Chemist: _____
Group member: _____
Group #_____

Copper Odyssey

This is a multi-day lab! We will be working through each of these reactions. Pay attention to the due dates for each part of the lab, as they will be turned in as we go. Remember late labs lose points! This is a big lab! (This lab is really five regular labs!) This will not only serve as a lab final but is also great review for the chemistry final! There will be a lab quiz at the conclusion of the copper odyssey, so be sure you understand the lab!

Purpose: To complete a series of experiments to convert copper form a solid state to a liquid state and back.

Procedure:

Conversion I (Day 1) - Changing elemental copper to copper (II) nitrate.

SAFETY: HNO_3 is a VERY strong acid, wear apron, and goggles at all times. NO_2 is a toxic gas, your reaction **must** be completed
in the fume hood.

1) Complete the conversion I pre-lab questions.
2) Obtain approximately 0.5g of copper wire and record the actual mass on your data table.
3) Use a marker and tape to label a 100mL Erlenmeyer flask with your names and period.
4) Place wire in bottle then go to fume hood and put flask in fume hood.
5) Make sure fume hood is on then add 20mL 6 M HNO_3 to the flask. Use a graduated cylinder to measure accurately.
6) Close fume hood glass door and observe the reaction for 5 minutes. Record your observations under Conversion I.
7) After 5 minutes place flask in the proper period tub and leave in hood overnight.
8) Answer Conversion I questions for homework.

Conversion II (Day 2) - Changing copper (II) nitrate to copper (II) hydroxide.

SAFETY: NaOH is a VERY strong base, wear apron, and goggles at all times. Rinse with water if you come into contact with base.

1) Complete the conversion II and III pre-lab questions.
2) Record your observations of the material produced on Conversion I when the reaction has stopped.
3) The copper nitrate solution should still be acidic. Test the solution by placing a drop of the solution on blue litmus paper using a stirring rod. Did the paper turn red or blue? Record the results under Conversion II.
4) Put the flask with $Cu(NO_3)_2$ solution inside a 250mL beaker containing ~50mL ice cold water. (this a cooling bath.)
5) Measure out 20 mL of 6M NaOH in a graduated cylinder.
6) Slowly pour 20mL of 6M NaOH into the $Cu(NO_3)_2$ solution. Stir and check with red litmus paper to see if the solution is basic. Did the paper turn blue? If not yet basic, add 5mL NaOH and recheck. Continue until solution is basic and appears dark blue in color. Record your observations under Conversion II.

Conversion III (Day 2) - Changing copper (II) hydroxide to copper (II) oxide

1) Place flask containing the $Cu(OH)_2$ into the warm water bath at (37°C). Allow 10 to 20 minutes for reaction to take place. Return to your desk and work on Conversion II questions until reaction is complete.
2) Once reaction is completed, record your observations of the material produced under Conversion III after being left in the water bath.
3) Place filter paper into a large hole funnel and set on top of a 400 ml flask.
4) To separate the product, CuO, from the liquid, pour contents of the small flask the filter lined funnel -that is positioned on top of a flask.
5) Rinse the small flask with distilled a stream of distilled water from the wash bottle then pour into filter. Try and get all of the material out to the small flask and into the filter paper.
6) Rinse the CuO with a stream of distilled water. Pour USE Caution to not rip filter paper. You will have to start over!!

7) Remove the label from your small flask and place on the large flask.
8) Place the funnel and large flask in the proper area and leave overnight.
9) Scrub your small flask with a brush and clean up your area.
8) Answer Conversion II and III questions for homework.

<u>Conversion IV</u> (Day 3) Changing copper (II) oxide to copper (II) chloride

Safety: HCl is a VERY strong acid, wear apron, and goggles at all times. Rinse with water if you come into contact with acid.

1) Complete the conversion IV pre-lab questions.
2) Record your observations of the Conversion III products.
3) Remove your funnel and place on a clean small 125 ml flask.
4) Pour out the waste water from the large flask. Wash and dry the flask and return to shelf.
5) Add 20ml 6M HCl directly onto the black/blue solid on the filter paper. Agitate carefully (do not tear filter paper) with a stirring rod. Let solution flow through filter.
6) Use distilled water to rinse the remaining black solid from filter paper. Try to use the minimum volume water.
7) When filtering is complete, wash, dry and put away funnel. Throw away filter paper.
8) Label and place small flask in correct area. Record observations under Conversion IV.
9) Answer Conversion IV questions for homework.

<u>Conversion V</u> - (Day 4) Changing copper (II) chloride to elemental copper

Safety: Be careful as the reaction give off considerable heat and gas. Complete under fume hood.
1) Complete the conversion V pre-lab questions.
2) Record your observations of the Conversion IV products.
3) Take your flask and pour into 125 ml beaker. Take beaker to fume hood and add small pieces of the Al foil one at a time. Wait until reaction has settled down before adding the next piece of foil. Be careful as the reaction give off considerable heat and gas.
4) When green color has gone, reaction is complete. If color does not disappear, another piece of Al may be needed.
5) Record observations under Conversion V reaction and remove flask from hood when complete.
6) Use forceps to remove any remaining aluminum.
7) Pour off liquid and dispose of down the sink. Be careful not to lose any solid material.
8) Obtain 2 small test tubes. Get their mass and record on page 11.
9) Use scoopula, pipette, or wash bottle to transfer copper to test tubes. Try to split your sample evenly.
10) Centrifuge for 4 minutes.
11) Remove test tubes and pour off supernatant (liquid on top).
12) Wash copper with distilled water. (Fill test tube 1/3 full) Agitate .Centrifuge. Remove supernatant.
13) Repeat step 12 one more time.
14) Repeat step 12 with acetone instead of water.
15) Dry overnight.
16) Mass the copper.
17) Answer Conversion V for homework.
18) Complete Copper Odyssey Questions – Techniques and General Principles.

Copper Odyssey Conversion I

<u>Conversion I</u> - Changing elemental copper to copper (II) nitrate.
Pre-lab: Balance the following reaction.

$$\_\_\_\ Cu_{(s)} + \_4\_\ HNO_{3(aq)} \rightarrow \_\_\_\ Cu(NO_3)_{2(aq)} + \_2\_\ NO_{2(g)} + \_2\_\ H_2O_{(l)}$$

In a complete sentence describe and name the above compounds.
Solid copper reacts with aqueous nitric acid to form aqueous copper (II) nitrate plus nitrogen dioxide gas and liquid water.

Data and Observations:

Original mass of copper __0.5_g

Original observations:
Copper wire 10.5 cm in length and clear nitric acid

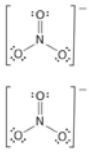
Reaction observations:
bubble on wire, acid turns blue and brown gas is formed. Wire dissapears

Conversion I Questions
Directions: Answer the following questions in complete sentences.
1. What type of chemical reaction is Conversion I? *Copper loses electrons and is oxidized to blue copper (II) ion. Nitrogen gains the electrons copper loses, and is reduced to reddish brown nitrogen dioxide gas. Nitric acid is an oxidizing agent. This type of reaction, in which electrons are lost and gained, is called an oxidation reduction reaction or redox reaction.*

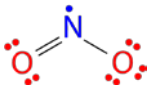
2. Identify each reactant and product as having metallic, ionic, or covalent bonds.
Cu- metallic
HNO_3-ionic
$Cu(NO_3)_2$-ionic
NO_2-covalent
H_2O-covalent

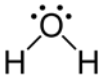
3. Draw the Lewis Dot structures for each of the above compounds (not the Cu).

Example: HNO_3
O= N- O
|
O
|
H



$[Cu]^{2+}$





4. Why does HNO_3 contain one nitrate and $Cu(NO_3)_2$ contain two nitrates? **Think charges**
Cu is a 2+ ion and H is a 1+ ion. Cu needs 2 nitrates to balance its charges and H needs one.

5. What does the 6M signify in the expression 6M HNO_3?

M= molarity
M= moles/Liter

6. Calculate the molar mass of each reactant. Be sure your work in clearly labeled!
Example: HNO_3 = 1 + 14 + (16 x 3) = 63 g/mol
Cu= 64 g/mol
$Cu(NO_3)_2$= 188 g/mol
$NO_{2(g)}$ = 46 g/mol
H_2O= 16 g/mol

7. Using the initial mass of copper you obtained determine the number of moles of copper in your sample. (**Hint**: use the molar mass from #6)

$$\frac{0.5\text{ g Cu}}{1} \times \frac{1\text{ mol Cu}}{64\text{ g Cu}} = 0.0078\text{ mol Cu}$$

8. Calculate the number of atoms of copper in your sample. (**Hint**: use your answer from #7 and 6.2×10^{23} atoms/mol)

$$\frac{0.0078\text{ mol Cu}}{1} \times \frac{6.2 \times 10^{23}\text{ atoms}}{1\text{ mol Cu}} = 4.83 \times 10^{21}\text{ atoms Cu}$$

9. Using the initial mass of copper you obtained determine the mass of NO_2 you expected to be produced. (**Hint**: use a mole ratio from your balanced equation in the pre-lab section)

$$\frac{0.5\text{ g Cu}}{1} \times \frac{1\text{ mol Cu}}{64\text{ g Cu}} \times \frac{2\text{ mol } NO_2}{1\text{ mol Cu}} \times \frac{46\text{ g } NO_2}{1\text{ mol } NO_2} = 0.72\text{ g } NO_2$$

10. Calculate the volume of NO_2 you expect to be produced at 27°C and 1.0 atm. (**Hint**: set up your solution using your answer from # 9, the molar mass of NO_2, (PV=nRT (R=0.08206 L atm/mol K)

$$\frac{0.72\text{ g } NO_2}{1} \times \frac{1\text{ mol } NO_2}{46\text{ g } NO_2} = 0.0156\text{ mol } NO_2$$

PV=nRT

1 atm (V) =(0.0156 mol NO_2) (0.08206 L atm/mol K) (300K)= 0.385 L NO_2

11. Calculate the number of moles of nitric acid used. (**Hint**: use balanced equation, a mole ratio & start with grams Cu)

$$\frac{0.5\text{ g Cu}}{1} \times \frac{1\text{ mol Cu}}{64\text{ g Cu}} \times \frac{4\text{ mol } HNO_3}{1\text{ mol Cu}} = 0.031\text{ mol } HNO_3$$

12. Calculate the mass of NO_2 produced from the amount of nitric acid used. (start with moles of nitric acid-from #11)

$$\frac{0.031\text{ mol } HNO_3}{1} \times \frac{2\text{ mol } NO_2}{4\text{ mol } HNO_3} \times \frac{46\text{ g mol } NO_2}{1\text{ mol } NO_2} = 0.713\text{ g } NO_2$$

13. Which reactant would you expect to be limiting? Why? (nitric acid or Cu- compare answer in # 11 to moles of Cu used)

Cu will be limiting reactant. Need 1 mole of Cu to every 4 moles of HNO_3

0.031 mol HNO_3
0.0078 mol Cu

14. Write the compound formula of the brown gas formed._____ **NO_2**_____

15. Write the compound formula of the blue product._____ **$Cu(NO_3)_2$**_____

16. Why did the bottle have to be put in the fume hood? **The NO_2 gas formed is poisonous**

17. The copper metal disappeared during this reaction. What became of the copper atoms?

They combined with the NO_3 to form $Cu(NO_3)_2$ this is a single displacement reaction.

18. Make a list of everything in the liquid in the bottle at the end of reaction one.
H_20
$Cu(NO_3)_2$

19. Give the old-fashioned, Latin name for nitric acid.

aqua fortis and **spirit of niter**,

20. Why did we bother to mass the copper wire?

So we will know if we get the same amount back and so that we could calculate amounts of reactants produced.

~~21. Write the equilibrium expression for conversion I. *Remember what types of substances are written in the expression!*~~

22. What would happen to the NO_2 as it moves higher in the atmosphere where the pressure drops to 0.07 atm and the temperature drops to 15°C? (Calculate the volume of NO_2) (use the data from #10)

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \qquad \frac{(1\text{ atm})(0.385\text{ L})}{300\text{K}} = \frac{(0.07\text{ atm})V_2}{288\text{ K}}$$

V_2=5.28 L
23. Why did we use nitric acid rather than some other acid, say hydrochloric acid?

$Cu + 2HCl \rightarrow CuCl_2 + H_2$
Because the reaction would have made a solid of CuCl

20. *Fill in the blanks:* In conversion one, elemental copper was changed to copper (II) __**nitrate**_____by the action of _____**the nitric acid**_____acid. The roman number (II) stands for the __**2 valence electrons**_____ on the copper. In the process, water and a toxic gas, ____**nitrogen dioxide**_____ were formed. This gas was brown in color and is the same gas that gives the brownish look to Los Angeles smog. Nitric acid is the only strong acid that will attack copper. The acid we used was not full strength, but had been diluted with water to a concentration of_____6M_____. In this reaction, **four** __moles_____ of nitric acid were used for every mole of copper ~~one copper atom.~~ The formula unit for nitric acid has ____**$4 \times 6.02 \times 10^{23} = 2.4 \times 10^{24}$**___ atoms in it. The formula unit of copper (II) nitrate had _____**6.02×10^{23}** _____atoms in it. While the nitrogen dioxide and the water molecules each have ___**6.02×10^{23}** _____ atoms in them.

Copper Odyssey Conversion II

Conversion II - Changing copper (II) nitrate to copper (II) hydroxide.
Pre-lab: Balance the following reaction.

$$\_\_\_\ Cu(NO_3)_{2(aq)} + \_2\ NaOH_{(aq)} \rightarrow \_\_\_\ Cu(OH)_{2(s)} + 2\_\ NaNO_{3(aq)}$$

In a complete sentence describe and name the above compounds.

Aqueous copper (II) nitrate reacts with aqueous sodium hydroxide to form copper (II) hydroxide and sodium nitrate.

Data and Observations:
Conversion I product description:

Clear aqua colored liquid

Conversion II reaction description: Identify each as either acidic or basic

a) $Cu(NO_3)_2$ **(Acidic or Basic)** **Circle one**

b) $Cu(NO_3)_2$ and NaOH mixture **(Acidic or Basic)** **Circle one**

Conversion II Questions
1. What type of chemical reaction is Conversion II?
Double displacement reaction

2. Identify each compound as ionic, nonpolar covalent, or polar covalent.
$Cu(NO_3)_2$ - ionic **$NaNO_{3-}$ ionic**

NaOH-ionic **$Cu(OH)_{2(s)}$ -ionic**

3. Which of the substances in this reaction is a base?

NaOH

4. What is the pH range of a base?
7.1 to 14

5. Compare the concentration of hydroxide ion to hydrogen ion in a basic solution.

Hydroxide ions high concentration and hydrogen ions low concentration

6. What test can be done to quickly determine if a substance is an acid, a base or neutral?

Litmus paper, pH paper

7. How did we determine whether or not we had added enough sodium hydroxide?
Litmus paper

8. What is the pH range of the solution at the end of conversion II?

4.1 to 14

9. Is the reaction exothermic or endothermic? Explain.

Exothermic- gave off heat so we put it in an ice bath

10. Why did we use an ice bath?
To cool it down the reaction is an exothermic reaction – producing heat.

11. The blue solid formed also had flecks of black. What was that?
$Cu(OH)_{2(s)}$

12. What is the mole ratio of $Cu(NO_3)_2$ to NaOH?

1 mole $Cu(NO_3)_2$ to 2 mole NaOH

13. $Cu(NO_3)_2$, NaOH, and $NaNO_3$ are aqueous. What does aqueous mean?

of or containing water, typically as a solvent or medium.

14. Write the neutralization of nitric acid with sodium hydroxide.

$HNO_3 + NaOH \rightarrow NaNO_3 + H_2O$

15. What are the general products of a neutralization reaction?
Acid + base → salt + Water

Copper Odyssey Conversion III

<u>Conversion III</u> - Changing copper (II) hydroxide to copper (II) oxide
Pre-lab: Balance the following reaction.

$$\_\_\_\ Cu(OH)_{2(s)} \rightarrow \_\_\_\ CuO_{(s)} + \_\_\_\ H_2O_{(l)}$$

In a complete sentence describe and name the above compounds.
Solid copper (II) hydroxide decomposes to form solid copper (II) oxide and liquid water

Data and Observations:

Conversion II product description:
Clumpy black or blue liquid substance

Conversion III reaction description :
Black or Blue solid in filter paper

Conversion III Questions
1. What type of chemical reaction is Conversion III?__**decomposition**____

2. Identify the compounds as ionic, nonpolar covalent, or polar covalent.

$Cu(OH)_{2(s)}$ = ionic
$CuO_{(s)}$ = ionic
$H_2O_{(l)=}$ = polar covalent

3. Why did we put the bottle in the hot water bath?
To speed up the reaction

4. What is the formula of copper (II) oxide?
CuO

5. What is the purpose of filter paper?

To separate out the solid and liquid parts of the mixture

6. What is the charge of copper in CuO? How do you know?

2^+

7. What is the charge of copper in copper (I) oxide? What would the formula of copper (I) oxide be?

1^+

Cu_2O

8. We used a water bath at 37°C. What is the temperature in Kelvin? (Show work) **37 + 273=310 K**

Copper Odyssey Conversion IV

Conversion IV - Changing copper (II) oxide to copper (II) chloride
Pre-lab: Balance the following reaction.

$$\_\_\_\ CuO_{(s)} + \_2\_\ HCl_{(aq)} \rightarrow \_\_\_\ CuCl_{2(aq)} + \_\ H_2O_{(l)}$$

In a complete sentence describe and name the above compounds.
Solid copper (II) oxide reacts with aqueous hydrochloric acid and produces aqueous copper (II) chloride and liquid water

Observations : Conversion III product description:

Black or Blue solid in filter paper

Conversion IV reaction observation:

Turns into a greenish liquid

Conversion IV Questions
1. What type of chemical reaction is Conversion IV? _____**double displacement**_____

2. What were we trying to wash away from the black copper (II) oxide before beginning?
Any excess NaOH

3. Is water polar or nonpolar? _____**polar**_____How do you know? _____**its bent shape**_____
_____

4. How can you tell that Conversion IV is underway?
The reaction started to bubble

5. How can one tell when Conversion IV is completed?
The liquid in the flask is green

6. List all of the substances in the bottle at the end of Conversion IV.
$CuCl_2$ H_2O

7. Is HCl acidic or basic? ___**acid**____How do you know?____**formula starts with an H**
8. Determine the number of moles of HCl in 20 mL of 6M HCl.
(Hint: convert mL to L then use Molarity=number of moles/L)
Molarity=number of moles/L
6M= x/.02 L
Moles= 0.12
9. Use the following information to answer the questions below. We dilute our concentrated HCl to 5.0L of 0.1 M .
   a. What is the [H+] of the HCl sample?
   The molarity is the concentration which is your [H+]
   0.1 or 1.0×10^{-1}
   b. What is the pH of the HCl sample?
pH= -log [H+],

pH= -log [1.0×10^{-1}] = 1

10. Look at the following formulas: Which are acids, bases and neither? **Then name the acid or base**

$Ca(OH)_2$ H_3PO_4 **acid, Phosphoric acid** $HC_2H_3O_2$ **acid, acetic acid** C_2H_2**-neither**
base, calcum hydroxide

KCl NH_4OH, **base ammonium hydroxide** HF, **acid Hydrofluoric acid**
Neither
Potassium chloride

LiOH- **base, lithium hydroxide**

11. Complete the table listing the symbol, name, classify as metal or nonmetal, give specific group, and give the symbol of another element which could be expected to react similar to the given element.

symbol	name	metal / transition metal /nonmetal	ion	Group	symbol of another element which could be expected to react similar
Cr	chromium	metal	Cr^{2+} Cr^{3+}	Transition metal	Mo, W, same column
Fe					
Co					
Ni					
Cu					
Zn					
As					
Br					

Copper Odyssey Conversion V

Conversion V - Changing copper (II) chloride to elemental copper
Pre-lab: Balance the following reaction.

$$\_3\_\ CuCl_{2(aq)} + \_\_2\_\ Al_{(s)} \rightarrow \_3\ Cu_{(s)} + \_\_2\_\ AlCl_{3(aq)}$$

In a complete sentence describe and name the above compounds.

Aqueous copper (II) chloride plus solid aluminum produces solid copper and aqueous aluminum chloride

Data and Observations :
Conversion IV product description: _____
_____
_____

Conversion V reaction description day of reaction: _____
_____
_____

Conversion V after being left overnight:_____
_____
_____

Mass of test tubes	_____g	_____g
Mass of test tubes + copper **(NEXT CLASS)**	_____g	_____g
Mass of copper recovered (subtract)	_____g	_____g
Total mass of copper (add the 2 above)	_____g	

Conversion V Questions
1. Look at the activity series page 286. Describe the placement of aluminum to copper. What does that mean? **You will need to read page 285 and 286!!! (don't ask questions until you read the section!)**

Al is more reactive than Cu. It is placed higher on the list. Use the link below to see a list of the reactivity of metals and an explanation.

http://www.cod.edu/people/faculty/jarman/richenda/1551_hons_materials/Activity%20series.htm

2. How is the aluminum able to replace the copper in this reaction? **You will need to read page 285 and 286!!!**

Activity series of metals- In chemistry, the reactivity series is a series of metals, in order of reactivity from highest to lowest. It is used to determine the products of single displacement reactions, whereby metal A will replace another metal B in a solution if A is higher in the series. And Al is more reactive than Cu, so it can replace the Cu in the solution.

3. If you have unreacted hydrochloric acid from conversion IV it may react with the aluminum. Write out the side reaction that is happening during this part of the copper odyssey.

$6HCl + 2Al \rightarrow 3 H_2 + 2AlCl_3$

4. If the side reaction occurs will you use more or less aluminum than the expected?

More, because it is being used in 2 reactions.

5. What could be done to make this reaction proceed more slowly?

Ice water bath, less surface area of the Al- so ball the Al up.

6. Why does increasing the temperature generally increase the speed of a chemical reaction?

Temperature: When you raise the **temperature** of a system, the molecules bounce around a lot more. They have more **energy**. When they bounce around more, they are more likely to collide. That fact means they are also more likely to combine. When you lower the temperature, the molecules are slower and collide less. That temperature drop lowers the rate of the reaction. http://www.chem4kids.com/files/react_rates.html

7. Why does increasing the surface area of the reactants increase the speed of a reaction?

More surface area creates more places for the reactions to take place so it can go faster.

8. Suppose a catalyst was very expensive. Why would this not be a great problem?

A catalyst speeds up the reaction, but this reaction took place immediately so no catalyst was needed.

9. Why would increasing the concentration of reactants result in a faster reaction rate?

Concentration: **If there is more of a substance in a system, there is a greater chance that molecules will collide and speed up the rate of the reaction. If there is less of something, there will be fewer collisions and the reaction will probably happen at a slower speed.** **http://www.chem4kids.com/files/react_rates.html**

10. What were the fumes coming off of the mixture when it was reacting with the aluminum?

11. The fumes from the reaction are a diatomic gas. List the seven diatomic gases.

$6HCl + 2Al \rightarrow 3 H_2 + 2AlCl_3$

Hydrogen gas (H_2)was coming off the reaction

H_2, N_2, O_2, F_2, Cl_2, Br_2, I_2

14. If you produced 2.5 moles of H_2 gas, what volume would the gas to occupy if the room is 27°C and 1.0 atm?

Hint : **Ideal Gas Law**: PV = nRT (where R is 0.08206 (L•atm)/(K•mol). And temp. is in K.

PV = nRT

1.0 atm (V)= (2.5mol) (0.08206 (L•atm)/(K•mol) (300K) =61.5 L

15. How would the volume of the gas be affected if the temperature of the room was 30°C instead of 27°C? (show work)

1.0 atm (V)= (2.5mol) (0.08206 (L•atm)/(K•mol) (303K) =62.2 L (volume increases)

16. What volume would the gas from #14 occupy if the conditions were changed **to 270°K** and 1.0 atm? (use info. From #14 for P_1, V_1 & T_1)

Hint : use combined gas law and temp is in Kelvin.

$$\frac{P_1 \cdot V_1}{T_1} = \frac{P_2 \cdot V_2}{T_2}$$

$\frac{(1.0\ atm)\ (61.5\ L)}{(300K)} = \frac{(1.0\ atm)\ (V_2)}{(270K)}$ **$V_2 = 55.35\ L$**

17. Calculate the percent yield of your copper odyssey reaction. **Hint**: $\text{Percent Yield} = \frac{\text{Actual Yield}}{\text{Theoretical Yield}} \times 100\%$

FYI: Your actual yield is the amount of Cu you were left with at the end of the experiment and the theoretical yield is the amount of Cu you started with at the beginning!

% yield = $\frac{0.43\ g}{0.5\ g}$ x 100= 86% (Use your data- everyone will have different values

18. Was your percent yield over 100%, 100%, or under 100%?

under

19. Explain why your percent yield was over 100%, 100% or under 100%. *Be specific and clear!*

If under- May have lost some copper during filtration or describe another step that you may have lost cu

If over- may have more due to oxidation of Cu- the addition of rust

20. Calculate your percent error. (Hint: the theoretical value is the amount of Cu you started with and the experimental value is the amount of Cu you were left with at the end of the experiment)

$$\%\ \text{Error} = \left| \frac{\text{Theoretical Value} - \text{Experimental Value}}{\text{Theoretical Value}} \right| \times 100$$

% error = $\frac{0.43\ g - .50\ g}{0.5\ g}$ x 100= 14% error (Use your data- everyone will have different values)

21. Explain your error. *Remember error should not be "I did the lab wrong or my partner is not very good at labs."*

If under- May have lost some copper during filtration or describe another step that you may have lost cu

If over- may have more due to oxidation of Cu- the addition of rust

Copper Odyssey Questions – Techniques and General Principles

1. Make a sketch of the following equipment and explain what each item is used for.

This section you should be ok with

equipment	sketch	Explanation of use
filter paper		
graduated cylinder		
flask		
beaker		
funnel		
scale		
forceps		

2. Describe the proper use of the centrifuge.

Keep balanced, if shaking re adjust. Do not open until stopped

3. What does it mean to decant. Sketch a drawing to show how it is done.

Pour off liquid on top

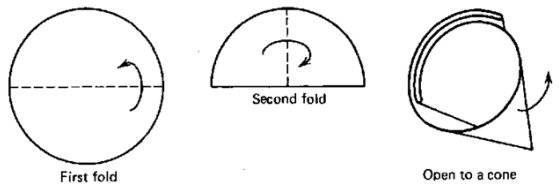
4. What is supernate? Why did we discard it in the lab?

liquid on top- it was water that was not needed. We wanted the copper

5. Why was it important to agitate the test tube in conversion V?

To rinse off the cu and remove any excess material from the copper

6. Make a sketch to show how filter paper is folded. Explain the advantages of opening up the larger pocket.



7. Explain when you would use a fire blanket, a fire extinguisher or a deluge shower.

Fire blanket- person on fire
Fire extinguisher- object on fire
Deluge shower- chemical contamination

8. What safety rules have you followed during this lab? (Name at least 5)
Wear goggle
Wear apron
Use fume hood
No running
Rinse off hands after lab

9. When diluting a concentrated acid, which do you put into the graduated cylinder first, the water or the acid? Why? What could be the consequences if you mess up?

So much heat is released when water is added to acid that the solution may boil very violently, splashing concentrated **acid** out of the container! If **you do it the correct way and add acid** to **water**, the solution that forms is very dilute and the small amount of heat released is not enough to vaporize and spatter it.
http://antoine.frostburg.edu/chem/senese/101/safety/faq/always-add-acid.shtml

10. In the cabinet where concentrated HCl is stored, the hinges are made of plastic as are all the shelves and shelf brackets. The cabinet is made of wood coated with a plastic resin. This is necessary even if there is never any spill of the acid in the cabinet. From what you know about HCl, why would this be necessary?

Acid dissolves metal – not plastic. If the cabinet was metal and there was a spill a reaction would take place and the cabinet would disintegrate.

11. Which of the following formulas are acids, which are bases and which are neither?

HI- **-Acid** HOH- **water** $Mg(OH)_2$ **-Base** $NaNO_3$ **-neither**

H_3PO_4 **-Acid** H_2SO_4 **-Acid** NH_4OH **-Base**

12. Compare the concentration of hydroxide ion produced by 1.0L of 1.0M NaOH and 1.0L of 1.0M barium hydroxide. (Assume both hydroxides are soluble in water.) **Since they are both strong bases and they both have the same molarity they would have the same concentration of hydroxide ions.**

13. Use the following information to answer the questions below. You have 25.0g of HNO_3 dissolved in water to a total volume of 0.5L.

a. What is the molarity of the HNO_3 solution? (M= mol/L)

$$\frac{25.0\text{g of } HNO_3}{1} \times \frac{1 \text{ mol } HNO_3}{63 \text{ g } HNO_3} = 0.40 \text{ mol } HNO_3 \quad M = \frac{0.40 \text{ mol } HNO_3}{0.5 \text{ L}} = 0.8 \text{ M}$$

b. What is the [H+] of the HNO_3 solution? (M= [H+])
[H+]= 0.8M

c. What is the pH of the HNO_3 solution? pH= -log [H+],
pH= -log [0.8]= 0.097

d. What is the pOH of the HNO_3 solution? pH + pOH = 14

0.097 + pOH = 14 pOH= 13.90

e. What is the [OH-] of the HNO_3 solution? [OH-]= inv Log [-pOH]

[OH-]= inv Log [-13.90] **[OH-]=1.26 x 10^{-14}**

f. Is the HNO_3 solution acidic or basic? **Acid ic because pH is less than 7.**

g. Identify the solute and solvent in this solution.

Water is the solvent and nitric acid the solute.

14. What part of the atom is involved in chemical reactions?

The electron

15. What is an old time word for base.

Alkaline

16. What is the difference between percent yield and percent error?

Yield is how much was produced and error is how off the data was from the exact answer

17. In theory, all of the copper should be recoverable at the end of this lab. Why?
Because of the law of conservation of mass/matter. The copper changed states and forms, but never disappeared

18. Name four ways that a reaction can be sped up.

Temperature, agitation, particle size, increasing concentration

19. Determine the solubility of the following compounds. (are they soluble in water?) Use the tables page 860 & 861.

$NaNO_3$ = Soluble	AgCl	$PbSO_4$	$MgSO_4$
$(NH_4)_2CO_3$	$CaCO_3$	$Pb(NO_3)_2$	KCl
$Sr_3(PO_4)_2$	BaS	NaOH	$HgCl_2$

20. Determine the number of valence electrons in each of the following elements.

Mg= 2 e-	Al= 3	Br=7	Kr= 8
Rb= 1	F=7	Fr=1	S=6
O=6	P=5	Cs=1	Rn= 8

21. Determine the charge of the transition metal in each of the ionic compounds.

CuO = 2+	Cu_2O = 4+	$Co_2(CO_3)_3$ = 3+
$CoCO_3$ = 2+	$HgBr_2$ = 2+	Fe_2O_3 = 3+
Cobalt (III) phosphate = 3+	lead(IV) sulfite = 4+	manganese (II) fluoride = 2+

22. During the lab we looked at reactivity of metals, which is one of the many trends we have studied in chemistry. Answer the following questions based on periodic trends.

a. Which of the following is a larger atom? P or Cl

b. Which of the following is a larger atom? Cs or Li

c. Which of the following is more electronegative? S or Mg

d. Which of the following is more electronegative? N or As

e. Which of the following has a greater first ionization energy? C or Be

f. Which of the following has a greater first ionization energy? Cu or Au

g. Which of the following has the largest radius? C^{4-} or C^{4+}

23. Write the electron configuration for the following atoms.

Cu = $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2, 3d^9$	Na = $1s^2, 2s^2, 2p^6, 3s^1$
H= $1s^1$	Cl = $1s^2, 2s^2, 2p^6, 3s^2, 3p^5$
N = $1s^2, 2s^2, 2p^3$	Al = $1s^2, 2s^2, 2p^6, 3s^2, 3p^1$
O = $1s^2, 2s^2, 2p^4$	

24. What would happen to the volume of a gas if the temperature is increased?

Volume increases = volume and temperature are directly proportional

25. What would happen to the pressure of a gas if the temperature is decreased?

Pressure decreases = pressure and temperature are directly proportional

26. What would happen to the temperature of a gas if the volume is decreases?

Temperature decreases = volume and temperature are directly proportional

27. What would happen to the temperature of a gas if the pressure was reduced?

Temperature decreases = pressure and temperature are directly proportional

28. What is the name given to biological catalysts?

Enzyme

29. Convert 300°C to Kelvin. (Show your work.)

300 °C + 273 = 573 K

30. Convert 455 K to Celsius. (Show your work.)

455 K – 273 = 182 °C

31. What is the lowest possible temperature?

0 K – absolute zero

32. Explain one of the advantages of being homeothermic / endothermic (warm blooded). *(Think in terms of chemical reactions and conditions for the chemical reactions!)*

Many answers would be accepted.

33. Give one disadvantage of being homeothermic / endothermic. *(Think in terms of chemical reactions and conditions for the chemical reactions!)*

Many answers would be accepted.

34. An important safety consideration in this segment of the lab was immediate rinsing of the graduated cylinder so that

35. In what sense is a base the "opposite" of an acid?

An acid is a H+ producer and bases are H+ acceptors.

36. Although the substances below were not in our reaction mixture, for practice list the elements in each substance below and count the number of atoms in each of the following:

$CuSO_4$ Copper= 1 atom, Sulfur= 1 atom, Oxygen = 4 atoms

$C_6H_{12}O_6$ **carbon= 6 atoms, Hydrogen= 12atoms, Oxygen = 6 atoms**

NaCl Sodium= 1 atom, chlorine= 1 atom,

$Al_2(SO_4)_3$ **Aluminum= 2 atoms, sulfur= 3atoms, Oxygen = 12atoms**

$Pb(NO_3)_2$ **lead= 1 atom, nitrogen= 2atoms, Oxygen = 6 atoms**

$CaCO_3$ **calcium= 1 atom, carbon= 1atom, Oxygen = 3 atoms**

37. Write the name or formula for the following compounds.

$HC_2H_3O_2$	Acidic Acid	hydrofluoric acid	HF
P_4O_6	Tetraphosphorous hexoxide	Carbon monoxide	CO
$Al_2(CrO_4)_3$	Aluminum chromate	Tin(IV) oxide	FeO_2

38. Why does one always add acid to water rather than the opposite when diluting concentrated acids?

Exothermic reactions can produce large amounts of heat. So adding acid to water will control the amount of heat being produced.

39. Why did we do the copper odyssey?
To review our lab skills, to have fun, to get ready for the final.

40. What are α, β, γ particles?

α=Alpha=$^{4}_{2}$He, β=$^{0}_{-1}$β , γ=$^{0}_{0}$ γ

41. Complete the problems below:
    1. $^{37}_{17}Cl \rightarrow ^{37}_{18}Ar$ + __$^{0}_{-1}$β _
    2. _$^{187}_{75}$Re _ → $^{187}_{76}Os + ^{0}_{-1}\beta$
    3. $^{13}_{6}C \rightarrow$ _$^{9}_{4}$Be _ + $^{4}_{2}He$
    4. $^{33}_{15}P \rightarrow$ __$^{1}_{0}$n__ + $^{32}_{15}P$
    5. $^{238}_{93}Np \rightarrow$ __$^{238}_{94}$Pu ____ + $^{0}_{-1}\beta$
    42. Technetium-99 has been used as a radiographic agent in bone scans ($^{99}_{43}Tc$ is absorbed by bone). If $^{99}_{43}Tc$ has a half-life of 6.0 hours how much of a 100μg sample would remain in the patient's body after 2.0 days?
    0.39 μg
    Time of one ½ life # of ½ lives
    ---->
    Starting amt----------→ end amt
    Total time
    43. Silicon-31 has a half-life of 2.5 hours. If we begin with a sample containing 1000mg of Si-31 how much will remain after 10 hours?
    2.5 hours 4 half lives 1000→ 500→ 250→125 mg→ 62.5 mg
    1000mg ----------→ ?
    10 hours
    44. How many protons, neutrons and electrons in each element?
        a. Plutonium-242 P= 94 e= 94 n= 242-94= 148
        b. Nitrogen-14 P= 7 e= 7 n= 14-7=7

    45. What is the difference between an isotope and an ion?
    Ion is a charged atom/ more or less electrons and a isotope has a different number of neutrons

    46. What is the density of 37.72 g of material whose volume is 6.80 cm^3?
    D = m/V
    37.72 g/ 6.8 cm^3 = 5.54 g/cm^3

    47. During the gold foil experiment completed by Rutherford, most particles fired at metal foil passed straight through. What does this tell us about the atom?
    That the atom is mostly empty space, but there must be a small, dense, positively charged center.

    48. What did the Cathode Ray Tube experiment tell us about electrons? Who worked on it?
    J.J. Thomson – discovered that there is a negatively charged particle in atoms by running it through an electrical current and the beam being attracted to the + end.

49. How do the isotopes hydrogen-1 and hydrogen-2 differ?

Hydrogen-1 has only 1 proton and 0 neutrons.

Hydrogen – 2 has only 1 proton and 1 neutron.

50. Classify each reaction and balance the equation

- $2C_3H_6 + 9O_2 \rightarrow 6CO_2 + 6H_2O$ **Combustion**
- $2Al(OH)_3 \rightarrow Al_2O_3 + 3H_2O$ **Decomposition**
- $4\ Li + O_2 \rightarrow 2\ Li_2O$ **Synthesis**
- $Zn + 2\ AgNO_3 \rightarrow 2\ Ag + Zn(NO_3)_2$ **Single Displacement**
- $CaI_2 + Cu(NO_3)_2 \rightarrow Ca(NO_3)_2 + CuI_2$ **Double Displacement**

51. Explain the law of conservation of matter and law of definite proportions:

The law of conservation of matter states that matter is neither created nor destroyed (it can simply be rearranged in chemical reactions)

The law of definite proportions states that chemical compounds always contain exactly the same proportions of elements by mass.

52. List the main points of Dalton's atomic theory. Which parts do we disagree with today?

Element Name	Element Symbol	Protons	Mass Number	Neutrons	Atomic Number	Electrons
Barium	$^{56}_{137}Ba$	56	137	81	56	56
Iron	$^{26}_{56}Fe$	26	56	30	26	26

53. How many protons and neutrons for the following isotopes contain?

a. Am-241 (95 P+, 146 N)

b. Pa-231 (91 P+, 140 N)

c. $^{131}_{53}I$ (53 P+, 78 N)

d. $^{75}_{34}Se$ (34 P+, 41 N)