen dioxide gas escaped up the vents?

Procedure 2

The beaker with the blue liquid contains copper(II)nitrate solution and left over nitric acid. You will now run two reactions. The first reaction will convert the acid into a harmless set of compounds and the second will change the copper(II)nitrate into a new copper compound.

First you must learn to use litmus paper to indicate if your beaker contains acid or base. Litmus paper comes in two colors, red an blue. They actually have the same dye in them, but that dye is RED if last exposed to an acid and BLUE if last exposed to a base.

RE**D** **B**LUE
ACI**D** **B**ASE

Memory aid: Notice the D's and B's go together.

Get 20 ml. of sodium hydroxide solution. **Caution: This solution is as dangerous as a strong acid.** Get two or three pieces each of red and blue litmus paper. Place one of each color on a watch glass. Using your stirring rod test the results of placing a drop of sodium hydroxide solution on each color paper. Be sure to rinse the stirring rod with water each time you want to test a new solution.

Is sodium hydroxide an acid or a base?_____

Now test the solution in your beaker. Does the beaker contain acid or base? _____

By adding basic sodium hydroxide to the solution in your beaker, it will first destroy the leftover acid from the previous reaction. Then, the copper(II)nitrate will react and be converted to copper(II)hydroxide. We will know the reaction is complete when we end up with excess base in the beaker.

Fill your 400 ml. beaker about one-third full of tap water. Float your 250 ml. beaker on this water. The next reaction is going to get hot and the tap water will help keep it cooler.

Add the sodium hydroxide solution slowly and cautiously, by adding two or three ml., stirring, and letting the beaker sit for a few seconds. Repeat this process until all of the sodium hydroxide has been added, stir well and test the solution on two new pieces of litmus paper. They should now indicate a basic solution. Don't just look at the smear of blue precipitate, make sure the paper turns blue. If you don't yet have a basic solution, add two or three more ml. of sodium hydroxide. Save this beaker for Procedure 3.

Data for Procedure 2

Description of beaker before the reaction: _____

_____

Description of beaker during reaction: _____

_____

Description after reaction: _____

_____

To the tune of
"Oh Clementine"

Added sodium hydroxide
Until litmus turned to blue.
Basic copper(II)hydroxide
Formed a solid colored blue.

Equation

You ran two reactions in the beaker during this procedure. First you reacted the excess nitric acid with sodium hydroxide. The products were sodium nitrate and water molecules. You never saw either of them because they mixed with the water in the beaker. Write and balance this equation:

Type of reaction: _____

In the second reaction the sodium hydroxide reacted with the copper(II)nitrate and produced sodium nitrate and copper(II) hydroxide, the blue precipitate. Write and balance this equation.

Type of reaction: _____

You know how many grams of copper(II)nitrate you had in your beaker (calculated from procedure 1). How many grams of copper(II)hydroxide did you produce in procedure 2.

Procedure 3

Add 75 ml. of pure water (not from the tap) to the beaker with the copper(II)hydroxide precipitate. Heat on a hot plate until it just starts to boil. While heating stir occasionally leaving your stirring rod in the beaker between mixings. Take care to watch the beaker closely during heating. If it starts to jump around, be prepared to remove it from the hot plate immediately with beaker tongs. When it just starts to boil, take it off the hot plate and let it cool, overnight if possible.

The black solid is copper(II)oxide. The liquid contains several impurities leftover form previous reactions. When the solid has settled near the bottom, decant the liquid into another beaker without losing any of the solid. Don't try to be perfect. If there is no black solid in the waste beaker, discard the liquid.

Add 50 ml. of pure water to the solid and stir gently. Let the solid settle and decant again carefully. Repeat this paragraph once. Save the beaker with the black solid for Procedure 4.

Data for Procedure 3

Description of beaker before heating: _____

_____

Description of beaker after heating: _____

Why did you keep adding water and pouring it away? _____

_____

To the tune of
"Oh Clementine"

When I heated up the blue stuff
Broke off a water molecule
Washed black solid with some water
To get copper oxide pure.

Equation and calculations 3

Heating copper(II)hydroxide breaks off two hydrogen atoms and one oxygen atom to produce a water molecule. Black copper(II)oxide is also produced. Write and balance this equation:

Type of reaction: _____

In Procedure 2 you calculated how much copper(II)hydroxide was in your beaker. Now calculate how much copper(II)oxide you produced in Procedure 3.

Procedure 4

To the beaker with the black copper(II)oxide, add 50 ml. of dilute sulfuric acid. **Caution: This is a strong acid solution.** Stir and observe. Save this solution for Procedure 5.

Data for Procedure 4

Description of beaker before reaction: _____

_____

Description of beaker after reaction: _____

_____

To the tune of
"Oh Clementine"

Put in some sulfuric acid
Solid black dissolved into
Copper sulfate's blue solution
H 2 O developed too.

Your beaker contained black copper(II)oxide. You added sulfuric acid and produced copper(II)sulfate and water. Write and balance this equation.

Type of reaction: _____

In Procedure 3 you calculated how much black copper(II)oxide was in your beaker. Now calculate how much copper(II)sulfate is floating around in your new blue solution.

Procedure 5

Your beaker contains dissolved copper(II)sulfate and leftover acid from Procedure 4. We will use zinc metal to react with each of these.

Weight out about 7 grams of granular zinc metal. Working in a hood or in front of one of the vents, add the metal to the solution. Put a watch glass over the top to prevent the acid from splattering. Observe. It will take a while for all the zinc to react. Check with your teacher to see if it is done. The beaker may be HOT. The reddish precipitate is copper metal, the same copper atoms you dissolved in Procedure 1. Now we have to purify it.

Observations

Description of beaker before reaction: _____

_____

Description during reaction: _____

_____

Description after reaction: _____

_____

To purify your copper, let the copper settle or shake it to the bottom. Decant the impure liquid into a beaker and discard if you didn't lose and copper. Wash the copper three times with 50 ml. of hot pure water. Wash means to add the water, stir gently, let it settle, and decant the impure liquid. Now you have pure WET copper. We need to dry it.

Accurately weigh an evaporating dish. Scrape your copper into the dish. Use a tiny amount of pure water to wash the last part into the dish. Decant any water that you are able from the evaporating dish. Fill a 400 ml. beaker about one-third full with water and place two or three boiling chips (boilezers) into the beaker. The boiling chips will aid in smooth boiling.

Put the evaporating dish on top of the 400 ml. beaker and start the water boiling. The steam will gently heat the wet copper and evaporate the water in the evaporating dish. When the copper is dry weigh the dish with the copper. Try not to heat too long or the copper will react with oxygen in the air to produce copper(II)oxide, sending you back to Procedure 3. (Record data on following page.)

To the tune of
"Oh Clementine"

Little pieces of zinc metal
Formed bubbles of hydrogen
A red lumpy precipitate grows
Copper metal forms again.

Washed the copper with some water
To get out impurity.
Weighed the pure dry copper metal.
What percent recovery?

Data for Procedure 5

Mass of evaporating dish_____

Mass of dish plus dry copper_____

Mass of copper actually produced_____

Equations and Calculations for Procedure 5

You ran two reactions in your beaker at the same time. Your beaker had copper(II)sulfate and leftover acid. You added zinc. First, let's look at the reaction with the acid.

The leftover sulfuric acid reacted with the zinc to produce bubbles of hydrogen gas and zinc sulfate. Write and balance this equation.

Type of reaction: _____

The copper sulfate reacted with the zinc to produce copper metal and zinc sulfate. Write and balance the equation for this reaction.

Type of reaction: _____

In Procedure 4 you calculated how much copper(II) sulfate was dissolved in the beaker. How much copper metal (that red precipitate) should you have formed?

Your calculations predict the copper you should have produced. Your data tells you how much copper you actually produced. What is you percent recovery?

Summary

With this lab include a short summary describing what happened to the copper atoms as the went through each procedure. Conclude with a paragraph that tries to account for the discrepancy between the amount of copper you should have gotten, and the amount you actually produced.

Solutions to Copper Conversion Lab

Assuming 1.50 g of Copper used.

$$Cu + 4\ HNO_3 \text{ ----> } Cu(NO_3)_2 + 2\ H_2O + 2\ NO_2$$

Single displacement and decomposition

You know how many grams of copper you used. How many grams of blue copper nitrate are dissolved in the liquid?

1) grams --> mol	2) mole ratio	3) grams --> mol
$1.50g \ \frac{mol}{63.55g} = 0.0236mol\ of\ Cu$	$\frac{0.0236mol\ of\ Cu}{1} = \frac{x}{1}$ $x = 0.0236mol\ of\ Cu(NO_3)_2$	$0.0236mol\ of\ Cu(NO_3)_2 \ \frac{187.57g}{mol} =$ $4.43g\ of\ Cu(NO_3)_2$

How many grams of nitrogen dioxide escaped up the vents?

1) grams --> mol	2) mole ratio	3) grams --> mol
$1.50g \ \frac{mol}{63.55g} = 0.0236mol\ of\ Cu$	$\frac{0.0236mol\ of\ Cu}{1} = \frac{x}{2}$ $x = 0.0472mol\ of\ NO_2$	$0.0472mol\ of\ NO_2 \ \frac{46.01g}{mol} =$ $2.17g\ of\ NO_2$

$$HNO_3 + NaOH \text{ ----> } NaNO_3 + H_2O$$

Doube Displacement

$$2\ NaOH + Cu(NO_3)_2 \text{ ----> } 2\ NaNO_3 + Cu(OH)_2$$

Double Displacement

You know how many grams of Copper(II) nitrate you had in your beaker (calculated from procedure 1). How many grams of copper(II)hydroxide did you produce in procedure 2?

1) grams --> mol	2) mole ratio	3) grams --> mol
$4.43g \ \frac{mol}{187.57g} =$ $0.0236mol\ of\ Cu(NO_3)_2$	$\frac{0.0236mol\ of\ Cu(NO_3)_2}{1} = \frac{x}{1}$ $x = 0.0236mol\ of\ Cu(OH)_2$	$0.0236mol\ of\ Cu(OH)_2 \ \frac{97.57g}{mol} =$ $2.30g\ of\ Cu(OH)_2$

$Cu(OH)_2$ ----> H_2O + CuO

Decomposition

In Procedure 2 you calculated how much copper(II)hydroxide was in your beaker. Now calculate how much copper(II)oxide you produced in Procedure 3.

1) grams --> mol	2) mole ratio	3) grams --> mol
$2.30g \ \frac{mol}{97.57g} =$	$\frac{0.0236mol\ of\ Cu(OH)_2}{1} = \frac{x}{1}$	$0.0236mol\ of\ CuO \ \frac{79.55g}{mol} =$
$0.0236mol\ of\ Cu(NO_3)_2$	$x = 0.0236mol\ of\ CuO$	$1.89g\ of\ CuO$

$CuO + H_2SO_4$ ----> $CuSO_4 + H_2O$

Double Displacement

In Procedure 3 you calculated how much black copper(II) oxide was in your beaker. Now calculate how much copper(II)sulfate is floating around in you new blue solution.

1) grams --> mol	2) mole ratio	3) grams --> mol
$1.89g \ \frac{mol}{79.55g} =$	$\frac{0.0236mol\ of\ CuO}{1} = \frac{x}{1}$	$0.0236mol\ of\ CuSO_4 \ \frac{159.61g}{mol} =$
$0.0236mol\ of\ CuO$	$x = 0.0236mol\ of\ CuSO_4$	$3.77g\ of\ CuSO_4$

$H_2SO_4 + Zn$ ----> $H_2 + ZnSO_4$

Single Displacement

$CuSO_4 + Zn$ ----> $Cu + ZnSO_4$

Single Displacement

In Procedure 4 you calculated how much copper(II)sulfate was dissolved in the beaker. How much copper metal (that red precipitate) should you have formed?

1) grams --> mol	2) mole ratio	3) grams --> mol
$3.77g \ \frac{mol}{159.61g} =$	$\frac{0.0236mol\ of\ CuSO_4}{1} = \frac{x}{1}$	$0.0236mol\ of\ Cu \ \frac{63.55g}{mol} =$
$0.0236mol\ of\ CuSO_4$	$x = 0.0236mol\ of\ Cu$	$1.50g\ of\ CuSO_4$