Lab: Alka-Seltzer® & Gas Solubility

FOR THE TEACHER

Summary
In this lab, students will use the reaction between Alka-Seltzer and water to investigate temperature and the solubility of carbon dioxide. They will use a neutralization reaction and an indicator to verify the amount of carbon dioxide produced at each temperature.

Resource Type  Grade Level
Lab                        High school

Objectives
By the end of this lab, students will
- investigate intermolecular forces.
- experience first-hand carbon dioxide's ability to dissolved in water.
- witness the temperature dependence of gas solubility.
- qualitatively, carry out a titration.
- use a neutralization reaction to compare concentration.

Chemistry Topics
This lesson supports students' understanding of
- Solubility
- Acid base reactions
- Titrations
- Indicators
- Intermolecular forces

Time
Teacher Preparation: 15 minutes
Lesson: 40 minutes

Materials
For each group:
- Alka-Seltzer tablet
- 1.0-M (NaOH) solution (~5 mL)
- Bromothymol blue indicator
- 10-mL graduated cylinder
- 25- or 50-mL graduated cylinder
- Three 250-mL beakers
- Thermometer
- Three large test tubes
- Test tube rack
- Hot plate
- Two thin-stem pipets
- Stirring rod
- Ice cubes

Safety
- Always wear safety goggles when working with chemicals.
If sodium hydroxide makes contact with skin, wash the area immediately and students should alert you immediately if this happens. Students should wash their hands thoroughly before leaving the lab. When students complete the lab, instruct them how to clean up their materials and dispose of any chemicals.

Teacher Notes
- This lab demonstrates a number of chemistry topics in a very accessible manner.
- Real-life materials and concepts are addressed.
- Set-up and clean-up are quick and straightforward.

FOR THE STUDENT
Student Activity Sheet: Alka-Seltzer & Gas Solubility

Lesson

Alka-Seltzer & Gas Solubility

Introduction
In this lab, you will generate carbon dioxide gas by putting Alka-Seltzer tablets in water. When CO₂ dissolves in water, some molecules react to form carbonic acid (H₂CO₃). As a result, solutions containing carbon dioxide have a pH less than 7. During this experiment, you’ll monitor the pH of your solutions using an acid-base indicator called bromothymol blue.

<table>
<thead>
<tr>
<th>Approximate pH</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 6.2</td>
<td>Yellow</td>
</tr>
<tr>
<td>6.2-7.6</td>
<td>Green</td>
</tr>
<tr>
<td>&gt; 7.6</td>
<td>Blue</td>
</tr>
</tbody>
</table>

Problem
How does the temperature of a solution affect the solubility of carbon dioxide?

Safety Precautions
- Wear safety goggles at all times.
- Sodium hydroxide is a corrosive liquid; it is especially dangerous to eyes and may burn skin. If you get sodium hydroxide on your skin, wash the area immediately.

Materials
- Alka-Seltzer tablet
- 1.0-M sodium hydroxide solution (~5 mL)
- Bromothymol blue indicator
- 10-mL graduated cylinder
- 25- or 50-mL graduated cylinder
- Three large test tubes
- Test tube rack
- Hot plate
- Two thin-stem pipets
- Stirring rod
Three 250-mL beakers  
Ice cubes  
Thermometer  
Weighing dish

Procedure
1. Add 3–4 ice cubes to a 250 mL beaker and enough tap water to bring the volume to 200 mL.
2. Add 200 mL of tap water to the other two beakers. Place one beaker on a hot plate (medium-high heat), and allow the other beaker to equilibrate to room temperature. Note: the room temperature beaker will serve as the experimental control.
3. Obtain two 1.0 gram samples of Alka-Seltzer by snapping off pieces of the tablet and weighing them in a weighing dish.
4. When the water on the hot plate has reached 75-80 ºC, remove the beaker from the heat.
5. Add two drops of bromothymol blue indicator to each beaker, including the room temperature control. Set the control aside.
6. Simultaneously drop the two 1.0 gram samples of Alka-Seltzer into the hot and cold beakers. No Alka-Seltzer is added to the room temperature water sample. Carefully observe and compare all evidence of physical and chemical changes in the hot and cold beakers. When the Alka-Seltzer tablets have fully reacted, note the color and appearance of the solution in each beaker.
7. Measure the temperature of each solution, including the room temperature control, and label three large test tubes with the corresponding temperature. Rinse the thermometer in between measurements to avoid contamination.
8. Using a graduated cylinder, remove 25 mL of solution from each beaker and place the sample in the appropriate labeled test tube.
9. Using a thin-stem pipet, add 1.0-M NaOH solution to the cold water reaction mixture. Count the number of drops of NaOH that must be added to the sample to match the color of the room temperature control solution. Stir or swirl the solution between drops to ensure thorough mixing. Record your data.
10. Repeat the previous step with the hot water reaction mixture, again keeping track of how many drops of NaOH it takes to match the color of the room temperature solution. Record your data.
11. The final solutions may be poured down the drain with plenty of excess water. Wash and return all glassware and clean your lab bench before the end of the period.

Results/Observations
Make sure to record necessary data and observations throughout the investigation.

Analysis
1. Why did you add NaOH to the Alka-Seltzer solutions? What was the purpose of the control sample?
2. From your experience with carbonated beverages, do CO₂ and H₂O molecules have strong or weak attractions? Please explain.
3. From the results of this experiment, how does temperature affect the solubility of CO₂ in water? Refer back to your data/observations and cite at least two specific pieces of evidence that support your conclusion.

4. Explain what happens to CO₂ and H₂O molecules as temperature increases. How does this affect the intermolecular forces between the two molecules? Does this explain your findings in question #2?

5. Why does a carbonated drink “go flat” as it sits in an open room? How can you prevent carbonated drinks from going flat?

6. Many power plants release warm water into streams and lakes. The effect is called thermal pollution. Briefly research this topic online. According to your research and the results of this experiment, explain why thermal pollution poses a threat to aquatic life.