UNIT 9 - STOICHIOMETRY

MOLE RELATIONSHIP IN A CHEMICAL REACTION LAB

The Law of Conservation of Matter states that "matter is neither created nor destroyed in a chemical reaction." In other words, the total mass of the reactants must equal the total mass of the products in a chemical reaction. Chemical equations are balanced so that they do not contradict the law of conservation of matter. The coefficients used to balance an equation also give the relative number of moles of reactants and products.

In this activity, you will test the Law of Conservation of Matter by causing a chemical reaction to occur with a given amount of reactant. You will then carefully determine the mass of one of the products. With these measurements, you will be able to calculate the moles of one reactant and one product and compare the number of moles. From the balanced equation, you should be able to see the relationship between the number of moles of a reactant and the number of moles of a product.

OBJECTIVES
- predict a balanced equation for the reaction taking place
- react a known mass of Na_2CO_3 with excess HCl
- calculate the mole ratio between Na_2CO_3 and NaCl
- determine whether your results support the Law of Conservation of Matter

EQUIPMENT

- goggles & apron	- balance	- forceps or tongs
- evaporating dish	- lab burner/oven/hot plate	- watch glass
- dropper pipet	- 250 mL beaker	

PROCEDURE

* SAFETY GOGGLES AND LAB APRON <u>MUST</u> BE WORN AT ALL TIMES DURING THIS EXPERIMENT! *

1. Clean and dry an evaporating dish. Determine the mass of the empty, dry evaporating dish to the nearest 0.01 g.
2. With a spatula, add about 1.0 grams of sodium carbonate to the evaporating dish, and read the mass to the nearest 0.01 g. (NOTE: You should not attempt to measure exactly 1.0 g since it is only a reference point. For example, mass readings of 0.87 and 1.12 would be equally acceptable.)
3. Cover the evaporating dish with a watch glass. Using the dropper bottle, carefully add hydrochloric acid to the evaporating dish (that already has the Na_2CO_3 in it).

CAUTION: HCl causes burns; avoid skin & eye contact. Rinse spills with plenty of water.

Allow the drops to enter the lip of the evaporating dish so that they gradually flow down the side.

4. Continue adding the acid slowly until the reaction has stopped. Do not add more acid than is needed to complete the reaction. (If you add more than is needed, the rest of the lab will take longer.)
5. Tilt the dish from side to side to make sure the HCl has reacted all of the Na_2CO_3. If any unreacted Na_2CO_3 remains, add a few more drops of HCl to complete the reaction. (The reaction is complete when there is no white powder left in the evaporating dish and HCl can be added without any fizzing occurring.) Remove the watch glass cover. Rinse the underside of the watch glass with a very small amount of water. Be careful to wash all material into the evaporating dish.
6. Heat the liquid in the evaporating dish until it boils **<u>GENTLY</u>**. Take care to avoid loss of liquid from boiling over. Continue to dry the solid slowly until all moisture appears to have evaporated.
7. Remove the dish from the heat and **<u>allow it to cool</u>**. Then measure and record the mass to the nearest 0.01 g.
8. After massing, the contents of the dish may be rinsed down the drain using plenty of water. Clean all lab equipment and return it to the container.

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DATA TABLE

Mass of empty evaporating dish	____________________g
Mass of evaporating dish & Na_2CO_3	____________________g
Mass of Na_2CO_3	____________________g
Mass of evaporating dish & NaCl	____________________g
Mass of NaCl	____________________g

QUESTIONS AND CALCULATIONS

1. One of the products in this reaction was NaCl, the other two products were gases. These gases are also produced in a combustion reaction. Write the balanced equation for the reaction in this experiment.

   _______________ + _______________ --> NaCl + _______________ + _______________

2. From your balanced equation, what is the mole ratio between Na_2CO_3 and NaCl? ______ : ______

3. Suppose you had started with 3.25 moles of sodium carbonate. (A) How many moles of sodium chloride would you expect to be formed? (B) If you started with X moles of Na_2CO_3, how many moles of NaCl would you expect to be formed? (C) Explain.

   (A) _______________ (B) _______________

   (C) ____

4. Calculate the number of moles of Na_2CO_3 used in this reaction. answer = ______________________

   Show your work here:

5. Calculate the number of moles of NaCl produced in this reaction. answer = ___________________

   Show your work here:

6. From the data you collected in the lab, what is the mole ratio between Na_2CO_3 and NaCl?

   Show your work here:

   answer = __1__ : ______

7. Starting with the mass of Na_2CO_3 that you actually used in the experiment, determine the theoretical yield (in grams) of NaCl in this experiment. (Stoichiometry problem!)

   Show your work here:

8. Compare the theoretical yield with your actual yield. What is your percent yield?

   $\% \text{ yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100$ answer = ____________ x 100 =

   (Note: Theoretical yield is answer from #7. Actual yield is the last line of your data table.)

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9. Was your percent yield more or less than 100 %? Explain what your percent yield means. (Explain why – in terms of the lab procedure - your percent yield was less than or more than 100 %.) Please answer this question below #10. Do not try to squeeze your answer in this little amount of space.

10. Write a paragraph describing the observations of this chemical reaction. Also include in this paragraph:
    - How did you know that a chemical reaction occurred?
    - What were two (2) sources of error in this experiment (in terms of procedure - not faulty equipment or miscalculations)?
    - What could be done to prevent these errors if you did the experiment again?

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Stoichiometry Assignment

1.) Given the equation: __ H_3PO_4 + __ $Ca(OH)_2$ → __ H_2O + __ $Ca_3(PO_4)_2$

Answer these questions using the equation above (don't forget to balance first!)

(A) What is the mole ratio between $Ca(OH)_2$ and H_2O?

(Write answer as __ moles $Ca(OH)_2$: __ moles H_2O)

(B) If 1.67 moles of $Ca(OH)_2$ completely react with H_3PO_4, how many moles of H_2O can be produced? How many moles of $Ca_3(PO_4)_2$ can be produced?

2.) How many moles of chlorine are needed to produce 35.2 grams of $FeCl_3$ according to this equation? __ Cl_2 + __ FeI_2 → __ $FeCl_3$ + __ I_2

3.) How many grams of calcium carbide are needed to completely react with 2.942 moles of water?

__ CaC_2 + __ H_2O → __ $Ca(OH)_2$ + __ C_2H_2

4.) How many grams of CuI can be produced from the complete reaction of 4.397 moles of KI?

__ $CuCl_2$ + __ KI → __ CuI + __ KCl + __ I_2

(Balancing hint: get an even number of Is on the product side first)

5.) Given the equation: __ $(NH_4)_2Cr_2O_7$ → __ Cr_2O_3 + __ H_2O + __ N_2

Answer these questions using the equation above:

(A) What type of reaction is represented?

(B) How many moles of water are produced by the complete decomposition of 28 grams of $(NH_4)_2Cr_2O_7$?

(C) What is the name of the reactant compound?

6.) How many grams of ammonia (NH_3) are needed to react completely with oxygen to produce 35.4 grams of water?

__ NH_3 + __ O_2 → __ NO + __ H_2O