Lab: To What DEGREE does it Matter?

FOR THE TEACHER

Summary
In this lab the students will explore how factors such as temperature may influence chemical reactions. Students will use citric acid and sodium bicarbonate (Alka-Seltzer) and a catalyst (water) to induce a reaction at varying degrees. Observations will be made of the rate at which the reactions take place under these varying conditions. The students will make predictions of how the temperature of the water will affect the chemical reaction. They will use a stop watch to time the reaction between the Alka-Seltzer and the varying temperatures of water and graph their observations for analysis, they will compare data to deduce whether temperature has any influence during a chemical reaction.

Grade Level
Elementary School

NGSS Alignment
This lab will help prepare your students to meet the performance expectations in the following standards:

- **MS-PS3-4**: Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of particles as measured by temperature of the sample.
- **Scientific and Engineering Practices**:
  - Analyzing and Interpreting Data

Objectives
By the end of this lab, students should be able to

- provide a definition of chemical reaction
- identify the roles of the reactant and product
- identify indicators of a chemical change
- determine whether temperature influences a chemical reaction

Chemistry Topics
This lab supports students’ understanding of

- chemical reactions
- reaction rate
- chemical change
- states of matter
- observations
- data collection

Time
**Teacher Preparation**: 10 minutes
**Lesson**: 50 minutes

Materials
(Per group)

- 3 clear plastic 16 oz. cups
- Refrigerator (to allow water to become cold)
- measuring cup
- hot water source (faucet)
- 3 tablets of Alka-Seltzer
- Stop watch
- water
- Thermometer
- graph paper (or pre-printed chart)
- safety goggles

Safety
- Always wear safety goggles when handling chemicals in the lab.
- 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.
- When working with acids, if any solution gets on students’ skin, they should immediately alert you and thoroughly flush their skin with water.

Teacher Notes
- Chemical reactions take place when the particles (reactants) come into physical contact with one another. Factors that increase the frequency of these encounters will increase the rate at which the (products) are formed. The chemical reaction between citric acid and sodium bicarbonate creates bubbles of carbon dioxide gas. When in the solid form (the tablet) these reactants are basically suspended away from one another. When the tablet is added to the water, the water acts as a catalyst allowing the two particles to mix and thus causing the chemical reaction creating the product (carbon dioxide gas bubbles). By using cold water, room temperature water, and warm water students will be able to determine if temperature influences the chemical reaction process.
- I teach 5th grade and this lab works well this age group.
- Room temperature water is achieved by some preplanning. Retrieve enough water for each group from the faucet and put water aside indoors until the temperature of the water has stabilized to the temperature of its environment.
- Warm water is retrieved by the students by utilizing the faucets. Warm water is allowed to run for 30-45 second until water temperature stabilizes at its peak temperature.
- Four to five students per group allows for a manageable number of groups and avoid overcrowding of experimental space.
- Each student in the group has a role assigned to them. Roles switch at every experiment so that each student has a chance to be the materials manager, scientist, etc. I have the students count off from 1-4 or 5 (based on the number in the group) and have each role listed with corresponding role responsibilities.
- The pre-lab questions can be documented in the students’ science notebooks or on the student lab handout and will be discussed at the end of the lab.
- Differentiation: lower - have students identify properties of all states of matter reflected in the experiment; higher- have student brainstorm other factors that may influence chemical reactions.
FOR THE STUDENT
Lesson

To What Degree does it Matter?

Background
Substances are generally in one of three forms of matter (e.g. solids, liquids, or gases). There are instances when an object goes through a chemical change and it produces substances that are in a different state than the reactants. During a chemical change, chemical reactions take place when the particles (reactants) come into physical contact with one another. Factors that increase the frequency of these encounters will increase the rate at which the (products) are formed.

Prelab Questions
1. What is a chemical change?
2. What is a chemical reaction?
3. Make a prediction of what you think may happen when the Alka-Seltzer tablets are put into water at varying temperatures?

Problem
Does temperature affect a chemical reaction?

Materials
- 3 clear plastic cups
- Refrigerator (to allow water to become cold)
- measuring cup
- hot water source
- 3 tablets of Alka-Seltzer
- Stop watch
- Thermometer
- water
- handout with table
- graph paper (or pre-printed chart)
- safety goggles

Safety
- Always wear safety goggles when handling chemicals in the lab.
- Wash your hands thoroughly before leaving the lab.
- Follow the teacher’s instructions for cleanup of materials and disposal of chemicals.
- When working with acids and bases, if any solution gets on your skin immediately rinse the area with water.

Procedure
- Materials Manager will retrieve all materials needed for this lab.
- Scientist #1 will conduct the lab for the cold water by following these steps:
  1. Pour 8 oz. of the cold water from refrigerator into one plastic cup.
  2. Use the thermometer to take the temperature of the water and record the temperature in the appropriate place in the data table.
  3. Have stop watch set to zero and ready to begin.
  4. Drop 1 Alka-Seltzer tablet into water and immediately start the stopwatch.
  5. Use the stopwatch to measure how long it takes for the chemical reaction to
be completed. You will know that the reaction is completed when the Alka-Seltzer is completely dissolved.
6. Record the time on the table in the data table.

- **Scientist #2** will conduct the lab for the room temperature water by following these steps:
  1. Use a measuring cup to measure 8 oz. of room temperature water and pour the water into a clear plastic cup.
  2. Use the thermometer to take the temperature of the water and record the temperature in the appropriate place in the data table.
  3. Have stop watch set to zero and ready to begin.
  4. Drop 1 Alka-Seltzer tablet into water and immediately start the stopwatch.
  5. Use the stopwatch to measure how long it takes for the chemical reaction to be completed. You will know that the reaction is completed when the Alka-Seltzer is completely dissolved.
  6. Record the time on the table in the data table.

- **Scientist #3** will conduct the lab for the warm/hot water by following these steps:
  1. Using the hot water on the faucet, run the water until it is as hot as it will get. *Alternatively, teacher will provide water that was heated using a microwave.*
  2. Use a measuring cup to measure 8 oz. of the hot water and pour the water into a clear plastic cup.
  3. Use the thermometer to take the temperature of the water and record the temperature in the appropriate place in the data table.
  4. Have stop watch set to zero and ready to begin.
  5. Drop 1 Alka-Seltzer tablet into water and immediately start the stopwatch.
  6. Use the stopwatch to measure how long it takes for the chemical reaction to be completed. You will know that the reaction is completed when the Alka-Seltzer is completely dissolved.
  7. Record the time on the table in the data table.

**Data**

Fill in the table below as you conduct each lab then create a graph using your collected data. Be sure to label each axis appropriately.

<table>
<thead>
<tr>
<th>My reactant in this lab is:</th>
<th>My product in this experiment is:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Water Sample</th>
<th>Temperature (°C)</th>
<th>Time of Reaction (sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Room</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Warm</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Analysis
1. What were we testing in our lab? What were the reactants and products in our lab?

2. Look at the data that you collected. What can you infer about the affect of the temperature of the water on the rate of the chemical reaction?

Extension
What is a chemical reaction that takes place in real life that may be affected by temperature?

Conclusion
- Let's look back at the predictions you made at the beginning of our lab. Were your predictions accurate based on what you observed? Explain why or why not.
- What can we infer about the temperature as it relates to the rate at which a chemical reaction takes place?