Chemistry 20: Five Day Copper Recovery Lab

Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Partner \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Start Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ End Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Objective: Recover 15 g of Cu(s) after making 5 chemical conversions

Materials: Copper wire

Assorted beakers

Dilute nitric acid

Watch glass

pH paper

NaOH(aq)

Ice/snow bath

Distilled Water

Dilute sulfuric acid

Zinc metal

***Conversion 1*  Change Cu(s) to Cu(NO3)2(aq)**

* Take approximately 1.50  g of copper wire. Clean off any corrosion using steel wool
* You may find it useful to cut the copper into small pieces as this will facilitate a quicker reaction.
* Find the exact mass and record this value \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Place the copper into a clean 400 mL beaker. Carefully add 20 mL of dilute nitric acid
* Place a watch glass on top and observe the reaction that is taking place. Record your observations.
* Be patient as this is a SLOW reaction. Do not expect immediate changes.
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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* Then place the beaker in the fume hood until the copper has completely dissolved
* The brownish-orange gas produced by the reaction is NO2(g). The blue colour of the solution is characteristic of many copper compounds dissolved in water.
* Write the non, total and net ionic equations for this conversion.
* Copper + nitric acid 🡪 copper (II) nitrate + nitrogen dioxide + water
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**
* **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Calculate the volume of NO2(g) produced at SATP**

**Calculate the mass of Cu(NO3)2(aq) that will be dissolved in the solution.**

**What has caused the solution to be blue in color?**

***Conversion 2:***  **Change Cu(NO3)2(aq) to Cu(OH)2(s)**

* Test the solution from conversion 1 with pH paper. Record the pH value \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Now obtain 20 mL of NaOH (aq). Test this solution with pH paper. Record the pH value \_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Fill a large beaker one third full of ice/snow and water. Carefully place the beaker containing conversion 1 inside. (like a double boiler)
* Cautiously and carefully add the 20 mL of NaOH(aq) to conversion 1.
* Mix the solutions with a gentle swirling motion. The NaOH(aq) neutralizes the excess acid from conversion1.
  + This is an exothermic reaction and the beakers may become hot. BE CAREFUL.
* Test the pH of the mixture again and record \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* If the pH is not as high as the pH of the NaOH(aq), keep adding more NaOH(aq) until it does match.
  + You want the NaOH(aq) to become the EXCESS reagent
* A pale blue solid precipitate should have formed.
* Write the non, total and net ionic equations for this conversion.
* Copper(II) nitrate + sodium hydroxide 🡪 copper (II) hydroxide + sodium nitrate
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Calculate the mass of Cu(OH)2(s) that is produced in this conversion
* What is a precipitate?
* Why did you continue to add the NaOH(aq) until the pH became high?

***Conversion 3:***  **Change Cu(OH)2(s) to CuO(s)**

* Add 100 mL of distilled water to the beaker containing conversion 2
* Using a hotplate and eye protection, carefully heat the beaker until the solution begins to boil. STIR!
* A brown-black precipitate will form
* Be careful that the solution does not spit out of the beaker or you will lose part of your copper for recovery!
* Remove from the heat and let the solution cool for at least 5 minutes
* Use a wash bottle to rinse the stir rod back into the beaker
* Decant the extra liquid. Ensure that no solid is lost.
* Wash the precipitate by adding an additional 100 mL of distilled water. STIR
* Let the precipitate settle again and decant off the extra liquid.
* Write the non, total and net ionic reactions for this conversion.
* Copper(II) hydroxide 🡪 copper (II) oxide + water
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Name the black solid produced in this step\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Calculate the mass of copper (II) oxide produced in this conversion.

***Conversion 4:***  **Change CuO(s) to CuSO4(aq)**

* Add 50 mL of dilute sulfuric acid to the black copper (II) oxide.
* Stir gently. The copper (II) oxide will dissolve and the solution will turn blue again.
* Write the non, total and net ionic equations for this conversion.
* Copper(II) oxide + sulfuric acid 🡪 copper (II) sulfate + water
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Determine the mass of copper (II) sulfate formed in this conversion

***Conversion 5:***  **Change CuSO4(aq) to Cu(s)**

* Weigh about 7.0 g of Zn(s) and record \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Add this Zn(s) to the copper (II) sulfate solution
* Immediately cover the beaker with a watch glass and allow it to stand until the blue colour disappears. You will have to swirl the beaker. (Be patient – this make take 10 – 15 minutes)
* If the reaction appears to slow or stop, add an additional 20 mL of acid.
* Let the beaker stand until the solid zinc metal disappears as well. Since the reaction involves the evolution of hydrogen gas, the **absence of bubbles** forming will be an indication that the zinc metal is all consumed
* You should now have the solid copper back!!
* There are actually two reactions that have happened!
* **The first explains the formation of the copper**
* Write a non, total and net ionic equation for this process.
* Copper(II) sulfate + Zinc 🡪 copper + Zinc sulfate
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* **The second reaction explains how you get rid of the excess zinc**
* Write a non, total and net ionic equation for this process.
* Sulfuric Acid + Zinc 🡪 hydrogen gas + zinc sulfate
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Now you need to collect and find the mass of the copper you have recovered.
  + Allow the solid copper to settle
  + Decant and discard the clear liquid
  + Wash the solid copper a **minimum of three times**. Use 50 mL portions of hot (almost boiling) distilled water
  + Each time, stir, and then decant the liquid
  + Accurately weigh an evaporating dish \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Transfer the copper metal to the dish. Decant off as much excess water as possible.
  + Allow the dish to sit and dry overnight (or several nights!).
  + Find the mass of the dish + the copper \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + If the copper metal gets too hot, it will go back to copper (II) oxide!. This is a bad thing …… you have already done this step!

**Observations:**

Conversion 1:

Conversion 2

Conversion 3

Conversion 4

Conversion 5

**Analysis of data**

Initial mass of copper \_\_\_\_\_\_\_\_\_\_\_

Final mass of copper and evaporating dish \_\_\_\_\_\_\_\_\_\_\_

Mass of evaporating dish \_\_\_\_\_\_\_\_\_\_\_

Mass of recovered copper \_\_\_\_\_\_\_\_\_\_\_

Use the mass of copper recovered to calculate the % recovery for this lab

Justify why you recover is

* Less than 100%
* More than 100%
* Exactly 100%

Choose only one of the above!!