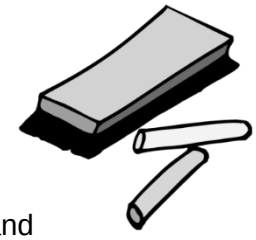
Name_____ Date_____ Per_____

LAB ACTIVITY: Percent Yield of Chalk (Calcium Carbonate)



Background/Discussion

In this lab, we are going to see a precipitation reaction (double replacement). This is a reaction where two soluble salts are added together and the result is the precipitation of a single product while the other remains in solution. We will be starting with known amounts of sodium carbonate and calcium chloride. We will then produce solutions of the two salts and react them to produce a precipitate. We will separate and dry this precipitate to measure our **actual yield**. We will then compare our actual yield to the **theoretical yield** to compute our **percent yield** for our experiment according to the following balanced chemical equation.

$$\mathbf{Na_2CO_{3\,(aq)} + CaCl_{2\,(aq)} \rightarrow CaCO_{3\,(s)} + 2\ NaCl_{\,(aq)}}$$

Limiting Reagents

Let's say I like one slice of ham between two slices of bread in my sandwiches. If I only have three slices of ham at my disposal, then all I can make is three sandwiches; that is assuming that I have six slices of bread. In fact, it doesn't matter whether I have six slices or forty-six slices, I can only make three sandwiches since I am **limited** by the amount of ham I have.

The same is true of reactions. I have a large quantity of Na_2CO_3 but I cannot produce any chalk unless I also have $CaCl_2$. Stoichiometry allows us to compare the amount of various substances involved in a reaction if we know the balanced chemical equation and the quantities of the other substances produced or needed. In order to determine **which of the reactants is limiting**, we must take into account both reactants' amounts present and how they relate stoichiometrically to one another in the balanced equation.

Percent Yield:

Reactions are expected to go to completion, but it is always another matter when you go into the lab and perform it. Preparations often require a variety of manipulations and transfers that cause a loss of product. Some of these losses are due to human error that can be eliminated with experience and improved technique. However, more often it is due to the actual procedure involved. **Percent Yield is a measure of the efficiency of the experimental design.**

Experimental Procedure for Making Chalk: Day 1

1) Mark a weigh boat with your initials and your lab partners' initials. Measure the mass of this weigh boat to the nearest 0.01g and record in the data table and save for step 8.
2) Obtain a piece of filter paper and measure its mass to the nearest 0.01g. Record the mass value in the data table and save for step 7.
3) Measure ~5.0 grams of calcium chloride and record its actual mass to the nearest 0.01g in the data table.
4) Place the calcium chloride into a 250 mL beaker and add about 150 mL of water to dissolve. If it is not dissolving, gently warm it up on a hot plate to get it to form a solution.
5) Weigh out ~3.0 grams of sodium carbonate and record its actual mass to the nearest 0.01g in the data table.
6) Pour the calcium chloride into the solution of sodium carbonate and gently swirl.
7) **Gravity filter** the white solid. This is done by folding the piece of filter paper into quarters and making a funnel. Place this inside of your glass funnel. Pour the solution into the center of the filter paper taking care not to let it get above the level of the filter paper. Wash the side of the beaker with a small amount of water and add this to the filter paper. Try to get the entire white solid (chalk) on the filter paper.
8) Carefully remove the filter paper (it will still be very moist) and place it in the weigh boat you weighed at the beginning. Place the weigh boat, $CaCO_3$, and filter paper in the drying oven over night.
9) Clean up!!!
You are now finished with Day 1: Complete Analysis 1-5 before next class time!

Pre-calculations: Calculate the **Molar Masses (g/mol)** needed for this experiment.

Calcium chloride: $CaCl_2$ =	**Sodium carbonate: Na_2CO_3 =**	**Calcium carbonate: $CaCO_3$ =**

Data Table: Day 1

DATA:	**MASS (g)**
Mass of weigh boat:	
Mass of Filter paper	
Mass of Sodium carbonate	
Mass of Calcium chloride	

Data Analysis: Day 1 - Show all work! (Dimensional Analyais or EQ / SUB / ANS)

1) Determine the moles of sodium carbonate added to the beaker.

2) Determine the moles of calcium chloride added to the beaker.

3) Write the balanced equation for the experiment.

4) Using your data above, **determine the limiting reagent** for this experiment.

5) Using the limiting reagent (from above), determine the mass of calcium carbonate that **should** form. **(theoretical yield)**

Percent Yield Activity: Day 2

Procedure: Day 2

1) When the product is dry, measure the mass of the weigh boat, filter paper and calcium carbonate to the nearest 0.01g. Record the mass value in your data table.

2) Clean up!

Data Table: Day 2

DATA:	**MASS (g)**
Mass of Weigh Boat, filter paper, calcium carbonate	

Data Analysis: Day 2 – Show all work!

1) Determine the **actual mass** of calcium carbonate you obtained.

2) Calculate the **Percent Yield** for your experiment.

3) Using the questions above and your results and observations from lab, **what best explains** the observed Percent Yield? Be specific and use your results (evidence) to support a claim with sound reasoning.

CLAIM – EVIDENCE – REASONING

- **Claim**: Provide a reason for the Percent Yield.
- **Evidence:** Provide data to support your claim.
- **Reasoning**: Logical explanation of how your evidence supports your claim.

OVER for Application Questions / Problems!

1) Chlorine can replace bromine in bromide compounds forming a chloride compound and bromine. The following equation is an example of the reaction: **$2KBr(aq) + Cl_2(aq) \rightarrow 2KCl(aq) + Br_2(l)$**

A) When 0.855g of Cl_2 and 3.205g of KBr are mixed in solution, which is the limiting reactant?

B) How many grams of **each** product are formed?

2) A process by which zirconium metal can be produced from the mineral zirconium (IV) orthosilicate, $ZrSiO_4$, starts by reacting it with chlorine gas to form zirconium (IV) chloride. What mass of $ZrCl_4$ can be produced if 862g of $ZrSiO_4$ and 952g of Cl_2 are available? (You must first determine limiting reactant).
$ZrSiO_4 + 2Cl_2 \rightarrow ZrCl_4 + SiO_2 + O_2$

3) In the reaction **$BaCO_3 + 2HNO_3 \rightarrow Ba(NO_3)_2 + CO_2 + H_2O$**, what mass of $Ba(NO_3)_2$ can be formed by combining 55g $BaCO_3$ and 26g HNO_3?

4) Huge quantities of sulfur dioxide are produced from zinc sulfide by means of the following reaction. If the typical yield is 86.78%, how much SO_2 should be expected if 4897g of ZnS are used? (assume oxygen gas is present in excess) **$2ZnS(s) + 3O_2(g) \rightarrow 2ZnO(s) + 2SO_2(g)$**

5) Aspirin, $C_9H_8O_4$, is synthesized by the reaction of salicylic acid, $C_7H_6O_3$, with acetic anhydride, $C_4H_6O_3$.
$2C_7H_6O_3 + C_4H_6O_3 \rightarrow 2\ C_9H_8O_4 + H_2O$

A) When 20.0 g of $C_7H_6O_3$and 20.0g of $C_4H_6O_3$ react, which is the limiting reagent?

B) If the percent yield is 72.5 %, what mass in grams of aspirin are actually formed?