Stoichiometry Lab for the Masses

Background and Purpose:

Carbonates when reacted with acids will produce carbon dioxide, water and an ionic salt. In this lab, we will perform this reaction of sodium bicarbonate with sulfuric acid and see how close our actual product yield comes to the theoretical yield. Remember that the **theoretical yield** is the maximum amount of product that could be produced when the reaction is carried out in the laboratory. In contrast, due to incomplete reactions, the amount of product that actually forms is known as the **actual yield**. We will be using a measured amount of **sodium bicarbonate as the limiting reagent** and thus **sulfuric acid will be in excess**, meaning that we have enough to react with all of the sodium bicarbonate plus extra just to be sure we have our best chance at maximizing the complete reaction. You will use stoichiometry to calculate our theoretical yield of carbon dioxide gas and use lab techniques to determine the actual yield of carbon dioxide gas after doing the experiment (three times). These two values will allow you to calculate your % yield for each of the 3 trials.

Start by balancing the chemical equation below. This will be necessary for your theoretical yield calculations.

__$NaHCO_3$(s) + __ H_2SO_4(aq) → __CO_2(g) + __H_2O (l) + __Na_2SO_4(aq)

Note: You will need to do three separate trials. Follow through with one trial, adding sulfuric acid until the reaction stops. Then clean out your styrofoam cup, dry it and move on to your next 2 trials.

Procedure:

1. **Fill a pipette** with 1M H_2SO4. This is sulfuric acid, which is **CORROSIVE** to body tissue, especially eyes. Please use caution, keep your goggles on, and wash your skin with water immediately if contact is made with this solution.
2. Get a clean styrofoam cup and yellow piece of cardstock. Poke a hole in the "lid" with your writing utensil. Place the pipette in the hole. You will be doing 3 trials of this lab. Complete the first trial all the way through step 9 before repeating for trials 2 and 3.
3. Measure **0.200g of baking soda** ($NaHCO_3$) in the styrofoam cup. It is OK to not have 0.200grams exactly as long as you properly record your amount in Table 1 for each trial that you do. Use the scale to determine exactly how much baking soda is added. This is a VERY SMALL amount of baking soda. You may measure its weight by zeroing the balance after putting the cup on the scale, and then weighing the amount of baking soda added. Record your amount in the Data section below.
4. Now use stoichiometry to **calculate** the mass of CO_2 gas that should be produced during this reaction, the **theoretical yield**. Use the mass of baking soda as your given, since this is the **limiting reagent**.
5. **Before Reaction:** Find the total mass of all the equipment and reactants prior to doing the reaction (including cup w/ $NaHCO_3$, lid, and pipette with H_2SO_4). Record this total mass in the Data Table.
6. **Do the Reaction:** Put the lid on the cup as a safety measure to prevent bubbling and splashing of the acid onto the table or your skin. Begin adding H_2SO_4 drop by drop. You do not need to count the drops since we are considering this to be the **excess reagent**. You should hear hissing as the CO_2 is generated. Continue adding drops until no more bubbles are produced, signifying the end of the reaction (and that all of the baking soda has completely reacted).
7. **After the Reaction:** Open the lid briefly to allow CO_2 gas to escape. Now reweigh all the equipment and the left over products. Record the total mass after the reaction in the Data Table.
8. Subtract the total mass after the reaction from the total mass before the reaction to come up with the amount of CO_2 gas that was produced and lost to the air in this reaction. This is your **actual yield.**
9. Rinse your cup contents down the sink and dry the cup.
10. **REPEAT steps 3 through 9** for a 2^{nd} and 3^{rd} trial. I would like for your initial mass of baking soda to be slightly different than your first trial, like 0.210g or 0.190grams, as long as your record its mass exactly.

Table 1: Masses of Limiting Reagent

	Trial 1	Trial 2	Trial 3
Mass of $NaHCO_3$			

Trial 1 Start with your known amount of $NaHCO_3$ from Table 1 to calculate theoretical yield of CO_2 in grams. Remember to convert from grams to moles, then moles of $NaHCO_3$ to moles of CO_2, then moles to gram using CO_2's molar mass. *This will be your theoretical yield.*

Trial 1

Trial 2

Trial 3

Table 2: Mass of Reactants and Mass of Products

Measure the masses of both reactants and all containers and equipment. Then measure the mass of products at the end, again including all the same containers and equipment.

	Mass of Reactant Materials	Mass of Product Materials
Trial 1		
Trial 2		
Trial 3		

Calculate mass of CO_2 produced by getting the difference between products' and reactants' masses for each of the 3 trials above**.**

Trial 1

Trial 2

Trial 3

Calculate Percent Yield (% yield) for each of the 3 trials above**.**

Trial 1

Trial 2

Trial 3

Lab Report (67)

Title: a single sentence fragment (no verb) that describes your experimental objective and gives some indication of the procedure.
Abstract: a one-paragraph summary of the *entire* experiment-your procedure, results, and conclusion. This should be written after the remainder of the report is complete, yet, it appears just after the title.
Introduction: a description of the scientific background for your experiment, including any previous experiments that your experiment builds on. (Remember to cite your sources!) The final sentence (analogous to the thesis statement in a term paper) is the objective of your experiment.
Materials and Methods: a detailed description (in paragraph format) of the procedure for your experiment.
Results: your data, as you observed/recorded them, in tables. Note that this section is only for data that you observed or measured directly. Your analysis (including calculations) belongs in the Discussion section.
Discussion: your calculations, an analysis of what your results mean, and your error analysis.

- Write the chemical equation for the reaction that took place. Do not forget to include the states of matter (s, l, g, or aq). Balance it.
- For each trial, calculate the number of grams of CO_2 that should be produced…theoretical yield.
- For each trial, calculate the difference in mass of products and reactants…actual yield.
- For each trial, calculate the "percent yield" for your reaction.

Conclusion: a short paragraph that restates the objective from your introduction and relates it to your results and discussion, and describes any future experiments or improvements that you would recommend.

- Why was your percent yield what it was? In other words, if you got 100%, why was it so perfect? If you got less than 100%, what happened?

Works Cited: a bibliography of all of the sources you got information from in your report.