Experiment 10

Stoichiometry- Gravimetric Analysis

Pre-lab Assignment

- Read the lab thoroughly.
- Answer the pre-lab questions that appear at the end of this lab exercise.

Purpose

The purpose this experiment is to perform two gas forming reactions and determine the actual yield, theoretical yield and percent yield of the sodium chloride (NaCl) that is produced.

Background

Part A

In part A, the lab, you will perform the reaction:

Unbalanced reaction:

$$Na_2CO_3\ (s) + HCl\ (aq) \rightarrow NaCl\ (aq) + CO_2\ (g) + H_2O\ (l)$$

sodium carbonate + aqueous hydrochloric acid →aqueous sodium chloride + carbon dioxide gas + liquid water

Sodium carbonate (Na_2CO_3) will be the liming reactant in the experiment and NaCl will be weighted at the end of the experiment.

Specifically, a pre-weighed mass of sodium carbonate will be allowed to react with a slight excess of hydrochloric acid. The sodium chloride product will then be carefully collected, dried and weighed at the end of the reaction and its actual yield and theoretical yield will be compared. The actual product yield is obtained by weighting the NaCl formed while the theoretical yield is calculated using the balanced chemical equation and is based on the initial amount of Na_2CO_3 used. The theoretical yield is the maximum mass of product that could be obtained from a reaction provided that no errors occur.

$$\textit{Percent Yield} = \frac{\textit{Actual mass of NaCl formed}}{\textit{Theoretical mass of NaCl}} \textit{ X 100}$$

Good experimental practices in the lab (with minimum error) generally result in a high percent yield, where the experimental yield closely matches the theoretical yield.

Procedure:

Safety:

- Wear Safety Goggles.
- Be especially careful when handling the 6M HCl as it can cause chemical burns to the skin. If any acid spills on you, rinse immediately under running water for up to 15 minutes and report the accident to your instructor. Acid spills may also be neutralized using a sodium bicarbonate solution.
- Be sure to exercise appropriate caution when using the Bunsen burner and handling hot equipment.

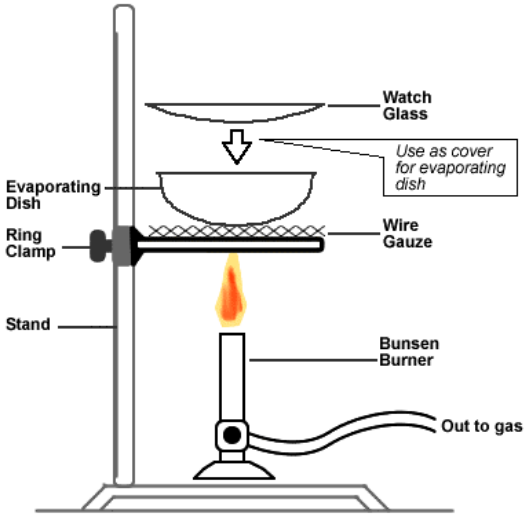
Materials and Equipment
Solid sodium carbonate (Na_2CO_3), sodium bicarbonate ($NaHCO_3$), 6.0 M hydrochloric acid (HCl), balance, evaporating dish, watch glass (to fit as a cover for the evaporating dish), stand and ring clamp, wire gauze, dropper pipette, stir rod and Bunsen Burner.

Part A
1. Measure and record the mass of your clean dry evaporating dish + watch glass (assembled together with the watch glass acting as a cover on top of the evaporating dish).

2. Carefully add 0.3 – 0.4 g of solid sodium carbonate (Na_2CO_3) to the evaporating dish. ***Do not do this over the balance as spills can damage the balance!*** Measure and record the mass of the evaporating dish + watch glass +Na_2CO_3. Calculate the mass of the Na_2CO_3

3. Obtain about 5-mL of hydrochloric acid (HCl) in your smallest beaker. Using your dropper pipette, add the HCl ***drop by drop*** to the sodium carbonate in the evaporating dish. The reaction will be evident by the bubbling that takes place. Gently mix the reactants after every 4-5 drops of HCl. Continue adding HCl until the bubbling stops. This indicates that the reaction is complete and that all of the Na_2CO_3 has reacted.

4. Assemble the stand, ring clamp and wire gauze apparatus for heating as shown in the figure below.
Cover the evaporating dish with the watch glass and place it on the wire gauze.



5. In the fume hood, ***gently heat*** the solution in the evaporating dish with a Bunsen Burner flame in order to remove the water generated in the reaction (as well as any excess HCl present). The flame should be wafted under the evaporating dish constantly. Continue heating until the contents are ***completely dry***. (When you think its dry, heat it 2 more minutes! – stop if white salt starts to turn brownish)

6. After allowing the evaporating dish to cool to room temperature, measure and record the mass of the evaporating dish, watch glass and residue (NaCl).

7. The waste from this experiment may be disposed of in the sink.

8. Percent Yields – Calculate the theoretical yield of NaCl for the reaction using stoichiometry. Use your mass of sodium carbonate reactants weighed out in lab as the starting point and the mole ratios from the balanced equations for these calculations. Then determine your percent yield for each reaction using the calculated theoretical yields along with your experimental yields of NaCl, obtained in lab.

Name _____

Part A Data Table	
	Mass (g)
1. Mass of clean, dry evaporating dish and watch glass	
2. Mass of evaporating dish, watch glass, and Na_2CO_3	
3. Mass of Na_2CO_3	
4. Mass of evaporating dish, watch glass, and NaCl residue after drying	
5 .Experimental mass of NaCl(sodium chloride)	
6. Theoretical mass of NaCl (*show work below*)	
7. Percent yield (*show work below*)	

Calculation of theoretical mass of NaCl (Show work)

Calculation of percent yield of NaCl (Show Work)

Part B

In Part B of the lab, sodium carbonate (Na_2CO_3) will be replaced with sodium bicarbonate ($NaHCO_3$). The balanced equation for the reaction is:

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

sodium bicarbonate + aqueous hydrochloric acid →aqueous sodium chloride + carbon dioxide gas + liquid water

Notice that the coefficients are different than in Part A.

Procedure

1. Repeat steps 1 to 6 with a 0.3 – 0.4 g sample of sodium bicarbonate ($NaHCO_3$) in place of the sodium carbonate (Na_2CO_3). Record your data in the table below.

Part B Data Table	
	Mass (g)
1. Mass of clean, dry evaporating dish and watch glass	
2. Mass of evaporating dish, watch glass, and $NaHCO_3$	
3. Mass of $NaHCO_3$	
4. Mass of evaporating dish, watch glass, and NaCl residue after drying	
5. Experimental mass of NaCl(sodium chloride)	
6. Theoretical mass of NaCl (show work below)	
7. Percent yield (show work below)	

Calculation of theoretical mass of NaCl (Show Work)

Calculation of percent yield of NaCl (Show Work)

Post-Lab Questions

1. If there were no errors that occurred during this lab what would your % yield be? Did you have a good percent yield?

2. What probably happened if your % yield was greater than 100 % ? How would you fix that problem?

3. Using the mass of Na_2CO_3 you used in Part A of the lab, what mass of carbon dioxide should have been generated in the Part A of the experiment?

4. If 6.0 grams of $CaCO_3$ reacts with excess HCl, what mass of water should be formed?
The balanced equation is:

$$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$$

Name _____

Pre-lab Assignment for Stoichiometry- Gravimetric Analysis

1. Write **balanced** equations for the two reactions you will perform in this lab. You will need to balance the equation for Part A of the experiment.

Part A:

Part B:

2. What will you look for to indicate that enough acid has been added to the sodium bicarbonate (in Reaction A) or sodium carbonate (in Reaction B), and that the reactions are complete?

3. After mixing the reactants together, you will then use a Bunsen Burner to heat the contents of the reaction "container"

a. What are you removing by heating?

b. What substance will remain in the container after heating with the Bunsen Burner?

4. Fermentation is the chemical process of making wine by converting glucose ($C_6H_{12}O_6$) into ethanol (C_2H_5OH) and carbon dioxide (CO_2):

$$C_6H_{12}O_{6(s)} \rightarrow 2\ C_2H_5OH_{(l)} + 2\ CO_{2(g)}$$

How many grams of carbon dioxide would be formed from 26 grams of glucose? Show all work.