Name:_____ Lab Partner(s):_____

Limiting Reagent Lab

Objective: to observe the impact of limiting reagents on the amounts of products formed when acetic acid reacts with sodium hydrogen carbonate.

Background: The reaction being studied is the familiar reaction of vinegar (5% acetic acid) with baking soda (a.k.a. sodium hydrogen carbonate OR sodium bicarbonate OR bicarbonate of soda) to produce carbon dioxide, sodium acetate, and water. Each flask will contain the same amount of vinegar but different amounts of baking soda. A balloon will be attached to the flask to visualize the amount of carbon dioxide gas produced.

$$HC_2H_3O_2(aq) + NaHCO_3(s) \rightarrow CO_2(g) + NaC_2H_3O_2(aq) + H_2O(l)$$

acetic acid + sodium hydrogen carbonate → carbon dioxide + sodium acetate + water

Procedure:

1. Label five Erlenmeyer flasks and five balloons 1 through 5, corresponding to the trials listed in the data table.
2. Using a graduated cylinder, measure 50.0 mL vinegar and pour it into each Erlenmeyer flask.
3. Recording the exact mass, measure approximately 0.5g sodium hydrogen carbonate on weigh paper and use a funnel to transfer it into balloon 1. Repeat this process with amounts of 1.0g, 2.0g, 4.0g, and 8.0g in balloons 2 through 5 respectively.
4. Being careful to keep the sodium hydrogen carbonate in the balloons, attach the balloons to the flasks.
5. Carefully pull each balloon upward to empty all the sodium hydrogen carbonate into the attached flask.
6. Swirl flasks as necessary to ensure complete mixing. Record observations (e.g., relative amount of gas in balloons, undissolved solids in flask, and any other observations).
7. Remove the balloon from flask 5. Quickly light a match. Holding the lit match horizontally, tip the flask so that the match is inside the flask. In the space for question #7, record your observation of what happens when the match is inside the flask.
8. Remove all balloons from flasks. Add 6 drops of bromothymol blue, a pH indicator, to each flask. Record the color of each solution.
9. Throw away balloons. Wash glassware. Clean up lab area.

Pre-Lab Questions:

1. How many moles of $HC_2H_3O_2$ will be in each flask, given that vinegar contains 0.83 moles $HC_2H_3O_2$ per liter? (1 pt.) Add this value to Table 2. (1 pt.)

2. What mass of $NaHCO_3$ will react with 50.0mL of vinegar? (1 pt.)

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Table 1. Raw data and observations. (5 points)

Trial	Volume of Vinegar (mL)	Mass of $NaHCO_3$ (g)	Estimated Size of Balloon (L)	Other Observations	Color with pH Indicator
1					
2					
3					
4					
5					

Table 2. Calculated results.

Trial	Moles of $HC_2H_3O_2$	Moles of $NaHCO_3$	Limiting Reagent	Theoretical Moles of CO_2	Theoretical Volume of CO_2 (L)
1					
2					
3					
4					
5					

Questions:

1. How many moles of $NaHCO_3$ were added in each trial? Show your calculation with units for <u>at least</u> one trial. (1 point) Add these values to Table 2. (2.5 points)

2. Based on the calculated number of moles of reactants and the mole ratio from the balanced chemical equation, determine which reactant is the limiting reagent for each trial. Record this information in Table 2. (2.5 points)

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3. Based on the moles of the limiting reagent, determine the theoretical number of moles of CO_2 produced in each trial. Record these numbers in Table 2. (2.5 points)

4. Theoretically, what volume of CO_2 should be produced in each trial, assuming standard temperature and pressure? Show your calculation for at least one trial. (1 point) Record the theoretical volume for each trial in Table 2. (2.5 points)

5. Explain how the relative volume of the balloons was related to the amounts of the reactants. Do some of the balloons have approximately the same volume? If so, why? (3 points)

6. Bromothymol blue is yellow in acids and blue in bases. Explain why the flasks have the colors they do. (2 points)

7. Explain what happened in step #7 and what was expected to happen, including why. (1 point)