Make an Acid-Base Reaction Go "Pop"

Introduction

Construct a popping toy in a bag using common laboratory chemicals and materials.

Science Concepts

Acids and Bases

Consumer chemistry

Materials

Acetic acid (vinegar), 35mL
Sodium bicarbonate, $NaHCO_3$, 10g
Balance, 0.1-g precision
Sink or bucket
Weigh boat, 1
Zipper-lock bags, small, 1

Safety Precautions

Acetic acid and sodium bicarbonate may be irritating to tissue, and especially to the eyes. Avoid contact of all chemicals with eyes and skin and wear chemical splash goggles and chemical resistant apron. Wash hands thoroughly with soap and water before leaving the laboratory.

Background

A toy "Bomb Bag™" is a small, sealed Mylar® pouch containing a packet of "magic water" and a white solid. The "magic water" solution is simply an aqueous citric acid solution (citric acid solid dissolved in water) with a volume of approximately 3mL. The solid material in the bag is sodium bicarbonate, typically weighing about 3 grams. As pressure is applied to the packet containing the citric acid solution, it will break, therefore allowing a chemical reaction between the sodium bicarbonate and the citric acid solution. The resulting chemical reaction produces carbon dioxide gas. As the volume of carbon dioxide gas exceeds the elastic volume of the bag, the bag will pop. The plastic bag used in this activity is very similar in size to that of the toy, but it is made of a more elastic material than Mylar, so a greater amount of gas is required to pop the bag.

Procedure

1. Have one partner weigh out 10 g of sodium bicarbonate in a weigh boat and measure 35 mL of vinegar.
2. Bend the weighing boat in half, forming a V-like shape, and pour the contents into a small zipper-lock plastic bag. See Figure 1.
3. Shake all the solid to one side of the bag and hold the solid in place by pinching your index and middle finger around the bag as shown in Figure 2.

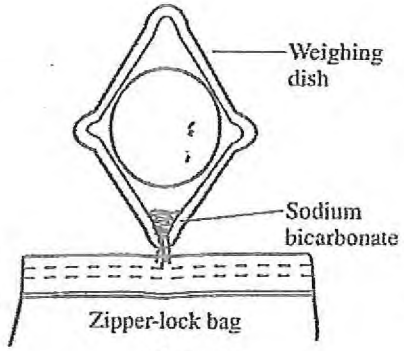

Figure 1.

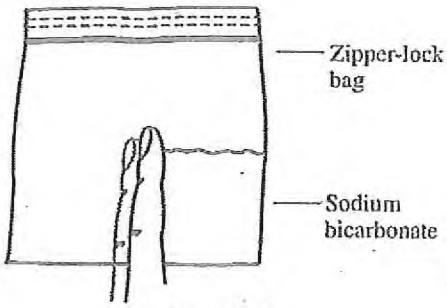

Figure 2.

4. While keeping your fingers in place, have your partner repeat steps 2 and 3 adding the vinegar to the opposite side of the bag.
5. With your finger still in place, have your partner zipper the bag tightly.
6. Remove your fingers and shake the bag for 1-2 seconds allowing the chemicals in the bag to completely mix. Then quickly place the expanding bag into a sink or bucket, and step back and wait for it to pop.

Disposal

Pick up the plastic pieces after the bag has popped and throw the pieces in the trash. Foam from the reaction may be washed down the sink with water.

Post-Lab Questions

1. Describe the observation and evidence for the chemical reaction between sodium bicarbonate and acetic acid in solution.
2. What chemical caused the Ziploc bag to pop?
3. What chemicals are used in the Bomb Bag™ toy?
4. Why did this experiment work with acetic acid?