Determining Percent Yield in the Laboratory

(Honors Chemistry)

In class, you have learned how to use stoichiometry to determine the theoretical yield of a product generated from a chemical reaction. In this lab, you will be performing two different reactions and obtaining an actual yield of the products. The actual yield and theoretical yield will be used to calculate the percent yield.

Safety: handle boiling liquids, hotplates, and hot glassware with caution.

Materials:

Hot Plate	Stirring Rod	Heat Gloves
Acetic Acid	Centigram Balance	500-mL Erlenmeyer Flask
Sodium Bicarbonate	Distilled Water	Weighing dish
Crucible	Crucible tongs	100-mL graduated cylinder

Part 1: Determining the percent yield of solid product during a double replacement reaction

$$NaHCO_{3\,(s)} + HC_2H_3O_{2\,(aq)} \rightarrow NaC_2H_3O_{2\,(s)} + CO_{2\,(g)} + H_2O_{(l)}$$

Procedure:

1. Calculate the mass, in grams, of 2.49×10^{-2} moles of sodium bicarbonate ($NaHCO_3$). _______________
2. Using a weighing dish and balance, measure out the amount of $NaHCO_3$ you calculated in step 1. Attempt to get as close to your calculated amount as possible. Record this amount in your data table.
3. Mass a clean 500-mL Erlenmeyer flask. Record this amount in your data table.
4. Dissolve the $NaHCO_3$ in about 15 milliliters of distilled water in the 500-mL flask. Stir until it is mostly dissolved. *(It is okay if some remains undissolved.)*
5. Obtain approximately 75-mL of acetic acid and *slowly* add it in small quantities to the flask containing the sodium bicarbonate solution. Wait for the bubbling to subside between additions so that the reaction does not overflow the flask.
6. When all the acetic acid has been added, swirl flask or stir for two minutes with a glass stirring rod.
7. When the solution is completely calm, move the flask to a hot plate and heat it to boiling. Be careful that the flask does not overflow, as this will hurt your calculations.
8. When all the liquid has boiled away, remove the flask *(using heat gloves)* from the hotplate and allow it to cool on your table until it reaches room temperature.
9. When the flask has completely cooled, weigh it and record the mass in your data table. The salt in your flask is sodium acetate, which is the solid product in your double replacement reaction.
10. After weighing, clean your flask and any other glassware you used *thoroughly* and return it to the bin.

Part 2: Determining the percent yield of solid product during a decomposition reaction

$$2NaHCO_{3\,(s)} \rightarrow Na_2CO_{3\,(s)} + CO_{2\,(g)} + H_2O_{\,(l)}$$

Procedure:

1. Measure the mass of a clean, dry, crucible and enter it in the data table.
2. Add roughly 3.00 grams of $NaHCO_3$ to the crucible.
3. Subtract the mass of the crucible from the mass of the crucible and $NaHCO_3$.
4. Heat the crucible and $NaHCO_3$ on medium heat for 8-10 minutes.
5. Gently stir the baking soda while heating to maximize the release of gases. Be careful not to lose product stuck to the stirring rod. This will hurt your calculations.
6. The reaction is complete when the reactant appears dry and no longer sticks to the glass stirring rod.
7. Use tongs to remove the hot crucible and place directly on your lab table until it cools to room temperature. This should take at least 5 minutes.
8. When the crucible has completely cooled, mass it and record the mass in your data table. The salt in your flask is sodium carbonate, which is the solid product of your decomposition reaction.
9. After weighing, clean your crucible and any other glassware you used ***thoroughly*** and return it to the bin.

Name ____ Hour ______

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Questions Part 1:

1. Calculate the mass, in grams, of 2.49 x 10^{-2} moles of sodium bicarbonate ($NaHCO_3$). Show work and put your answer in the data table.

2. Calculate the theoretical yield of $NaC_2H_3O_2$ using the mass of the sodium bicarbonate. Show work and put your answer in the data table.

3. Calculate the actual yield of $NaC_2H_3O_2$ by using the mass of the empty flask and the mass of the flask after the reaction. Show work and put your answer in the data table.

4. Using the actual yield of $NaC_2H_3O_2$ from # 3 and theoretical yield from #2, calculate the percent yield of $NaC_2H_3O_2$ recovered in this lab. Show your work and put your answer in Data Table 1.

5. Was your percent yield of $NaC_2H_3O_2$ 100%? What factors might have caused any error you found? Explain, citing specific examples.

6. Do you think it is common for scientists to get 100% yields? Why or why not?

7. If you had to do this lab again, what would you do differently to improve your results? Explain, using

Data Table Part 1:

Mass of Sodium Bicarbonate	
Mass of 500-mL Erlenmeyer Flask	
Theoretical Yield of sodium acetate	
Mass of 500-mL Erlenmeyer Flask and sodium acetate	
Actual Yield of sodium acetate	
Percent Yield of Sodium Acetate	

Questions Part 2:

1. Calculate the theoretical yield of Na_2CO_3 using the mass of the sodium bicarbonate from Data Table 2. Show work and put your answer in the data table.

2. Calculate the actual yield of Na_2CO_3 by using the mass of the empty crucible and the mass of the crucible after the reaction. Show work and put your answer in the data table.

3. Using the actual yield of Na_2CO_3 from Q2 and theoretical yield from Q1, calculate the percent yield of Na_2CO_3 recovered in this lab. Show your work and put your answer in Data Table 2.

4. Was your percent yield of Na_2CO_3 100%? What factors might have caused any error you found? Explain, citing specific examples.

5. Do you think it is possible to get greater than 100% in the lab? Explain.

6. List 2 reasons that might have causee you to get less than 100% yield.

Data Table Part 2:

Mass of Clean, dry, crucible	
Mass of crucible and $NaHCO_3$	
Mass of $NaHCO_3$	
Theoretical Yield of sodium carbonate	
Actual Yield of sodium carbonate	
Percent Yield of Sodium carbonate	