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

1 500mL graduated cylinder or large beaker filled with water
1LBS of Dry Ice in Cooler
Tongs to handle dry ice
20 mL of Universal indicator with dropper

Elephant toothpaste (per group)

1 500 mL graduated cylinder
food coloring
5 mL Dawn detergent
20 mL 30% hydrogen peroxide (H_20_2)
5 mL saturated solution of potassium iodide (KI)
Disposable gloves
Safety glasses

Procedure

To prepare before the session:

1. Prepare saturated solution of potassium iodide (already done). 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 – CO_2***).

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. In a 500 mL graduated cylinder fill ¾ full of water, add a couple mL of Universal Indicator, add a little dry ice. What happens? When dry ice is added to water, some of it forms carbonic acid, and lowers the pH. This is why the solution changes color.
At the same time, the dry ice is subliming to gaseous carbon dioxide. The "fog" that we see is condensed water vapor though, not carbon dioxide.

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

$NaHCO_3 + HOOCCH_3 = NaOOCCH_3 + H_2O + CO_2$

Dry Ice, Water and Universal Indicator

$CO_{2\,(s)} + H_2O_{\,(l)} \rightarrow H_2CO_{3\,(aq)}$

Hydrogen Peroxide and Potassium Iodide (Elephant Toothpaste)

The rapid catalyzed decomposition of hydrogen peroxide produces O_2 gas which forms a foam with the liquid detergent:
$2H_2O_2$ (aq) -> $2H_2O + O_2$ (g)
The I-1ion 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

SAFTEY Notes:
Volunteers must wear safety goggles and gloves at all times when working with chemicals.
Students and families must also wear goggles and gloves if they are doing the reaction.

Reaction 2-Universal indicator can stain, dry ice can cause severe burns, goggles should be worn at all times, and caution should be taken. Dry Ice should not be put down drain at school.

Reaction 3-The person doing the experiment must wear goggles and gloves. KI will stain, and hydrogen peroxide will burn. 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 in provided trash bags.

Resources

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

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

http://sites.jmu.edu/chemdemo/2011/06/13/dry-ice-in-universal-indicator/