Carbonated Beverage Lab
Chemistry

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Name

OBJECTIVE To find the correct ratio of reactants by mass to neutralize an acid.

INTRODUCTION

Carbonated beverages are very common in our society today. The "carbonation" we are so familiar with is in fact carbon dioxide, CO_2, dissolved into a liquid solution. Because of the phase difference, the much lighter CO_2 gas must escape by leaving the liquid at the surface. However, some of the gas remains trapped in the liquid and may not leave the solution without an appropriate stress added to it (like shaking, jolting, or transferring containers); even small changes in temperature are cause for CO_2 to fall out of a liquid solution.

In this simple experiment, we will investigate a CO_2 producing reaction. We will react two solids, sodium bicarbonate (aka "baking soda", $NaHCO_3$) and citric acid ($H_3C_6H_5O_7$), in water:

$$H_3C_6H_5O_7\,(aq) + \mathbf{3}\,NaHCO_3\,(aq) \rightarrow Na_3C_6H_5O_7\,(aq) + \mathbf{3}\,H_2O\,(l) + \mathbf{3}\,CO_2\,(g)$$

We note here that our reactants, though initially in the solid phase, must be brought into an aqueous solution to react. This should make sense considering that particles must be in very close contact to react, and the restricted movement of the solid state would not allow such proximity.

In our lab, we will experiment with our own lab-made carbonated beverages, but **we will not drink any materials in lab**. We will first explore three extreme cases: (i) no chemicals, (ii) addition of only sodium bicarbonate, (iii) addition of only citric acid. We will then attempt to "eyeball" the correct proportions. Finally, we will use proper stoichiometric calculations to find the correct proportion of reactants.

PRELAB QUESTIONS

1. Write the chemical formula for baking soda and citric acid. Calculate the molar mass for each of them. *This calculation will require at least two decimal places.*

2. Solve for the mass in grams of citric acid required to react with 10.00g of baking soda. Use the chemical equation and the calculated molar masses for this calculation.

MATERIALS

- Citric acid (food grade)
- Baking soda ($NaHCO_3$)
- Beaker (2)
- Glass stir rod
- Thermometer
- pH paper

SAFETY WARNING:
Citric acid consumption causes nausea, vomiting, and diarrhea in large doses; it is an extreme irritant to the eyes and respiratory tract in powder form. Baking soda consumption causes gastrointestinal disturbance in extremely high dosage; it may cause coughing or sneezing if inhaled in powder form.

PROCEDURE

1. Fill two beakers to 100.mL. Use a graduated cylinder to ensure exactly 100.mL is used. Measure the temperature and pH of this water.
2. Add 5 - 10g of baking soda to the water (mark this beaker B). Measure the temperature and pH of this mixture. Record all observations.
3. Add 5 - 10g of citric acid to a second beaker water (mark this beaker C). Measure the temperature and pH of this mixture. Record all observations.
4. We will now add solid reactants to each. Add an **equal** number of grams of citric acid to the baking soda beaker. Record obeservations.
5. Estimate the amount of baking soda required to neutralize all of the acid. Add this amount of baking soda to the citric acid beaker. Record obeservations.
6. Calculate the amount of citric acid required to completely react with 10.00g baking soda. In a clean beaker, add 100.mL water, 10.00g baking soda, and the correct amount of citric acid. Record observations.

OBSERVATIONS

Copy the following table with enough room for observations:

Trial	Baking Soda mass (g)	Citric Acid mass (g)	Temperature (ºC)	pH	Observations
1	0	0			
2		0			
3	0				
4					
5					
6					

POSTLAB QUESTION

1 What were the indications of a chemical reaction in this lab?

2 Is this reaction exothermic or endothermic? Why did the temperature change in this lab? Explain briefly.

3 For reactions 4 & 5, which reactant was in excess? How can you tell?

Reaction 4

Reaction 5