The Stoichiometry of Vinegar and Baking Soda

Purpose: To predict the amount of carbon dioxide and sodium acetate produced in a chemical reactions, then calculate the percent yield of each.

Materials:

Acetic acid (vinegar) Sodium bicarbonate(baking soda) 125 mL Erlenmeyer flask

150 mL beaker electronic balance hot plate balloon

Background: The chemical reaction between vinegar and baking soda is actually two reactions, one that immediately follows the other.

In the first reaction, the products are

1. $NaHCO_3 + HC_2H_3O_2 \rightarrow NaC_2H_3O_2 + H_2CO_3$

Carbonic acid is very unstable and immediately decomposes into water and carbon dioxide.

2. $H_2CO_3 \rightarrow H_2O + CO_2$

The net of these two reactions is listed below.

3. $NaHCO_3 + HC_2H_3O_2 \rightarrow NaC_2H_3O_2 + H_2O + CO_2$

You will also see this written as

4. $NaHCO_3 + CH_3COOH \rightarrow CH_3COONa + H_2O + CO_2$

PRELAB:

1.Write equation number 1 above. Write the names of each of the products and reactants below the equation. Write what type of reaction it is.

2. Write equation number 3 above. Write the names of the products and reactants below the equation. Write what type of reaction it is.

3. Calculate the molar mass of each of the products and reactants in equation number 3.

4. Write the mole ratios between $NaHCO_3$, CO_2, and $NaC_2H_3O_2$.

5. Write and answer the following, showing your work: If you begin with 3.00 grams of sodium bicarbonate with excess acetic acid, how many grams of carbon dioxide should be produced? How many grams of sodium acetate should be produced?

6. If you end up with 1.60 grams of CO_2, what is your percent yield?

$$\text{percent yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100$$

7. If you end up with with 3.00 g of sodium acetate, what is your percent yield? If you started with 3.00 grams of sodium bicarbonate, why is this not 100% ?

Name_____ Lab partners_____ Period_____

Data Table:

1	Mass of empty 125 mL Erlenmeyer flask	
2	Mass of Erlenmeyer plus acetic acid	
Mass of acetic acid		
3	Mass of empty balloon	
4	Mass of balloon plus 2 scoops sodium bicarbonate	
Mass of sodium bicarbonate		
5	Mass of everything before reaction	
6	Mass of everything after reaction	
Difference is mass of products and reactants		
7	Mass of Erlenmeyer and liquid product	
	Mass of erlenmeyer from #1	
Mass of liquid product		
8	Mass of empty beaker	
9	Mass of beaker plus liquid product plus rinse water	
Mass of liquid product plus rinse water		
10	Mass of beaker plus sodium acetate	
	Mass of beaker from #8	
Mass of sodium acetate		

Procedure:

1. Mass the 125 mL Erlenmeyer flask and record.

2. Add about 75 mL of acetic acid to the flask, mass the combination and record.

3. Mass the balloon and record.

4. Add 2 small scoops of sodium bicarbonate to the balloon, and mass the balloon with the sodium bicarbonate.

5. CAREFULLY fit the balloon over the top of the flask, being careful to not let any sodium bicarbonate drop into the flask. (The balloon should hang to the side of the flask.)

6. Mass the entire apparatus and record in box 5.

7. With the apparatus on the balance, carefully lift the balloon and shake it until all of the sodium bicarbonate falls into the acetic acid. One person will want to hold onto the balloon where it fits around the mouth of the flask. Slowly swirl the solution until you can tell that the reaction is complete.

8. Mass the entire apparatus and record in box 6.

9. Slowly remove the balloon from the flask and mass the flask and liquid. Record.

10. Mass the 250 mL beaker and record.

11. CAREFULLY pour the liquid from the Erlenmeyer flask into the 250 mL beaker. Rinse the flask as instructed with distilled water, letting the water wash into the beaker with the liquid.

12. Put the beaker on a hot plate and heat gently.

13. When about 50 mL of liquid remains in the beaker, remove from heat and allow to evaporate.

14. The next day, mass the beaker with the solid sodium acetate product and record.

CONCLUSION:

1. Copy the information from your composition book onto the lab report.

2. Calculate the masses in the right column of the data table.

3. How many moles of sodium bicarbonate did you begin with? (Show your work)

4. Calculate the expected yield in grams of CO_2 gas.

5. Calculate the expected yield in grams of sodium acetate.

6. Calculate the percent yield of CO_2.

7. Calculate the percent yield of sodium acetate.

8. Was the percent yield of CO_2 and sodium acetate 100%? If not, what could have caused it to be different than 100?

9. How did the mass of the apparatus before the reaction compare to the mass after the reaction?

How does this relate to the Law of Conservation of Mass?

10. Describe the sodium acetate. How can you tell that it is different than the sodium bicarbonate you began with?