Demo: Inflating a Balloon with Chemistry!

Summary
In this demonstration, the teacher will perform a reaction between acetic acid (vinegar) and sodium bicarbonate (baking soda) in order to inflate a balloon and to introduce the concept of a chemical reaction to students. Students will observe the reaction, and identify indicators of chemical change as well as discuss the different types of matter that are involved.

Grade Level
Elementary, middle or high school

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

- **5-PS1-4**: Conduct an investigation to determine whether the mixing of two or more substances results in new substances.
- **MS-PS1-2**: Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.
- **HS-PS1-2**: Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.

- **Scientific and Engineering Practices**:
  - Analyzing and Interpreting Data
  - Engaging in Argument from Evidence

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

- Define *chemical reaction*.
- Understand the meaning of *reactant* and *product*.
- Classify products and reactants by the appropriate state of matter in a reaction.
- Identify indicators of chemical change in a chemical reaction.

Chemistry Topics
This lesson supports students’ understanding of

- Chemical reactions
- Chemical Change
- Observations
- States of matter

Time
**Teacher Preparation**: 10 minutes
**Lesson**: 30 minutes

Materials
For each group:

- Baking soda (sodium bicarbonate, NaHCO₃) - 1.5 tsp. or 8.75 grams
- Store bought vinegar (5% acetic acid solution, HC₂H₃O₂) – tbsp., or ~150 ml
- Empty plastic water bottle – 700 ml or larger
- Funnel
• Balloon(s)
• Food coloring (optional)

Safety
• Always wear safety goggles when handling chemicals in the lab.
• Students should wear proper safety gear during chemistry demonstrations. Safety goggles and lab apron are required.
• Students should wash their hands thoroughly before leaving the lab.

Teacher Notes
• The reaction of sodium bicarbonate (baking soda) and acetic acid (vinegar) produces carbon dioxide gas, water and sodium acetate (soluble in water). The carbon dioxide gas can originally be seen as bubbles in the solution, but will quickly be released from the solution. The amount of carbon dioxide gas will exceed the space in the bottle, and will move into the deflated balloon, and will inflate it.
• This demonstration provides the opportunity to introduce students the following vocabulary words and topics:
  o Chemical reaction: A process where atoms of the reactant(s) will rearrange themselves to create a new arrangement of atoms, called the product(s).
  o Reactant: A substance or substances present at the start of the reaction.
  o Product: A resulting substance or substances formed by a chemical reaction.
  o Chemical Change: Any change that result in the formation of a new substance or substances.
  o Indicators of Chemical Change or Chemical Reaction: 1-Formation of gas; 2-Change of color; 3-Formation of a precipitate; 4-Formation of heat and light. Please note that these indicators do not always designate that a chemical change occurred, as there are many instances of these occurring without a resulting chemical change.
• Teachers should also engage students in a discussion about the types of matter observed in this experiment.
  o The types of matter identified in chemical reactions are solids, liquids, gases and aqueous solutions. Liquids and aqueous solutions differ in that liquids are pure substances in the liquid form, whereas aqueous is a substance dissolved in water.
  o Reactants: Baking Soda – Solid; Vinegar – Aqueous (this may be tricky to some, but by examining the vinegar container you will find that it is 5% acetic acid, and 95% water.)
  o Products: Carbon Dioxide – Gas; Water- Liquid; Sodium Acetate – Aqueous (a clear solution will be left in the flask upon completion of the reaction, it is a solution of water and Sodium Acetate)
• Procedure:
  1. Measure 1.5 tsp. or 8.75 grams of baking soda.
  2. Insert a funnel into the opening of a balloon and add the baking soda to the balloon through the funnel. See image below.
  3. Measure 10 tbsp. or approximately 150ml of vinegar.
4. Add the vinegar to the empty bottle.
5. If you wish to add food coloring to the vinegar, add 3-5 drops. The food coloring will help students to see the gas formation/bubbles during the demo.
6. Secure the balloon around the opening of the bottle, but make sure that the baking soda remains in the balloon at this time. Allow the balloon to hang to the side once it is attached to the bottle until you are ready to complete the demo. See video for reference.
7. Lift the balloon, straightening it out over the opening of the flask. This will allow the baking soda to drop out of the balloon and enter the flask.
8. Hold the bottle at the base while the reaction occurs.
9. The baking soda will quickly react with the vinegar in the flask, creating carbon dioxide gas as one of its products, causing the balloon to quickly inflate.
10. After the reaction is complete the balloon will remain inflated. You can pop the balloon with a tack if you wish to confirm with the students that the balloon was filled with gas.

- Have students complete the provided student worksheet, before and after the demonstration. Allow students to feel the bottle, as there should be a decrease in temperature (endothermic reaction) during the reaction.
- Opportunities for extension:
  o Introduce the law of conservation of mass, as shown in this demonstration.
  o Use this demonstration to lead into the concept of writing chemical equations and balancing chemical equations.
  o This demonstration can be used as an introduction, followed by an opportunity for students to complete this lab themselves. Teachers may want to assign groups to reacting different amount of baking soda and vinegar to investigate the implications on the amount of carbon dioxide gas produced.
  o High school teachers may want to extend this demonstration to a lab opportunity to teach Limiting Reactants & Percent Yield, or to focus on Acid-Base reactions and Mole Ratios.

FOR THE STUDENT
Lesson
Inflating a Balloon with Chemistry!

Background
You will have the opportunity to observe a demonstration of a chemical reaction carried out by your teacher. First, attempt to answer all of the questions below to the best of your ability (it is okay if you aren’t completely sure about an answer!)

Questions
1. What are some examples of things you expect to see when observing a chemical reaction?
2. What is the difference between a “reactant” and a “product” in a chemical reaction?
3. What types of matter can be involved in a chemical reaction?

Safety
- Proper safety gear should be worn during chemistry demonstrations. Safety goggles and lab apron are required.
- Wash your hands thoroughly before leaving the lab.

Observations
Record your observations for what happened during each portion of the experiment in the data table below.

<table>
<thead>
<tr>
<th>Before the reaction</th>
<th>During the Reaction</th>
<th>After the Reaction</th>
</tr>
</thead>
</table>

**Analysis**

Answer the following questions based on what you recorded in your data table.

1. Describe the types of matter used to generate this chemical reaction.

2. Describe the types of matter that were formed in this chemical reaction.

3. How do you know that a chemical reaction occurred?