Exploring Reactions

FRAMEWORK

I. Scientific and Engineering Practices
   1. Asking questions
   4. Analyzing and interpreting data
   6. Constructing Explanations

II. Cross-Cutting Concepts
   7. Stability and Change

III. Physical Sciences
   PS 1. Matter and its interactions
   PS 3. Energy

SKILLS/OBJECTIVES

- Exploring the differences between chemical and physical reactions through experimentation
- Developing an understanding of chemical versus physical reaction with real-world examples

MATERIALS

- Safety goggles and lab coats
- 8, 2 liter bottles of Diet Coke
- 4, 2 liters of other sodas (Sprite, Mountain Dew, Root Beer, Ginger Ale)
- Various mint and non-mint candies (Tic-Tacs, Life Savers, Mentos, Junior Mints)
- Packet of Mentos/Bottle plus some extra for repeat demonstrations
- Paper to roll into tubes big enough to fit the candies
- Facial Tissues
- Teaspoons
- Baking Soda
- Vinegar
- Plastic 35mm Film Containers (Extra 10 containers for mistakes and demonstrations)
- Eye Droppers
- Goggles
- Paper towels for cleanup
- Pack of different colored markers
- Small prize for winning team (Candy, Glow Sticks, Bouncy Balls, Silly Bands, Etc.)

NOTES

For Activity 1, conduct it outside, and ideally it would be a nice day

BACKGROUND

- Chemical changes take place on the molecular level and produce new substances. Examples of chemical changes include burning something, cooking an egg, and rusting of a frying pan
- Physical changes are concerned with energy and states of matter and do not produce new substances. Examples of physical changes include melting, freezing, vaporization, and condensation. Examples you may have seen during your day include crushing a can, melting an ice cube, shaking up a soda bottle and letting it fizz out the top, and breaking a bottle.
- Explain how to tell a chemical reaction apart from a physical reaction. A chemical change makes a substance that wasn't there before and may show clues such as light, heat, color change, gas production, odor, or sound. A physical reaction contains the same starting and ending materials even though they may look different.
- Ask the kids if they know of any reactions and see if they can describe what may be going on.
- Conduct the experiments below with the students, letting them witness the reactions first hand. Describe the reactants before each reaction and describe the result once they are mixed.
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Activity # 1	**Mentos and Diet Cola (Physical Reaction)**
Materials	o Safety goggles and lab coats o 8, 2 liter bottles of Diet Coke o 4, 2 liters of other sodas (Sprite, Mountain Dew, Root Beer, Ginger Ale) o Various mint and non-mint candies (Tic-Tacs, Life Savers, Mentos, Junior Mints) o Packet of Mentos/Bottle plus some extra for repeat demonstrations o Paper to roll into tubes big enough to fit the candies
Worksheet	No

- P**lace 2 liter bottles outside in circular formation** about 10 feet from each other
- **Split the students into teams** of two or three and have them put on safety goggles and lab coats
- Tell the kids that they are a NASA team getting ready to observe the countdown to an incredible reaction
- **Open each bottle**

- **Start by placing a nickel, dime, or small rock into each bottle and observe what happens**
- Anything that disrupts the surface tension of the liquid will create pockets where bubbles can form
- The coin only gathers a few bubbles
- Have each team be ready **with 4-6 Mentos candies in a paper tube**
- Ask the kids what they think will happen
- **Count down from ten to imitate a rocket ship blast off**
- When you reach blastoff have **the kids drop the candies into the bottles at the same time and instruct them to run backwards and watch the reaction**
- After the Diet Coke and Mentos demonstration is complete, have the kids place the other **four 2 liters of soda in a square**.
- Have the kids form four groups
- Give each group one of the **other candy types and have each group stand behind one of the sodas.**
- Do another countdown from ten seconds and let the students drop the new candies into the new sodas and observe what happens
- Club members assist with the cleanup and help take the kids back inside

Explanation:

- The candy disrupts the surface tension of the liquid and helps to release the carbon dioxide that is responsible for the fizz
- This is strictly a physical reaction
- Each candy has many little holes on its surface which increases its surface area dramatically
- A rough candy with a high ratio of surface area to volume creates more places for the bubbles to go
- As the candy travels to the bottom of the bottle it creates more and more bubbles which then create more bubbles and the rocket-like reaction is observed
- Another factor is that the coatings of Mentos contain gum arabic, a surfactant that further reduces surface tension in the liquid. (As found in a study conducted by Tonya Coffey, a physicist at Appalachian State University in Boone, North Carolina)

Activity # 2	**Chemical Properties**
Materials	o Facial Tissues o Teaspoons o Baking Soda o Vinegar o Plastic 35mm Film Containers (Extra 10 containers for mistakes and demonstrations) o Eye Droppers o Goggles

	o Paper towels for cleanup o Pack of different colored markers o Small prize for winning team (Candy, Glow Sticks, Bouncy Balls, Silly Bands, Etc.)
Worksheet	No

Procedure: Team Activity

- Have the kids work in pairs. Give each **pair one film container**
- Have everyone put on goggles and pretend to be lab scientists
- Have each team mark **the lid of their film container a different color** so they will be able to find their lids after the reaction occurs
- One student takes **a square of tissue paper and puts one teaspoon of baking soda in the center.** Roll the paper around the baking soda into a paper ball.
- Each student then takes **a film container and puts the ball of baking soda inside**
- One student will hold the film container lid in one hand while the other student uses an **eye dropper to drop some vinegar in the container**.
- Once **one or two drops are placed on the tissue ball the other student quickly closes the lid** and stands up with the container.
- Each **team stands side by side in a line pointing their containers towards one side of the room** and waits for the tops to shoot off from the reaction taking place in the containers.
- The science club volunteers will judge how far each cap flies off and offer a prize to the team that sent their cap the furthest
- When vinegar (acetic acid) mixes with baking soda (sodium bicarbonate), it produces a chemical reaction. Carbon dioxide gas is produced. As more and more gas is produced, pressure in the film container builds, until the lid is blown off, revealing bubbling foam.
- It is important to have the lid completely snapped on or the carbon dioxide gas will seep out the sides and pressure will not build.
- Let the students repeat the experiment with different ratios of vinegar and baking soda until they create the loudest and most satisfying pop.

CONCLUSION

- What are some differences between chemical and physical reactions? What are some examples?
- What should we look for if we are trying to figure out if a reaction is a chemical one or a physical one?