OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION Activity

Candle Extinguisher

Target Grade: Grades K-8

Time Required: 5 minutes

Standards/Topics Covered:

Next Generation Science 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.

Central Focus:

Get ready to be amazed with this activity! In this activity, students will observe "magic" when an empty cup is able to extinguish a lit candle. Through a chemical reaction, students will be able to observe as the chemical properties of baking soda and vinegar change to form new substances and a gas. Students will be able to compare the physical properties of air and carbon dioxide as the reaction occurs and the candle is extinguished.

Key terms: chemicals, chemistry, react, substances, property

Background Information:

A chemical reaction is a process in which substances undergo a chemical change to form a different substance. Mixing baking soda and vinegar will create a chemical reaction because one is an acid and the other a base. Baking soda is a basic compound called sodium bicarbonate while vinegar is a diluted solution that contains acetic acid (95% water, 5% acetic acid).

There are five signs that indicate a chemical reaction has occurred: odor, energy change, gas bubbles, precipitate formation, and color change. When any of these changes occur, the reaction is irreversible and cannot be undone. The reaction occurs once the vinegar is added to the baking soda. In this reaction, evidence of a chemical reaction is the formation of carbon dioxide gas and gas bubbles.

There are two separate types of reactions taking place when mixing baking soda and vinegar. The first is called an acid-base reaction. When the two substances are mixed together, hydrogen ions in the vinegar react with the sodium and bicarbonate ions in the baking soda. This initial reaction results in two new chemicals: carbonic acid and sodium acetate.

A decomposition reaction is the second reaction that occurs. The first reaction created carbonic acid which immediately begins to decompose into water and releases carbon dioxide gas (CO_2). The CO_2 rises to the top of the mixture and creates the bubbles that are a hallmark of the baking soda and vinegar reaction.

Oxygen is required for a flame to burn. The carbon dioxide gas produced in this reaction is more dense than normal air, and it sinks to the bottom of the cup. When poured over a flame, the carbon dioxide will push out the surrounding oxygen molecules and extinguish the flame. As the carbon dioxide is colorless, it gives the appearance of an empty cup extinguishing the flame.

Materials

- Candle
- Lighter
- 2 cups
- 1 tsp. baking soda
- 1 tbsp. white vinegar

Instructions

- To begin this activity, first light the candle and put it to the side.
- Measure 1 teaspoon of baking soda into an empty cup.
- Add 1 tablespoon of white vinegar to the baking soda. This will undergo a chemical reaction and will release carbon dioxide gas.
- Pour only the air from the cup with the baking soda and white vinegar into an empty cup.
- Pour your "empty" cup (with CO_2) over the lit candle.
- The candle will extinguish.

Closure

1. Has a reaction occurred? How can you tell?
   Yes, a reaction has occurred. A sign a chemical reaction has occurred is the formation of gas, which can be seen in the form of bubbles. Once the vinegar is added to the baking soda, carbon dioxide is released as a product. The bubbling is the release of CO_2.

2. What is being poured out of the "empty" cup? Why does this pour out differently than air?
   Carbon dioxide is being poured out of the seemingly empty cup. Carbon dioxide is a colorless, odorless gas that forms as a product from the chemical reaction occurs between the vinegar and the baking soda. Carbon dioxide is heavier than normal air. When the reaction occurs and the "air" is poured from one cup to the other, it is actually the CO_2 being poured. Although the CO_2 is colorless like air, it is much heavier and is able to put out the flame of the candle when poured over it.