Activity 2:

The Gelatin Party

Teaching Objectives:

- To introduce the concept of pressure and propellants in aerosol cans
- To give students a better understanding of how volume and pressure work together
- To establish the use of metric units in collecting data

Skills:

- Investigation, measuring, collecting data

Materials:

- Whipped cream in aerosol can
- 4-5 10-oz beakers or graduated cylinders
- Stack of clear 10-oz cups
- Computer or calculator
- Paper towels
- 2 boxes of gelatin (optional)

This activity will show your students how a gas can expand. It also will let your students investigate the difference in volume between the contents of an aerosol product and the discharged amount. Using whipped cream, your students will work collaboratively to measure the discharged product as it is sprayed out of the can.

They will then record this amount and compare it, mathematically, to the can's volume. (Directions for finding the can's volume by water displacement are given.)

This will help them see the effects of putting the can's contents under pressure. When the pressure drops, as it does outside the can, the volume of the contents increases. The discharged whipped cream can be put to good use by having a gelatin party as the closing event for this activity.

Your students may already have wondered at some time how so much whipped cream can come out of an aerosol can. If they have read the label, they will know that the contents are under pressure. Most of them, however, will not have any real understanding of what "under pressure" means.

This activity will help them get a mathematical sense of the difference in volume between the contents in the can of whipped cream and the contents when it comes out of the can. You will build on this knowledge using later activities in this package that will help students understand expansion and contraction of gases in aerosol cans.

Background

The gas inside aerosol products, the propellant, which is dissolved in the other ingredients, pushes the product out of the can.

There are two types of propellants used in aerosol products: compressed gases, which are present only in a gaseous form, and liquefied propellants, which are gases at room temperature and pressure, and liquid under higher pressure. The majority of consumer aerosol products use liquefied propellants, most of which are naturally occurring hydrocarbons such as propane and butane. Propellants are under pressure inside the aerosol

can; outside the aerosol can, the pressure is less. In nature, as can be seen with air masses in the atmosphere, gases move from areas of high pressure to lower pressure. In an aerosol product, when the valve is opened, the product moves through the dip tube and out of the can. When it comes out into the air, the gas expands.

Aerosol Fact

Chlorofluorocarbons (CFCs) have not been used in consumer aerosol products in the U.S. since 1978. An exception was made for some unique medical uses such as asthma inhalers, but this use will be phased out by December 31, 2008!

Your students may think that some aerosol products (deodorant, for example) seem to have less product than other packaging forms (i.e., stick). This may be because there appears to be empty space inside the can. In most aerosol products, a small amount of space is needed to enable the product to work. This space contains the gaseous propellant and prevents rupture or distortion of the can.

Demonstration Option

If your budget is limited, or you are concerned about creating a mess in the classroom, you may want to do the activity as a demonstration for the whole class. In this case, you can ask two student groups to do the spraying and measuring for the whole class.

Two groups will give enough data for comparison, but will keep the expense and mess to a minimum (and you will still have enough whipped cream for the party).

The propellants in whipped cream are compressed gases and are used to push product out of the can and to provide an aeration effect, i.e., whipped cream. You can simulate the action of the gas in whipped cream by whipping a pint of heavy cream for your students. This will give them some sense of how much the addition of a gas can inflate a product.

Prep Time

1. You will need to arrange for a room outside of the science lab for this activity as your students will both be handling and eating food.

2. You also need to send home a permission slip just in case you have any students who can't have sucrose (table sugar) or lactose. The gelatin desserts will need to be made and chilled in advance. If the cost of the whipped cream is a problem, you could do this activity as a demonstration, but still have the gelatin party for the whole class.

3. The whipped cream and gelatin will need to be chilled until your students are ready to use them.

4. Your students will spray whipped cream into clean 10-oz plastic cups. To make this job easier, each of the students in a particular group will have a specific job: one will be in charge of spraying, one will measure volume, one will record, and one will collect and take back the materials. Metric measuring devices for students to copy and cut out are provided in the back of this activity.

Determining the Volume of a Can

One way to determine the volume of a can is to see how much water the can displaces. These are the steps you should use:

Step 1. Fill a large container with water all the way to the top

Step 2. Put the water-filled container in a pan to hold the overflow which will spill over the top when you put the aerosol can in the water

Step 3. Place the whipped cream can completely under the water

Step 4. Measure the volume of the overflow water now in the pan by putting it in a measuring cup

Procedure

1. Students will do a displacement exercise to find the volume of the whipped cream can. They will then use their calculators to figure out how much greater the discharged volume of whipped cream is than the volume of the can. They can do this by dividing the discharged volume by the estimated can volume. The value they get will tell them how many times the volume of the contents expanded when it was discharged.

When the students are finished with the spraying and measuring, it would be a great time to have them put their whipped cream onto gelatin for a class party.

2. Advise your students that it would be a good idea to get some sense of the volume that their cups hold (in metric units) before they start spraying whipped cream. They can tape the measuring strip (provided at the end of this section) to the side of a 10-oz. clear plastic cup.

The top and bottom diameters, and the height of the side for the appropriate type of cup have been provided on the photocopy page. If you have graduated cylinders available, then your students can use these to verify the metric volumes at certain heights on their 10-oz cups. This will ensure that they have the measuring strip taped in the correct position.

The cream won't deflate immediately, but it has a tendency not to keep its full volume for very long. If they have figured out how much the cups hold in advance, that will make the measuring process much smoother.

3. To provide another illustration of what happens when a gas mixed with a product expands, you can whip a pint of heavy cream into a metal bowl with a mixer. Be sure to record the cream's volume, both before and after it is whipped. As you beat air into the cream, its volume increases greatly.

4. Some of your students may be able to figure out the discharge volume by reading the can's label carefully. Using the part of the label where serving size information is provided, it is possible to figure out the discharged volume by multiplying the serving size volume by the number of servings per can. Two tablespoons are equivalent to one fluid ounce.

Your students can compare this calculated value with their measured value from the experiment. A typical can of whipped cream has a discharged volume that is about 1.5 times greater than the undercharged volume of the can.

5. To whip heavy cream, place it in a chilled stainless steel bowl. Beat it at high speed with an electric mixer until it is still. Be sure to measure the volume before and after you whip the air into it.

Pulling it All Together

Ask students to post their results for the "before and after" can volume on a chalkboard data chart. They also can list the values that they calculated for how many times the volume increased from inside the can to outside.

Ask your students to look for agreement and disagreement among the values. If you find some that are way off, ask students to look for the causes of this. It may have been a measurement error, or a calculation problem.

See if your students can come up with logical reasons for why the volumes inside and outside are so different. What inflates the whipped cream so much?

If you have chosen to whip the heavy cream as a demonstration for your students, they will be able to see what the incorporation of air into the cream can do for its volume.

Safety Considerations For This Activity

Since your students will be working with and tasting food products, you will need to conduct this activity outside the science classroom. You may want to move to the cafeteria, a regular classroom or the Home Economics lab. Be sure that all materials used for containing and eating the food are clean.

Activity 2:

The Gelatin Party

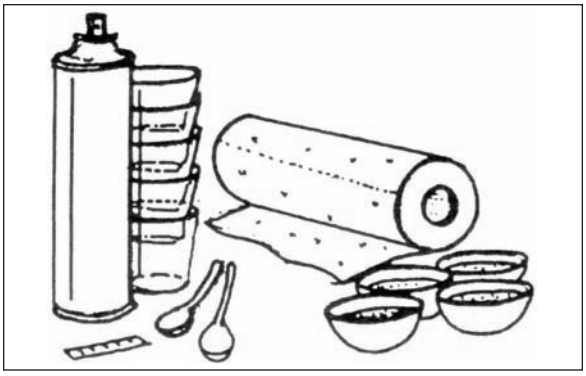
Most aerosol cans seem to squirt out a lot of stuff. It's as if the product you get is much more than the can appears to contain. In this activity, you will be working with your group to investigate the difference between the volume inside a can of whipped cream and the volume of the whipped cream when it is sprayed.

Step 1

Collect all the materials for your group:

- aerosol can of whipped cream (unused)
- spoons (one for every person)
- stack of 10-oz clear plastic cups (about 10)
- metric volume measuring strip
- cups of gelatin (one for every person)
- paper towels
- container large enough to hold the whipped cream can
- pan to hold water overflow
- volume measure (such as a graduated cylinder or measuring cup)

(Your teacher will arrange for either a large ice cooler or refrigerator to be available.)



Make a Prediction

Before you begin investigating, discuss what you think the likely result will be, based on your knowledge of aerosols. How many cups do you think the squirted out whipped cream is most likely to fill up?

Now make your PREDICTION and record it like this:

"My prediction is that the aerosol will deliver:"

_____ cups, or
_____ fluid ounces, or
_____ cubic centimeters

Also record the reasons for your prediction:

"The reasons for my prediction are:"

_____

_____

_____

_____

_____

_____

_____

_____

Step 2

This activity moves quickly, once you start spraying and measuring whipped cream.

You will need to divide the work so that:

- one person is the sprayer
- one is the measurer
- one is the recorder
- one is the materials manager (gets and takes back materials)

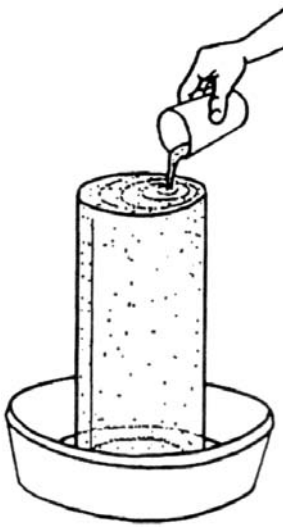
Step 3

Once all the materials are assembled and the recorder is ready, set up a row of cups and begin squirting the whipped cream in, cup by cup. It is important that each cup is filled to the same level each time. The recorder needs to be ready to write down the volume right away, before the whipped cream deflates.

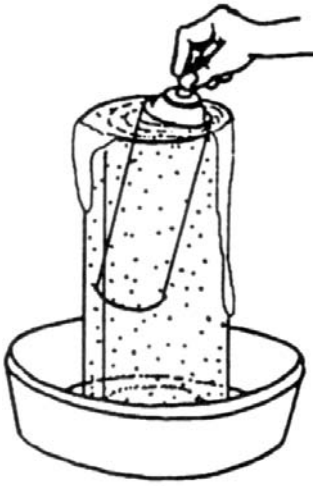
Step 4

You can estimate the volume inside the can this way:

1. Fill the large container with water all the way to the top.
2. Place the water-filled container into a pan that will hold any overflow.



3. Hold the whipped cream can completely under the water.
4. Measure the volume of the overflow from the container by pouring it into a measuring cup.

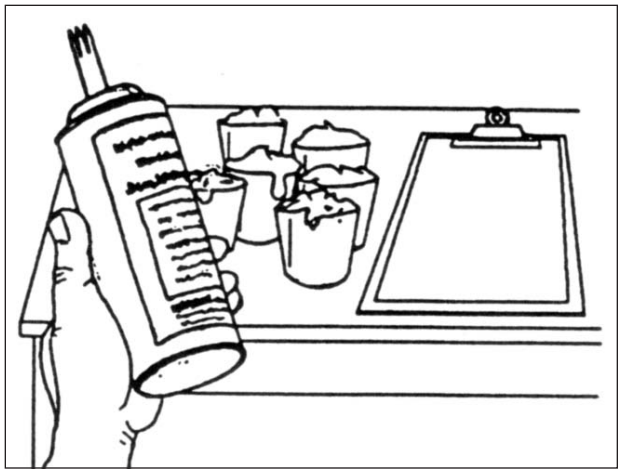


Step 5

Compare the estimated volume of the can with the discharged whipped cream volume.

What is the difference?

How many times greater is the discharged volume than the can volume? (You can find this out by dividing the discharged volume by the can volume.)



THINGS TO THINK ABOUT

- **Were your results close to what you predicted?**
- **How far off were you?**
- **What do you think has to happen for the can volume to expand that much?**
- **Watch your teacher demonstrate how cream is whipped. What is there about this process that can help you understand what is happening in the can?**

Metric Volume Measuring Strip

The measuring strip below is designed to be used with a clear 10-oz (300 mL) plastic cup that fits the dimensions given below. To use the strip, simply cut it out, then attach it to the side of the plastic cup, folding it under and taping it where indicated.