LAB – Chem I
Precipitation of Copper (II) Phosphate
(Directions—Do not turn in this sheet)

Name_____
Lab partner(s)_____
Period_____ Date_____

Introduction: When doing a reaction, it is important to know how much of each reactant is needed to form a particular amount of product. In this lab, you will be doing the following precipitation reaction:

3 $CuSO_4$ (aq)	+	**2 Na_3PO_4 (aq)**	→	**$Cu_3(PO_4)_2$ (s)**	+	**3 Na_2SO_4 (aq)**
copper (II) sulfate		sodium phosphate		copper (II) phosphate		sodium sulfate
(clear blue soln)		*(clear colorless soln)*		*(blue solid)*		*(colorless solution)*

You will compare how much product you actually isolated with how much you should have gotten (according to mass-mass calculations). In addition, this lab will introduce you to some basic laboratory techniques such as filtration, washing and drying.

Purpose: The purpose of the lab is to successfully carry out the above precipitation reaction, successfully isolate the products and obtain a good yield of both products.

Pre-lab question: Do the pre-lab question that is on the write-up sheet.

Procedure:

1) Mass out about 0.50 g of **blue copper (II) sulfate hydrate** directly into a clean 100 ml **beaker**. Record mass.
2) Label your initials on a clean, dry 125 mL **Erlenmeyer flask**. Record its mass.
3) Mass out the amount of white sodium phosphate hydrate needed into the flask. (See your pre-lab question & add about *0.03g-0.05 g to your calculated mass.)*. Record mass of solid used.
4) **Completely dissolve** each of the solids by adding about **15 mL of distilled water** to each solid. Carefully swirl the solutions. Make sure that each solid has dissolved.
5) Slowly **pour** the colorless sodium phosphate solution that is in the flask into the blue copper (II) sulfate solution that is in the beaker. Rinse the last traces of sodium phosphate from the flask into the beaker with **two small amounts** of distilled water (use water bottle). Carefully swirl the resulting mixture (in beaker) for a good three minutes to make sure substances have reacted fully.
6) Obtain a piece a **filter paper** and write your names on it ***with pencil***. Mass it out and record in table.
7) Set up ring stand with ring and funnel. Fold the filter paper, fit the filter paper into the funnel and moisten the paper with some distilled water.
8) Put the flask under the funnel. Carefully pour the mixture from the beaker into the filter paper. *Don't let it overflow!!! (Hint: Swirl and pour quickly so that you get the maximum amount of solid out.)*
9) Try to remove as much of the blue solid from the beaker as possible by spraying the beaker with some distilled water and pouring into filter. (It helps if you *tilt* your beaker above the filter as you spray.)
10) Wash the solid in filter paper by spraying with water bottle *(Don't overdo it! 5 seconds is long enough.)*
11) When the filtering is complete, carefully remove the filter paper from the funnel. Carefully unfold it and lay it flat to dry overnight. *(You will mass it out dry, tomorrow.*)
12) Remove the flask and boil the filtrate (the solution in the flask) on a hot plate. It may take as long as 20 to 30 minutes to boil away all of the water, so take turns keeping watch. Remove flask from the hot plate immediately when all the liquid has boiled away.

Day 2:

13) Mass out the dry filter paper with blue copper (II) phosphate residue. Record mass.
14) Mass out your flask with the white sodium sulfate residue in it. Record mass.

Data Chart: Fill in the data chart on the write-up sheet as you do the procedure.

Calculations: Do all calculations on the write-up sheet.

Conclusion: [12 pts] *You must answer in complete sentences.* ***This must be TYPED and in your own words!!***

--**Briefly summarize the purpose and techniques of this experiment** (Write the overall reaction and explain how you mixed the reactants and then describe the basic process of isolating the products and explain how their solubility differences allowed for isolation. *(What happened when the reactants were combined? How was* $\mathbf{Cu_3(PO_4)_2}$ *collected? How was* $\mathbf{Na_2SO_4}$ *collected? Relate each to solubility and use the terms soluble and insoluble.)*

-- **Report the results of your calculations and analyze them**. Report % yields for both products, were they good (95% -105% is good)? Were your yields too high or too low? Is there any indication that one of your products might have been contaminated by a reactant (Do your products have the correct colors?)

-- No matter if your results are good or not, **discuss two sources of error for each product**, which could explain your loss/gain of each product.

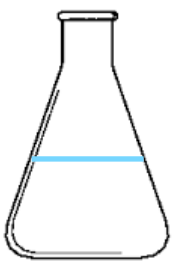
Post Lab Questions: [8 pts] *(Answer in COMPLETE sentences.* ***This must be TYPED and in your own words!!***

1) In this experiment, you tried to add almost the exact mole ratios needed to allow both reactants to completely react.
   a) How would the purity of your two products have been affected if you had used excess copper (II) sulfate? *Which product would be contaminated—blue* copper (II) *phosphate or white sodium sulfate? Why would this product be contaminated (solubility!!)? Would you be able to see this contamination (colors?)?*

   b) How would the purity of your two products have been affected if you had used excess Na_3PO_4? *Which product would be contaminated—blue* copper (II) *phosphate or white sodium sulfate? Why would this product be contaminated (solubility!!)? Would you be able to see this contamination (colors?)?*

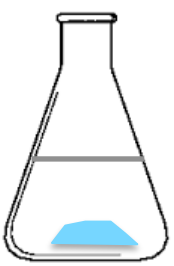
2) Two different lab groups had two different looking Erlenmeyer flasks when they were done filtering. I have explained what each flask looks like. You need to explain what the difference between the two flasks is and WHAT WENT WRONG in each case. Explain exactly what chemicals are in each flask.

Case 1



light blue aqueous solution

Case 2



clear aqueous solution with blue solid

LAB-Chem I Data sheet
Precipitation of copper (II) Phosphate

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Period_____ Date_____

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copper (II) sulfate		sodium phosphate		copper (II) phosphate		sodium sulfate
(clear blue soln)		*(clear colorless soln)*		*(blue solid)*		*(colorless solution)*

Prelab question: [1 pt]
How many grams of solid Na_3PO_4 hydrate are needed to fully react 0.50 g of solid **$CuSO_4$** hydrate?
**Hydrates are solids that have some water stuck within the crystal, but the solid still looks "dry". Thus, to calculate molar masses of hydrates, the mass due to the added water must be included. The "•" indicates the number of H_2O molecules added. *Note: once dissolved in H_2O, this water mixes with the solution and is not included in the reaction.*

MM of $CuSO_4 \cdot 5\ H_2O$ (hydrate) =

MM of $Na_3PO_4 \cdot 12\ H_2O$ (hydrate) =

$$?\ g\ Na_3PO_4 \cdot 12\ H_2O = 0.50\ g\ CuSO_4 \cdot 5\ H_2O \times \frac{\qquad}{\qquad} \times \frac{\qquad}{\qquad} \times \frac{\qquad}{\qquad} =$$

DATA: Record all data here. Record to nearest 0.01 g. Show ALL UNITS!!!

Day 1 Data (Reactants)		Day 2 data (dry products)	
	Mass (g)		**Mass (g)**
copper (II) sulfate hydrate (blue)		copper (II) phosphate on filter paper	
sodium phosphate hydrate (white)		copper (II) phosphate (dry blue solid)	
Dry Erlenmeyer flask			
Filter paper		sodium sulfate in flask	
		sodium sulfate (dry white solid)	

What is the color of your filtrate (the solution that goes through the filter)? _____

Calculations: [5 pts]
1) Once you have started filtering, fill in the part of the chart concerning the reactants. On Day 2, after collecting dry products, complete the chart by filling in the parts concerning the products.

	Reactants		Products	
	cupric sulfate hydrate (blue) $CuSO_4 \cdot 5\ H_2O$	sodium phosphate hydrate (white) $Na_3PO_4 \cdot 12\ H_2O$	cupric phosphate (dry blue solid) **$Cu_3(PO_4)_2$**	sodium sulfate (dry white solid) **Na_2SO_4**
Experimental mass (g)				
Molar Mass (g/mol)				
Experimental moles				
Divide each of the moles by the moles of $CuSO_4$	1.00 mole			
Multiply by 3 to get the mole ratios in the balanced equation	3.00 moles			

2) Do the mole ratios match the mole to mole ratios in the balanced equation? _____ (should be close)
3) You are using extra of one reactant to insure that all of the other reactant reacts. Identify the following:
   The limiting reactant is _____
   The excess reactant is _____

4) Calculate the **theoretical yield of copper (II) phosphate (blue product).** *(Hint: Start with the mass of your **Hydrate** limiting reactant and convert to the mass of cupric phosphate that should be produced.)*

5) Calculate your **percent yield of copper (II) phosphate (blue product).** (Wait to do this on Day 2.)

$$\%\ \text{yield} = \frac{\text{experimental yield (g)}}{\text{theoretical yield (g)}} \times 100\% =$$

6) **Calculate the theoretical yield of sodium sulfate (white product)**. *(Hint: Start with the mass of your **Hydrate** limiting reactant and convert to the mass of sodium sulfate that should be produced.)*

7) Calculate your **percent yield of sodium sulfate (white product).** (Wait to do this on Day 2.)

8) In any reaction, mass should be conserved. Thus, the mass of the reactants should equal the mass of the products. However, in this lab, there is one complication due to the fact that the reactants are hydrates. Since all the water is evaporated away in the products, we must *subtract out* the mass of water in the hydrate reactants before comparing with the mass of the products. Work through the following steps to see if mass was conserved in this experiment.
   a) How many grams of water were in the sample of copper (II) sulfate hydrate that you used?

$$\_\_\_\_\ \text{g } CuSO_4 \text{ hydrate} \times \frac{1 \text{ mol } CuSO_4 \text{ hydrate}}{\_\_\_\_\_ \text{ g } CuSO_4 \text{ hydrate}} \times \frac{\_\_ \text{ mol water}}{1 \text{ mol } CuSO_4 \text{ hydrate}} \times \frac{\_\_\_\_\_ \text{ g water}}{1 \text{ mol water}} =$$

   b) How many grams of water were in the sample of sodium phosphate hydrate that you used?

$$\_\_\_\_ \text{ g } Na_3PO_4 \text{ hydrate} \times \frac{1 \text{ mol } Na_3PO_4 \text{ hydrate}}{\_\_\_\_\_ \text{ g } Na_3PO_4 \text{ hydrate}} \times \frac{\_\_ \text{ mol water}}{1 \text{ mol } Na_3PO_4 \text{ hydrate}} \times \frac{\_\_\_\_\_ \text{ g water}}{1 \text{ mol water}} =$$

   c) Now do simple subtraction to get the mass of anhydrous reactants (mass without water):
      Mass of anhydrous copper (II) sulfate = _____
      Mass of anhydrous sodium phosphate = _____

   d) Total mass of both anhydrous (dry) reactants = _____
   Total mass of both dry products = _____
   Did you lose or gain mass in your reaction and how much? _____
   Do you think you should have lost mass, gained mass, or should mass have been constant? Why?