Lab 2: STOICHIOMETRY: THE MASS AND MOLE RELATIONSHIPS IN A CHEMICAL REACTION

Prelab

In order to complete the calculations in this laboratory, it is required that you calculate the *molar mass* (also known as the *formula weight or molecular mass*) for three inorganic compounds. As always, please prepare your lab notebook by entering the title of the lab, your name, and the "*Purpose*" (enter the date and your lab partners name during the lab period). Make a table similar to the one below and complete the information; enter this information under the "*Prelab*" heading after the "*Purpose*" heading:

Inorganic compound	**Name of this compound**	**Cation in this compound**	**Anion in this compound**	**Molar mass (g/mol)** *show your work in notebook*
Na_2CO_3				
$NaHCO_3$				
NaCl				

Next you will need to write out the chemical reactions under a heading of "**Chemical Reactions**." The chemical reactions are written below in words. In your prelab you will write the chemical reactions as balanced chemical reactions, complete with the physical states [(s) – for solids, (aq) – for aqueous, (l) – for liquid, and (g) – for gas].

Example reaction: 2 Al (s) + 6 HCl (aq) → 2 $AlCl_3$ (aq) + 3 H_2 (g)

Reaction 1: Solid Na_2CO_3 is reacted with aqueous hydrochloric acid to form aqueous sodium chloride, liquid water and carbon dioxide gas. Balance this chemical reaction.

Reaction 2: Solid $NaHCO_3$ is reacted with aqueous hydrochloric acid to form aqueous sodium chloride, liquid water and carbon dioxide gas. Balance this chemical reaction.

NOTE: This lab uses a concentrated form of HCl, a strong acid. Avoid skin contact and clean up any spills immediately. The HCl is dispensed in dropper bottles to minimize spillage, gloves are NOT recommended.

PURPOSE

The purpose of this lab activity is to investigate a chemical reaction with specific attention paid to the relationship between the mass of a substance and the moles of this substance. This relationship is generally referred to as the reaction ***stoichiometry***. As a part of learning about reaction stoichiometry, you will also be introduced to balanced chemical reactions. The lab activity will introduce you to the use of the Bunsen/Tirrill burner and another opportunity to hone your skills in using the top-loading balance (***PLEASE clean up any spills***). It is again important to document all of your laboratory activities in your lab notebook.

INTRODUCTION

You will be given one sample labeled **A** or **B**. This sample is either sodium carbonate (Na_2CO_3) or sodium bicarbonate ($NaHCO_3$). The goal of the experiment is to determine which compound you have been given. Both compounds react with HCl to form NaCl, water and carbon dioxide, but they form different amounts of NaCl. You can calculate the expected grams of NaCl using stoichiometry and the balance chemical reaction.

EXPERIMENTAL

- Measure the mass of a 250 mL Erlenmeyer flask to the nearest 0.01 g. ***Record the mass in your lab notebook.*** Place approximately 2 g of your unknown solid in the flask. You can use any amount of solid between 1.8 g and 2.2 g, but you need to know the exact mass of solid that you use. Record the combined mass of the flask and solid to the nearest 0.01 g. ***Record this mass in your lab notebook.***
- Return to your lab bench with your flask and unknown solid. Slowly add dropwise 3 M HCl into the unknown solid until no more CO_2 (no more bubbles) is given off. Swirl the sample while adding HCl to make sure the contents is well mixed.
- Place the flask on a ring stand as shown in lab-lecture. Gently heat the mixture with a small flame until only dry solid remains. It is possible that some material will splatter out of the flask if you heat too quickly, so be cautious.
- Allow flask and NaCl to cool for ~10 minutes; when you can pick it up with your hand, it is cool enough. Determine the mass of the flask to the nearest 0.01 g and record your data in your lab notebook.
- Clean and return all glassware to your drawer.
- Once you have entered all data into your lab notebook, cleaned and rinsed all glassware with RO water, returned glassware to your drawer, then go to WebAssign and complete your "Reporting Sheet."

WASTE MANAGEMENT

None of the products generated in today's experiment are toxic and therefore all waste may be poured into the sink.

Name _____

Reporting Sheet: *Lab 2: STOICHIOMETRY.*

Data Analysis

In the space below, assume your sample is Na_2CO_3. Use the original unknown mass to calculate the hypothetical mass of NaCl that would have been synthesized. This calculation can be accomplished using the following steps:

a) (3 pts) Convert the mass of unknown, assumed to be Na_2CO_3, to moles of Na_2CO_3 using the ***molar mass*** of Na_2CO_3.

_____ moles of Na_2CO_3

b) (2 pts) Convert the moles of Na_2CO_3 consumed to the moles of NaCl formed using the ***balanced chemical equation***.

_____ moles of NaCl

c) (3 pts) Convert the moles of NaCl to grams of NaCl using the ***molar mass*** of NaCl.

_____ grams of NaCl

2) (5 pts) Now assume your sample is $NaHCO_3$. Use the original unknown mass to calculate the hypothetical mass of NaCl that would have been formed. Use the method outlined above:

_____ grams of NaCl

3) (2 pts) Fill in the spaces in the following statement.

My unknown was labeled _____. If this unknown was Na_2CO_3, then I would expect to have formed _____ grams of NaCl as a product. If this unknown was $NaHCO_3$, then I would expect to have formed _____ grams of NaCl as a product. Since my reaction formed _____ grams of NaCl, then this unknown is _____.

Note: If your actual mass of NaCl is not clearly one of the predicted amounts, then make a suggestion in the space below of why this may be the case.

This Reporting Sheet is due one week after the completion of the lab activity.

GRADING (Lab 2)

- *Notebook Preparation*
  - lab activity entered into Table of Contents (1 pts)..... _____ pts
  - header information on ALL pages (1 pts)..... _____ pts
  - Purpose in notebook (2 pts) ..... _____ pts

-*Prelab Activity*
  - Complete table as requested in lab notebook (12 pts)..... _____pts
    (Including calculations of molar masses)
  - Balanced Chemical Reactions in lab notebook (4 pts)..... _____pts

- *Data collection*
  - Mass of unknown clearly noted in lab notebook (3 pts)..... _____ pts
  - Unknown label clearly noted in lab notebook (2 pt)..... _____pts

- *Data Analysis*
  - Reporting Sheet Calculations (15 pts) ..... _____ pts

Total point (40 pts) ..... _____ pts

Instructor's Notes:

Lab-Lecture Demos

(aq) means aqueous…used when a substance is dissolved in water…as in HCl (aq).
- transfer unknown using a scoopula.
- show swirling solution on bench…ie do not pick up the flask and shake, but rather leave it on the bench and swirl in 2-dimensions.
- ring-stand with wire mesh and Bunsen burner.
- lighting and controlling the Bunsen burner flame.

Setup

- unknowns labeled A and B (these are Na_2CO_3 and $NaHCO_3$)
- 3 M HCl in dropper bottles
- additional pan balances if possible.

Note: This lab can be done using either the Erlenmeyer flask (version "…_04) or a beaker with watch glass (version "… _03"). The problem with the watch glass is that they do tend to get broken either by students dropping them or by thermal cracking (most are not Pyrex). It is also harder to remove all of the water from the pseudo closed beaker-watch glass setup.