

The Elephant Toothpaste

The Big Idea

- 1) Chemical reactions involve elements and compounds combining to form new substances.
- 2) Evidences of chemical reactions include color change, gas formation, solid formation and energy change.

Background

Often chemical reactions are used in demonstrations to give the sense that something “magical” has occurred. To break down that notion, we will simply define a chemical reaction as a combination of elements and/or compounds in which a new substance is formed. In other words, elements and/or compounds are switched around and a new substance(s) with new properties is produced. Furthermore, there are clues that a chemical reaction has taken place – color change, gas formation, solid formation (precipitate forms) and energy is released or absorbed (exothermic or endothermic).

Materials

Demonstration - Vinegar and Baking Soda

100 mL glass beaker
3 tablespoons of baking soda
30 mL of vinegar

Demonstration - Color change

16 test tubes filled with water
3 test tube racks
Laundry detergent
20 mL of phenolphthalein with dropper

Elephant toothpaste (per group)

1 500 mL graduated cylinder
food coloring
10 mL Dawn detergent
80 mL 30% hydrogen peroxide (H_2O_2)
20 mL saturated solution of potassium iodide (KI)
Disposable gloves
Safety glasses



Procedure

To prepare before the session:

1. Prepare the 16 test tubes filled 1/3 of the way with water. In a 100 mL beaker, mix 2 teaspoons of detergent with 50 mL of water to create a solution that is basic but still clear. Add a few drops of this base solution to 2 of the test tubes. All the test tubes should look the same.
2. Prepare saturated solution of potassium iodide. Prepare 8 dixie cups with 20 mL of this solution.
3. Using fresh 30% hydrogen peroxide, prepare 8 dixie cups of 80 mL. Use gloves when working with the hydrogen peroxide.
4. Have each material in bins or piles that are easy to distribute.

During session

1. Ask participants to describe chemistry. Accept and acknowledge all relevant answers.
2. Introduce the first concept, which is that a chemical reaction is a process in which two or more elements and/or compounds are combined to create new substances. Demonstrated to them the class “volcano” experiment by combining vinegar with baking soda in the glass beaker. Point out to the families that in this case two substances were combined and as a result new substances were formed. Have the families come up with **one of the new substances formed** (*gas – CO₂*).
3. Ask the families how they new a chemical reaction had taken place. (***Bubbles formed – indicating gas had formed.***) Describe the second concept – there are “clues” to indicate that a chemical reaction has taken place. Gas formation, color change, solid formation and energy is released (exothermic) or absorbed (endothermic).
4. To illustrate one of the other “clues”, do the second demonstration. Have families take a test tube. There should be enough for 2 per family. Demonstrate to them how to have “conversations” – take two test tubes and pour one of them into the second, gently mix then pour the same amount of liquid back into the first test tube. (Thereby mixing the two test tubes) Instruct the people with test tubes to have 3 conversations with others in the room. After all the conversations have taken place, tell them that two of the test tubes contained some soap. Using an indicator and a chemical reaction, you could tell who had “inherited” some of that soap. Walk around the room and add a drop of phenolphthalein to each test tube. The test tubes with soap will turn bright pink. Conclude by saying that color change is clue to a chemical reaction.
5. Tell the families that they will conduct a chemical reaction and that they are to look for the clues. Review the clues with them. Elephant toothpaste :
 1. Pass out safety glasses and at least one pair of gloves per group.

2. Lay a plastic garbage bag on the desk and place the graduated cylinder in the middle of the garbage bag.

3. It would be preferable to have the science leaders pour the 30% hydrogen peroxide into the graduated cylinders themselves for it is an irritant. Then pass out the Dawn detergent, food coloring and KI solution.

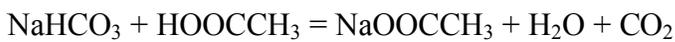
4. Have the families pour the Dawn detergent into the graduated cylinder with the hydrogen peroxide and place drops of food coloring down two opposing sides of the cylinder.

5. At the count of three, have one member of each group pour the KI solution into the cylinder and advise all group members to sit back.

6. Ask what clues they saw that indicated a chemical reaction had taken place. (*bubbles formed (gas formation) and heat was produced (exothermic reaction).*)

Reactions

Baking Soda and Vinegar

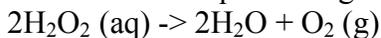


Phenolphthalein in alkaline solutions

Phenolphthalein is insoluble in water, and is usually dissolved in alcohols for use in experiments. It is itself a weak acid, which can lose H⁺ ions in solution. The phenolphthalein molecule is colorless. However, the phenolphthalein ion is pink. When a base is added to the phenolphthalein, the molecule \rightleftharpoons ions equilibrium shifts to the right, leading to more ionization as H⁺ ions are removed. This is predicted by Le Chatelier's principle. (<http://en.wikipedia.org/wiki/Phenolphthalein>)

Hydrogen Peroxide and Potassium Iodide (Elephant Toothpaste)

The rapid catalyzed decomposition of hydrogen peroxide produces O₂ gas which forms a foam with the liquid detergent:



The I⁻ion is a catalyst for the reaction. The brown color of the foam is evidence of iodine in the reaction. It will stain clothes, skin, and carpet

Notes:

The foam is fun but still may have some concentrated hydrogen peroxide and KI. So avoid skin contact and discourage playing with the foam. Clean up quickly.

Resources

<http://library.thinkquest.org/10429/high/cool/labs/elephantlab.htm>

<http://www.using-hydrogen-peroxide.com/elephant-toothpaste.html>