

Lab 5: Determination of % NaHCO₃ in Alka Seltzer Tablets

Objectives:

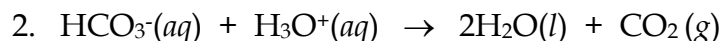
- To determine the amount of NaHCO₃ in Alka Seltzer tablets by observing the amount of CO₂ produced from the acid base reaction of HCO₃⁻ with acetic acid (in vinegar).
- To practice stoichiometry.
- To study the concept of limiting reactant.

Background:

Alka Seltzer is an effervescent tablet that contains aspirin (acetylsalicylic acid), citric acid, and sodium bicarbonate (NaHCO₃). As soon as the tablet dissolves in water, the NaHCO₃ dissociates to form a bicarbonate ion (HCO₃⁻) and a sodium ion (Na⁺)



Acetic acid, which will 'donate' H⁺ to water to create H₃O⁺(aq) is then added to the mixture. With the addition of acetic acid the following acid-base reaction then takes place:



(The sodium ion does not take part in this reaction, and so is not included in the equation.)

According to the reaction equation, one mole of HCO₃⁻ reacts with one mole of H₃O⁺. If the number of moles of each reactant is not the same, than one reactant will be completely used up during the reaction, while some of the other reactant will remain at the end of the reaction. The reactant that is completely used up is called the "limiting reactant". In this experiment you will dissolve Alka Seltzer in various concentrations of vinegar and measure the amount of CO₂ produced. From this data you will calculate the amount of NaHCO₃ in the Alka Seltzer by percent weight. You will also determine the limiting reactant at each concentration.

Pre-lab Question: (To be submitted at the beginning of lab)

1. Summary of the procedure in your own words.
2. What are the bubbles that form when Alka Seltzer is dissolved in water?
3. What is the ratio of moles of CO₂ produced to moles of NaHCO₃ reacted?

Procedures:

1. Using a 50 mL graduated cylinder, add 35 mL of distilled water to a clean 250 mL beaker. Weigh and record the total mass of the beaker plus water (column 1, Run #1, in data table). Also **record the measured volume** of the water (**don't just write 35 mL**).
2. Weigh and record the mass of an Alka Seltzer tablet (**with correct sig. figs.**) **Record the amount of NaHCO₃ indicated on the label of Alka Seltzer.**

- Drop the tablet into the beaker and swirl carefully. As soon as the bubbling ceases, weigh the beaker with the dissolved Alka Seltzer solution. Record this mass (**with correct sig. figs.**)
- Rinse the beaker with distilled water. Then, repeat steps 1-3 with 5 mL vinegar + 30 mL water, 10 mL vinegar + 25 mL water, and so on, increasing the volume of vinegar by 5 mL each time while keeping the total volume of the solution at 35 mL. Record your data in the table below (Run #2 – Run #8). Again, be sure to **record the actual measured volumes** and record them **with the correct number of significant figures** for the glassware that you use.

Lab Report Guide:

- 1. Results (4 pts)**
 - Tables neatly filled out with data
 - Proper significant figures
 - Legible sample calculations
 - Plot the calculated percent by mass of the reacted NaHCO_3 in a tablet vs. the volume of vinegar used, either by hand (on graph paper) or using a computer spreadsheet.
- 2. Error Analysis (1 pts)**
 - Typed brief discussion comparing the measured mass of NaHCO_3 to mass printed on the label. Describe possible sources of error. Note that “human error” is not an acceptable answer. Please be specific.
- 3. Post Lab Questions (5 pts)**
 - Typed answers to the Post Lab questions. Note that single sentence answers will not suffice. State the answer to the question followed by a brief description of the evidence supporting that answer.

Post-Lab Questions:

- Based on your plot (from analysis section). Hint – Consider the reaction equation and vinegar is a source of H_3O^+ ions.
 - At what range of volumes of vinegar is H_3O^+ the limiting reactant?
 - At what range of volumes of vinegar is HCO_3^- the limiting reactant?
- Based on your data and your plot, what is the percent by mass of NaHCO_3 in the average Alka Seltzer tablet? Show any calculations used to determine your answer. Remember to average only the HCO_3^- limited range.
- How might this product reduce indigestion or heartburn?
- Mass can neither be created nor destroyed. If solution decreases in mass where did this “lost” mass go?
- Would it be possible to do a similar experiment by measuring the volume of CO_2 generated? Explain in detail.

Data Sheet: (Please fill out this table and submit with the lab report. Recopy if messy)

	Run #1	Run #2	Run #3	Run #4	Run #5	Run #6	Run #7	Run #8
Volume of vinegar (mL)	0.00							
Volume of water (mL)								0.00
Mass of beaker with liquid (g)								
Mass of Alka Seltzer tablet (g)								
Mass of beaker with liquid after bubbles cease (g)								
Calculated mass of CO₂ lost (g)								
Moles of CO₂ lost								
Moles of NaHCO₃ reacted								
Calculated mass of NaHCO₃ reacted (g)								
Calculated % by mass of reacted NaHCO₃ in tablet								

Analysis:

Do the calculations in the data table (in bold). Show work for an example of each type of calculation (use run #1) below.

Calculations for run #1: