Chemistry **Name:_________________________**
Lab – $NaHCO_3$ and HCl **Date: ______________ Block ______**

Mole and Mass Relationship in a Chemical Reaction
$NaHCO_3$ and HCl

INTRODUCTION
In a balanced chemical equation symbols and formulas represent all reactants and products. Coefficients are used on each side of the equation to satisfy the Law of Conservation of Mass – atoms never "disappear" during the reaction, but they are rearranged. Just as we can interpret coefficients on the ***micro-*** level (the ratio of individual atoms and molecules involved), we can also interpret the coefficients on the ***macro-*** level as the ***ratio of moles*** of all species involved in the reaction

$2H_2$ (g) + O_2 (g) → $2H_2O$ (g) means

2 molecules H_2 + **1 molecule** of O_2 *yields* **2 molecules** of H_2O
or, if you consider 6.02×10^{23} times as many molecules, then the interpretation is:

2 moles of hydrogen gas *plus* **1 mole** of oxygen gas *yields* **2 moles** of water
or any number of moles in a 2:1:2 ratio

In addition, because these reactants and products are gases, there is also a volume relationship:
2 (x 22.4) liters of H_2 + 1 (x 22.4) liters of O_2 *yields* 2 (x 22.4) liters of H_2O

Since you can easily know the ratio of reacting ***moles***, and since it is possible to convert between moles and grams when you know the formulas of reacting species, you can make accurate predictions about the amounts of all reactants and products involved in a reaction. This lab will illustrate the actual mole and mass relationship among reactants and products in a reaction.

PROCEDURE
In this experiment you will react $NaHCO_3$ (commonly called baking soda) with hydrochloric acid, HCl. You will start with a know mass of $NaHCO_3$ and will produce NaCl as a product. You can determine from the balanced equation the expected mole ratio of $NaHCO_3$ to NaCl. Moles can be converted to masses quite easily. So, in addition to making a prediction about the amount of NaCl you should produce, you will compare the amount you actually produce. Careful lab work gives good results! **WEAR GOGGLES THROUGHOUT THE PROCEDURE.**

1. Obtain and record the mass of a clean, dry evaporating dish or beaker **and** watch glass.
2. Add approximately 2.50 grams of $NaHCO_3$ to the evaporating dish. (Use the tare function on your balance, but be sure to clear any mass from the previous user.) Record the amount of $NaHCO_3$ used.
3. Set up a Bunsen burner, ring, and wire mesh and set the evaporating dish or beaker on the wire mesh. Cover the dish with the watch glass, **curved side down. Do not light the burner yet.**
4. Obtain 5 mL of 6M HCl. Handle the acid carefully, wipe spills on the desk, graduated cylinder, and acid bottle. Raise one side of the lid and add the acid slowly to the $NaHCO_3$, using the underside of the lid to catch spatters.
5. Swirl the mixture in the dish to ensure thorough mixing and then add additional acid, several drops at a time, until the reaction stops. Swirl again for thorough mixing.
6. Place the watch glass **curved side up** onto the lab table. Heat the evaporating dish gently – move the burner back and forth to avoid spattering. When almost all of the liquid is gone, replace the watch glass and continue to heat the contents to dryness.
7. Allow the dish and lid to cool. Work on questions/calculations on the back of this sheet.
8. Obtain the mass of the evaporating dish, watch glass, and solid residue.
9. If time permits, heat to constant mass.

Quantitative Data Table – Measured Data

	Data	**Calculations and/or Qualitative Observations**
Mass of glassware and watch glass		
Mass of $NaHCO_3$ used		
Mass of glassware and watch glass and product		
Mass of product		

QUESTIONS/CALCUATIONS: **Show all calculations neatly on a separate paper**.

1. Write the balanced equation for this reaction. Use appropriate symbols to identify the physical state of the each substances (you should know this based on your observations of reactants and products).

2. There are actually two types of reactions occurring here – identify them.

3. Referring to the coefficients in this equation,
   a. what is the ratio of moles of $NaHCO_3$ reacted to moles of NaCl produced?
   b. what is the ratio of moles of $NaHCO_3$ reacted to moles of H_2O produced?
   c. what is the ratio of moles of $NaHCO_3$ reacted to moles of CO_2 produced?

4. What mass of $NaHCO_3$ did you use in this reaction? Convert this mass to moles.

5. Based on the actual number of moles used and the coefficients in the balanced equation, how many moles of NaCl would you expect to produce? Convert this number of moles of NaCl to mass in grams. This predicted value is known as the *theoretical yield.*

6. Based on the expected ratio, how many moles of H_2O would you expect to product? Convert this number of moles to number of molecules of H_2O.

7. How many moles of CO_2 gas would be expected? Convert this value to STP volume.

8. The acid you used was an aqueous solution of the compound hydrogen chloride. (In pure form, hydrogen chloride is a gas.) Only the molecules of HCl participated in the reaction – the water in the acid provided the environment in which the HCl was able to interact. How many moles of HCl were consumed by the $NaHCO_3$ as it reacted?

9. What procedural step was used to guarantee that enough moles of HCl were provided by the acid to react all of the $NaHCO_3$?
   a. what happened to the *excess* HCl? (Because there was more than enough HCl used in this reaction, it is called the "excess reagent")

10. What mass of NaCl was actually produced? This is known as the *actual yield*.

11. Calculate the percent yield of your NaCl.
    $$\% \text{ Yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100$$

12. **Practice:** If you started with 7.5 grams of $NaHCO_3$ and sufficient HCl for a complete reaction, what mass of NaCl would you expect to produce? (*besides the balanced equation, no numeric lab data is used*)

13. **Practice:** If you wanted to produce exactly 1.75 grams of NaCl, what mass of $NaHCO_3$ would you start with (assuming a "perfect" procedure)? (*besides the balanced equation, no numeric lab data is used*)