Name: KEY Per ____

Partner Name: _____ Partner Cell #_____

COPPER ODYSSEY LAB

This is a multi-day lab! We will be working through each of these reactions. Don't be absent!

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

Copper Odyssey Conversion I

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.

Procedure: 15 minutes

Copper wire
6M HNO_3

1) Complete the conversion I pre-lab questions below (A-B).
2) Obtain approximately 0.5g of copper wire and record the actual mass on your data table.
3) Use a marker and blue 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.

blue tape
Erl flask

Pre-lab:

A) Balance the following reaction.

$$\_1\_\ Cu_{(s)} + \_4\_\ HNO_{3(aq)} \rightarrow \_1\_\ Cu(NO_3)_{2(aq)} + \_2\_\ NO_{2(g)} + \_2\_\ H_2O_{(l)}$$

B) Translate the above equation into names and states of matter

- use a periodic table & polyatomic ion sheet.
- Acid names on text book pages 468-469

Solid copper reacts with aqueous nitric acid to form aqueous copper (II) nitrate, nitrogen dioxide gas, and liquid water.

Data and Observations:

Original mass of copper	~0.5 g
Observations before reaction:	
Observations during reaction:	

Conversion I Questions

Directions: Answer the following questions in complete sentences.

1. What type of chemical reaction is Conversion I? **Explain your reasoning**: (synthesis, decomp., single displacement, double displacement, more than one?)

Single replacement and more (oxidation-reduction ... not learned this year)

2. Fill in the chart below.

Reactant/product	Describe: state of matter & color	Bond type: metallic, ionic, or covalent
Cu	solid orange/brown	metallic
HNO_3	liquid colorless	ionic
$Cu(NO_3)_2$	liquid blue	ionic
NO_2	gas brown	covalent
H_2O	liquid colorless	covalent

3. Why does $\overset{-1}{HNO_3}$ contain one nitrate and $Cu\overset{-2}{(NO_3)_2}$ contain two nitrates? **Think charges**

H = +1 Cu = +2 NO_3 must balance to zero with the cation

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

Molarity = moles / L

5. Calculate the molar mass of each reactant. Be sure your work in clearly labeled!

Reactant/product	Molar mass
HNO_3	**Example:** HNO_3 = 1 + 14 + (16 x 3) = 63 g/mol
Cu	63.55 g/mol
$Cu(NO_3)_2$	187.55 g/mol
NO_2	46 g/mol
H_2O	18 g/mol

Use your mole flow chart for the following problems; if you need one print it from my website under the Cu Odyssey folder.

6. Using the initial mass of copper you obtained determine the number of moles of copper in your sample.

$$.5g \times \frac{1\,mol}{63.55g} = 7.86 \times 10^{-3}\ moles$$

7. Calculate the number of atoms of copper in your sample.

$$7.86 \times 10^{-3}\ moles \times \frac{6.02 \times 10^{23}\ atoms}{1\ mole} = 4.73 \times 10^{23}\ atoms$$

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

$$.5g\,Cu \times \frac{1\,mole\,Cu}{63.55g} \times \frac{2\,mol\,NO_2}{1\,mol\,Cu} \times \frac{46.01g\,NO_2}{1\,mol\,NO_2} = 0.724g\,NO_2$$

Approx. 0.724g

9. 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 # 8, the molar mass of NO_2, (PV=nRT (R=0.08206 L atm/mol K)

$$(1\,atm)(V) = (0.0157\,moles)\left(0.08206\,\frac{L\,atm}{mol\,K}\right)(300\,K)$$

$$V = 0.387L \text{ or } 387mL$$

$$0.724g\,NO_2 \times \frac{1\,mol}{46.01g} = 0.0157mol$$

Approx. 0.37 L NO_2

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

$$.5g\,Cu \times \frac{1\,mole\,Cu}{63.55g} \times \frac{4\,mol\,HNO_3}{1\,mol\,Cu} = 0.032\,moles\,HNO_3$$

Approx. 0.031 mol HNO_3

11. Calculate the mass of NO_2 produced from the amount of nitric acid used. (start with moles of nitric acid-from #10)

$$0.032\,mol\,HNO_3 \times \frac{2\,mol\,NO_2}{4\,mol\,HNO_3} \times \frac{46.01g}{1\,mol\,NO_2} = 0.736g\,NO_2$$

Approx. 0.713 g NO_2

12. Write the compound formula of the brown gas formed. NO_2 (check the balanced equation in the pre-lab)

...ce the compound formula of the blue product. $Cu(NO_3)_2$ (check the balanced equation)

...he copper metal "disappeared" during this reaction. What really became of the copper atoms? (check the balanced equation)
acid broke bonds in Cu & formed new bonds w/ nitric acid to produce copper (II) nitrate

15. Why did the bottle have to be put in the fume hood? (read safety section)
NO_2 = toxic gas

16. Make a list of everything in the liquid in the bottle at the end of reaction one. (check the balanced equation)
copper-(II) nitrate, $H_2O(\ell)$, nitrogen dioxide gas

17. Why did we bother to mass the copper wire? **(Hint: what is the point of the lab?)**
for theoretical calculations

18. What would happen to the volume NO_2 as it moves higher in the atmosphere where the pressure drops to 0.07 atm and the temperature drops to 15°C?

a) Calculate the volume of NO_2 (use the data from #9 and $P_1V_1 = P_2V_2$)

T_1 T_2

$\frac{(1\,atm)(V_1)}{300K} = \frac{(0.07\,atm)V_2}{288K}$ $V_1 = 0.387L$

$V_2 \approx 5.3L$ way bigger!

b) The volume of NO_2 would **(increase/decrease/stay the same)** circle one

19. Why did we use nitric acid rather than some other acid, say hydrochloric acid? (read question 20 for a hint)

stronger

would produce copper-(II) chloride = powder

20. *Fill in the blanks:* In conversion one, elemental copper was changed to copper (II) nitrate by the action of nitric acid. The roman number (II) stands for the charge 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 one mole of copper. A single nitric acid formula unit has 5 atoms in it. The formula unit of copper (II) nitrate had 9 atoms in it. While the nitrogen dioxide and the water molecules each have 3 atoms in them.