Activity 3:

The Foaming Bottle Model

This activity will let your students investigate the science of how aerosol propellants work and help them understand how the can works to deliver the product.

Your students will be generating carbon dioxide gas in plastic 16-oz bottles to propel their product (dish detergent) out of the bottle. The model works on the principle that a gas will move from an area of high pressure (inside the bottle) to an area of lower pressure (outside the bottle).

Teaching Objectives:

- To show how gases move from areas where they are under high pressure to areas where they are under lower pressure
- To review the concept of pressure and propellants in aerosol cans

Skills:

- Investigation, classification, discussion, data collection

Materials:

- Baking soda
- Vinegar
- 16-oz plastic bottles
- Cafeteria trays or cookie sheets
- Dish detergent
- Safety goggles

Background

Your students probably will have heard the rush of gas as it escapes from an aerosol can. They will know by this time that the contents of the can are under pressure. When the valve on the can is pressed, a pathway is opened to the outside air where the pressure is less. The propellant rushes out, taking the other contents of the can with it.

Your students may have seen the effects of a gas under pressure when they shake up a soda bottle before opening it. The contents of the bottle rush out when opened.

The gas that inflates whipped cream from an aerosol can is under pressure inside the can; outside the can the pressure is less. When the valve on the aerosol opens, the gas carries the product through the dip tube and out of the can. The gas expands when it comes out into the air.

It is important that you make the distinction to your students that the ingredients inside aerosol products are specially matched to be chemically compatible. In other words, they don't react to form other products. The ingredients that the students are using for their model, vinegar and baking soda, do react to form a new product, carbon dioxide. In this respect, the foaming bottle model does not show the chemical compatibility of aerosol ingredients.

Demonstration Option

If you are concerned about creating a mess, or about your students investigating gases under pressure, you could do this activity as a demonstration.

Prep Time

1. You will need to collect 16-oz plastic soda bottles and large cafeteria trays prior to this activity. Each group of students will need to have a bottle and a tray covered with a paper towel to work on. If you don't have sinks in your classroom, you will need to move somewhere where water is readily available for cleaning up after each use.

2. Make sure that your baking soda has not been sitting around the classroom too long, or you may not get the results you want.

3. Students should wear safety splash goggles for this activity. While all they are generating is carbon dioxide gas and soap suds, soap in the eyes is a distinct possibility without protection.

4. Provide plenty of paper towels for this activity.

Procedure

1. Your students will first collect all of the needed materials and cover a tray with paper towels.

2. They will then put a bottle in the middle of the tray, and put the soap and vinegar into the bottle.

Note: The soap is added to the baking soda and vinegar mixture for a couple of reasons: it acts as the "product" carried out of the container by the gas, and it makes the reaction results easier to observe. Any household dish detergent will work fine. Liquid hand soap, however, will not give good results.

3. Allow your students a chance to make their predictions and record their reasons for them.

4. Add the baking soda to the bottle. When baking soda and vinegar are combined, they react to form a salt, water, and carbon dioxide gas. The reaction happens as soon as the chemicals are combined, so warn your students to be ready!

This gas, when shaken with the soap, makes the soap foam. The foam will escape out of the bottle and onto the tray.

Remind your students to use senses other than sight to make observations during this investigation. Hearing and touch will both come into play when observing the baking soda and vinegar reaction.

5. You will need to set up a demonstration to show your students what happens when you shake the bottle. By doing this as a demonstration, the soap suds are reduced and contained, and you can use the opportunity to question your students about what they think might happen, and what might be a better way of going about the task.

6. When the students have finished making their first foaming bottle, they will have a chance to brainstorm suggestions for how they could put a gas under greater pressure before it escapes, and then try the activity again.

NOTE: It is up to you whether you want your students to actually try their methods of putting their gas under greater pressure. The safest method is for you to mix the vinegar and baking soda in a demonstration bottle, briefly capping the bottle as the reaction occurs.

7. Your students could increase the pressure of the gas inside their bottles by putting their hands over the bottles as the reaction occurs, then removing their hands. Be sure everyone is wearing goggles throughout this activity.

Safety Considerations for this Activity

Do not let your students put a cork or stopper into the end of the bottle, as it could fly out and hurt someone.

Students must wear chemical splash goggles for this activity to keep soap suds out of their eyes. It is also important to remind students to clean up any spills immediately, as soap suds are very slippery on the floor.

Pulling it All Together

Ask your students to share their observations of the foaming bottle model at the end of the class period. If you choose to allow the students to put their gas under greater pressure, also ask them to share their methods for doing this.

Ask your students to reflect on the foaming bottle as a model of what happens inside an aerosol can.

How is the foaming bottle a good model? (It shows how gases move from areas of high pressure to lower pressure. It also shows how the gas can carry a product out of the container.)

How could the foaming bottle be a better model? (It could contain chemical compatible ingredients. It also could have a valve to control the rate at which the product is delivered.)

How is the propellant in aerosol products kept from escaping from the can?

Another reminder for your students is that in aerosol products there is no chemical reaction taking place. This experiment does involve a chemical reaction in the making of carbon dioxide.

At this point, draw your students' attention to the fact that the gas under pressure moved rapidly to where the pressure was less (outside the bottle). Ask them to draw a parallel between this and what happens in aerosol products.

Using the DVD

You may want to use the video **"Another Awesome Aerosol Adventure"** at this point to illustrate or emphasize some of the concepts that your students have been investigating. Refer to minutes 3:20 through 6:30 in the videotape to show how aerosol products work.

Activity 3:

The Foaming Bottle Model

You will be working with a group of your classmates to make and test a model of what happens when a gas moves from a place where it is under high pressure to where it is under lower pressure. This is what happens with aerosol products. In aerosol products, the gas inside (the propellant) is under such high pressure when the can's valve is opened, the propellant rushes out to where the pressure is lower, taking the product with it. You will be using a chemical reaction to make the gas in your model. This reaction is not what happens inside a real aerosol, but it is an easy way to demonstrate how a gas behaves under pressure.

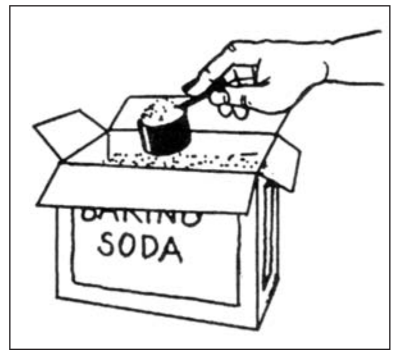
Step 1

Collect all the materials for your group:

- 16-oz plastic soda bottle without cap
- liquid dish detergent
- large tray
- funnel
- tablespoon measure
- baking soda
- vinegar
- paper towels
- safety goggles

Step 2

It is important that your team is organized for this investigation. It will take several pairs of hands to do this activity, so you will need to divide up the work so that:



- one person measures the vinegar, baking soda and dish detergent
- one person adds the ingredients to the bottle
- one person shakes the bottle
- one person records observations and results

Step 3

Everyone in the group needs to put on goggles first. Cover your tray with paper towels and put the bottle in the middle of the tray. Once all the materials are assembled and the recorder is ready, two tablespoons of dish detergent and three tablespoons of vinegar should be put into the bottle. (The funnel will help with this.) Rinse and dry the funnel.

Step 4

Put 2 tablespoons of baking soda into the funnel, but keep your finger over the end. Carefully put the funnel into the bottle and shake the baking soda into the bottle. Put your finger over the bottle and shake, then put it down in the center of the tray.

Safety Warning

Do not place a cap on the bottle.

Watch what happens to the contents. Record your observations.

Step 5

When you finish, talk over with your group members how it might be possible to increase the pressure of the gas inside the bottle. Discuss your ideas with your teacher. Rinse out the bottle and try the investigation again. Your teacher will do a demonstration later to show what happens when the pressure of the gas is increased.

Prediction Point

- What do you think will happen to the bottle's contents when the gas in it is under greater pressure?
- Record your predictions and your reasons for them.

Step 6

Look over your recorded observations. Share what your group has found with other groups in your class.

See what ideas other groups have had for increasing the pressure of the gas inside the bottle. (This is carbon dioxide gas that you were making. Carbon dioxide is the same gas that gives carbonated beverages their "fizz", and is one of the gases used as a propellant in a small percentage of aerosol products.)

Did anyone in your class have any ideas for how to release the gas and the other ingredients with a valve?

Things to Think About

• Were your results close to what you predicted? If not, how can you account for the difference?

• How is the foaming bottle investigation like the release of a product from an aerosol? How is it different?

• What could you do to make the foaming bottle more like what really happens with aerosol products? Is it possible with the materials you have?

• What part of the foaming bottle was the propellant? What was the product? How did the difference in pressure inside and outside the bottle cause the propellant to work? Discuss some of these ideas with other people in your group.