CHEMISTRY EXPERIMENT
THEORETICAL YIELD

In this experiment sodium hydrogen carbonate (baking soda) will be reacted with hydrochloric acid to obtain a high yield of sodium chloride. The unbalanced equation for the reaction is:

$$\_\_\_\ NaHCO_3(s) + \_\_\_\ HCl(aq) \rightarrow \_\_\_\ NaCl(aq) + \_\_\_\ CO_2(g) + \_\_\_\ H_2O(l)$$

You will:

- completely react an accurately measured quantity of $NaHCO_3$ and dilute HCl.
- isolate the NaCl from the other products and determine its mass.

The **theoretical yield** can be calculated by using the mole ratio from the balanced equation for the reaction.

After completing the lab, the **percent yield** can then be determined by comparing the experimental yield to the previously established theoretical yield.

PROCEDURE:

Day One:

1. Determine the mass of a 100mL beaker to the nearest 0.01 gram.
2. Weigh out, precisely, your assigned mass (_____g) of sodium hydrogen carbonate into the beaker. Use a microspatula to adjust amount. Record the total mass of beaker plus contents.
3. Cover the beaker with a watch glass, convex side down and slightly off center so that the lip of the beaker is uncovered. Then:
    - Add dilute (3M) HCl down the lip of the beaker to the sodium hydrogen carbonate in the beaker.
    - Continue this process until no more reaction takes place when a drop of acid is added (the bubbling stops).
    - Gently swirl the beaker so that all of the solid contacts the acid. Do **NOT** add excess hydrochloric acid!
4. Carefully rinse the underside of the watch glass with a small amount of distilled water and collect the washings in the beaker. Wash the watch glass with tap water, dry, and return.
5. **Gently** heat the beaker and contents on a hot plate until the sodium chloride solution *just begins to boil*. This will drive off any excess HCl and begin the evaporation process.
6. Using beaker tongs, place the beaker in a drying oven to evaporate the water from the NaCl overnight.

Day Two:

1. Weigh the beaker and contents (now crystalline NaCl) to the nearest 0.01 gram. Record.
2. Clean, rinse, and dry the beaker. The NaCl can be washed down the drain.

THEORETICAL YIELD Lab Write-up

PURPOSE: The purpose of this experiment is to obtain a high yield of sodium chloride and to compare that yield to a value obtained by doing a mass-to-mass stoichiometric calculation, thus validating this type of calculation.

Day One CALCULATION:

Write the balanced equation for the reaction. Then calculate the **theoretical yield** of NaCl that should be obtained using your assigned mass of $NaHCO_3$. This is a gram-to-gram **stoichiometry** calculation.

(g of A → mol of A → mol of B → g of B) Show factor-label method and units!!!

Equation:

___ $NaHCO_{3(s)}$ + ___ $HCl_{(aq)}$ → ___ $NaCl_{(aq)}$ + ___ $CO_{2(g)}$ + ___ $H_2O_{(l)}$

Mass of 100mL beaker _____grams

Mass of beaker + $NaHCO_3$ _____grams = Mass of $NaHCO_3$ _____ grams

Calculation of Theoretical Yield:

_____g $NaHCO_3$ $\left(\frac{\quad}{\quad}\right)\left(\frac{\quad}{\quad}\right)\left(\frac{\quad}{\quad}\right)$ = _____ g NaCl

Day Two DATA: Mass of beaker + NaCl _____grams

ANALYSIS/CALCULATIONS:

1. Use subtraction to find the Experimental Yield of NaCl.

2. Determine the percentage yield of NaCl.

$$\% \text{ Yield NaCl} = \frac{\text{Experimental Yield NaCl}}{\text{Theoretical Yield NaCl}} \times 100 =$$

CONCLUSION/QUESTIONS:

1. State in a sentence what your % Yield means. This is asking you to explain the numerical result to calculation #2 above, not how you got it.

2. Based on your % Yield, how accurately did your stoichiometric calculation actually predict your product? Explain any discrepancies.

3. Calculate the volume, in mL, of 3.00 M HCl that would be theoretically required to react with the grams of $NaHCO_3$ that you used in the reaction. This is a solution stoichiometry problem. g A → mol A → mol B → mL B

_____g $NaHCO_3$ $\left(\frac{\quad}{\quad}\right)\left(\frac{\quad}{\quad}\right)\left(\frac{1000\text{ mL}}{3.0\text{ mol HCl}}\right)$ = _____ mL HCl