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 $Cu(NO_3)_{2(aq)}$**

- Take approximately 1.50 ±0.03g 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 $NO_{2(g)}$. 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

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Calculate the volume of $NO_{2(g)}$ produced at SATP

Calculate the mass of $Cu(NO_3)_{2(aq)}$ that will be dissolved in the solution.

What has caused the solution to be blue in color?

Conversion 2: **Change $Cu(NO_3)_{2(aq)}$ 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

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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

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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 $CuSO_{4(aq)}$**

- 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

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

Conversion 5: **Change $CuSO_{4(aq)}$ 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

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- **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

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- 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 your recovery is

- ☐ Less than 100%
- ☐ More than 100%
- ☐ Exactly 100%

Choose only one of the above!!