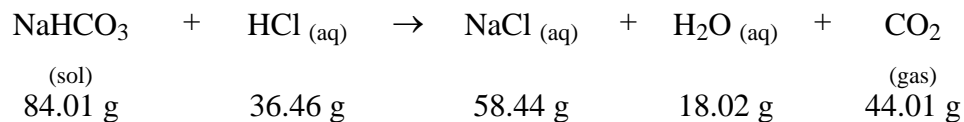# Lab Session 4, Experiment 3: Preparation of Sodium Chloride

Sodium chloride will be synthesized by reacting sodium bicarbonate with hydrochloric acid. The reaction equation is shown below:

$$NaHCO_3 \quad + \quad HCl_{(aq)} \quad \rightarrow \quad NaCl_{(aq)} \quad + \quad H_2O_{(aq)} \quad + \quad CO_2$$

<div style="text-align: center">

(sol)   (gas)

84.01 g   36.46 g   58.44 g   18.02 g   44.01 g

</div>

The quantitative interpretation of the reaction is as follows: 84.01 g (1 mol) of sodium bicarbonate reacts with 36.46 g (1 mol) of hydrochloric acid to generate 58.44 g (1 mol) of salt, 18.02 g (1 mol) of water, and 44.01 g (or 1 mol) of carbon dioxide. Of course the starting quantity of $NaHCO_3$ may be more or less than 84.01 g, but a proportionate quantity of the hydrochloric acid will be consumed, and proportionate quantities of the products will be formed. For example, should 100.00 g of $NaHCO_3$ react with excess acid, the theoretical mass of salt produced would be calculated as follows:

$$\frac{58.44 \text{ g sodium chloride}}{84.01 \text{ g sodium bicarbonate}} \bigg| \; 100.00 \text{ g sodium bicarbonate} \; = \; 69.55 \text{ g sodium chloride}$$

Note that when a bicarbonate is reacted with excess acid, the salt produced is the only substance not readily volatile. That is, the unreacted acid, the water, and the carbon dioxide are easily removed by heating.

3A Experiment

Chemicals needed: sodium bicarbonate, concentrated hydrochloric acid.

1. Accurately weigh an empty, dry evaporating dish, and record its mass in blanks (b) and (e) in the table below.

2. Add to the dish about 5 g of $NaHCO_3$ and weigh again. Record the mass in blank (a) in the table below.

3. Add 5 to 6 mL of distilled water to the dish to wet the bicarbonate. Cover the dish with a watch glass.

4. Move the watch glass aside slightly and add, in small portions, about 6 mL of concentrated hydrochloric acid from a 10 mL graduated cylinder. These small portions of acid should be added so that the acid runs down the inside wall of the evaporating dish. After the addition of 6 mL of acid, continue adding acid only as long as $CO_{2\ (gas)}$ continues to be evolved.

5. Remove the watch glass and evaporate to dryness over a water bath (the evaporating dish is placed on top of a beaker containing boiling water).

6. Next, heat the dish on wire gauze with the burner for about 3 minutes. Allow the dish to cool and weigh accurately. Again, heat the dish, cool, and weigh. Continue heating and weighing until the dish reaches constant mass. Record this constant mass in blank (d) in the table below.

(a) Mass of dish and $NaHCO_3$		g
(b) Mass of empty dish		g
(c) Mass of $NaHCO_3$ [(a)–(b)]		g
(d) Mass of dish and residue		g
(e) Mass of empty dish (b)		g
(f) Mass of NaCl residue [(d)–(e)]		g

7. In the reaction studied, what reactant was present in limiting quantity?

3B Calculations

1. Calculate the theoretical yield of NaCl.

$$\frac{58.44 \text{ g NaCl}}{84.01 \text{ g NaHCO}_3} \left| \rule{0pt}{20pt} \underline{\hspace{2cm}} \text{ g NaHCO}_3 \right. = \underline{\hspace{3cm}} \text{g NaCl}$$

2. Calculate the percentage yield of NaCl.

$$\frac{\text{Actual yield} \times 100}{\text{Theoretical yield}} = \frac{(\underline{\hspace{2cm}})}{(\underline{\hspace{2cm}})} \times 100 = \underline{\hspace{3cm}} \%$$

3C Exercises

In the following problems, show calculations:

3. What theoretical mass of NaCl would result from reacting 60.00 g of $NaHCO_3$ with excess HCl (aqueous)?

$$\frac{58.44 \text{ g NaCl}}{84.01 \text{ g NaHCO}_3} \left| \frac{60.00 \text{ g NaHCO}_3}{} \right. = \underline{\hspace{3cm}} \text{g NaCl}$$

4. What theoretical mass of NaCl would result from reacting 3.00 moles of $NaHCO_3$ with excess HCl (aqueous)?

$$\frac{3.00 \text{ mol NaHCO}_3}{} \left| \frac{1 \text{ mol NaCl}}{1 \text{ mol NaHCO}_3} \right| \frac{58.44 \text{ g NaCl}}{1 \text{ mol NaCl}} = \underline{\hspace{3cm}} \text{g NaCl}$$

5. What mass of CO_2 would be generated along with 35.00 g of NaCl?

$$\frac{35.00 \text{ g NaCl}}{58.44 \text{ g NaCl}} \left| \frac{44.01 \text{ g CO}_2}{} \right. = \underline{\hspace{3cm}} \text{g CO}_2$$

Report Form 3: Preparation of Sodium Chloride

Name_____

Partner_____Section #_____

3A Experiment

(a) Mass of dish and NaHCO₃	g
(b) Mass of empty dish	g
(c) Mass of NaHCO₃ [(a)–(b)]	g
(d) Mass of dish and residue	g
(e) Mass of empty dish (b)	g
(f) Mass of NaCl residue [(d)–(e)]	g

In the reaction studied, what reactant was present in limiting quantity?

3B Calculations

1. Theoretical yield of NaCl._____

2. Percentage yield of NaCl._____

3C Exercises

3. What theoretical mass of NaCl would result from reacting 60.00 g of $NaHCO_3$ with excess HCl (aqueous)?_____

4. What theoretical mass of NaCl would result from reacting 3.00 mol of $NaHCO_3$ with excess HCl (aqueous)?_____

5. What mass of CO_2 would be generated along with 35.00 g of NaCl?_____