**Your Activity**
Identify three unlabeled white powders from the kitchen by observing how one reacts with water and with each other.

**Material**
- Baking Soda
- Glass
- Lemon Juice
- Spoon or Straw
- Liquid Dishwashing Soap (e.g. Dawn)
- Food Coloring (Optional)

**Create**
1. Always wear safety goggles
2. Put a teaspoon spoonful of baking soda into the glass
3. Stir in squirt of dishwashing liquid
4. Add a drop or two of food coloring, if you want colored bubbles
5. Squeeze lemon juice into the mixture or pour in lemon juice. As you stir the juice into the baking soda and detergent, bubbles will form that will start to push up and out of the glass.
6. You can extend the reaction by adding more lemon juice and baking soda.
7. The bubbles are long-lasting. You can’t drink the mixture, but you can still use it for washing dishes.

**Science Topics**
Chemistry

**What’s going on?**
The sodium bicarbonate of the baking soda reacts with the citric acid in lemon juice to form carbon dioxide gas. The gas bubbles are trapped by the dishwashing soap, forming fizzy bubbles.

There are many uses of Carbon Dioxide. Carbon Dioxide is used by food industry, the oil industry, the agricultural industry and the chemical industry. A candy called Pop Rocks is pressurized with carbon dioxide gas at about 40 bar (580 psi). When placed in the mouth, it dissolves (just like other hard candy) and releases the gas bubbles with an audible pop. Leavening agents cause dough to rise by producing carbon dioxide. Baker’s yeast produces carbon dioxide by fermentation of sugars within the dough, while chemical leaveners such as baking powder and baking soda release carbon dioxide when heated or if exposed to acids. Carbon dioxide is used to produce carbonated soft drinks and soda water. Carbon dioxide in the form of dry ice is often used in the wine making process to cool down bunches of grapes quickly after picking to help prevent spontaneous fermentation by wild yeast.
Fizz Inflator

Your Activity
Build a fizz inflator

Material
One small empty plastic water bottle  ½ cup of vinegar
Small balloon  Baking Soda
Funnel

Create

1. Always wear safety goggles
2. Carefully pour the vinegar into the bottle.
3. This is the tricky part: Loosen up the balloon by stretching it a few times and then use the funnel to fill it a bit more than half way with baking soda. If you don’t have a funnel you can make one using the paper and some tape.
4. Now carefully put the neck of the balloon all the way over the neck of the bottle without letting any baking soda into the bottle.
5. Ready? Lift the balloon up so that the baking soda falls from the balloon into the bottle and mixes with the vinegar. Watch the fizz-inflator at work!
6. Answer following questions:
   a. Does water temperature affect how fast the balloon fills up?
   b. Does the size of the bottle affect how much the balloon fills?
   c. Can the amount the balloon fills-up be controlled by the amount of vinegar or baking soda?

Science Topics
Chemistry

What's going on?
The baking soda and the vinegar create an ACID-BASE reaction and the two chemicals work together to create a gas, (carbon dioxide) Gasses need a lot of room to spread out and the carbon dioxide starts to fill the bottle, and then moves into the balloon to inflate it.
Introduction

Students will learn that baking soda and vinegar produce a gas. Explain that in chemical reactions, the change resulting from the reaction can be controlled by the amount of each substance used. Tell students that they will investigate how the amount of baking soda and vinegar used in a reaction influences the amount of gas produced.

There are 4 parts to this activity:

1) Demonstration
2) Lemon Fizz
3) Fizz Inflator
4) Adjust the amount of baking soda and vinegar to control the amount of gas produced in the reaction

Background

Carbon dioxide, CO\textsubscript{2}, is one of the gases in our atmosphere, being uniformly distributed over the earth's surface at a concentration of about 0.033% or 330 ppm. Commercially, CO\textsubscript{2} finds uses as a refrigerant (dry ice is solid CO\textsubscript{2}), in beverage carbonation, and in fire extinguishers. Because the concentration of carbon dioxide in the atmosphere is low, it is not practical to obtain the gas by extracting it from air. Most commercial carbon dioxide is recovered as a by-product of other processes. Carbon dioxide is a colorless, odorless gas. It is produced when any carbon-based material used for fuel (coal, oil, wood, etc.) is burned. People exhale CO\textsubscript{2} which contributes to the CO\textsubscript{2} levels in the air.

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Materials

This is required for each group:

- Baking Soda
- Vinegar
- Water
- Liquid dish detergent
- One 50 ml Graduated Cylinder
- ½, ¼ and 1/8 teaspoons
- 1 dropper
- 2 small clear plastic cups
Notes about the Materials

- Be sure you and the students wear properly fitting goggles.
- Use a 50 ml graduated cylinder if possible. If you have a different size, you will need to adjust the amount of baking soda and vinegar used so that the resulting foam overflows in demo portion of the activity.
- Students will need to rinse out the graduated cylinders during the activity. Using a squirt bottle and waste container is one easy way to do this if you do not have sinks at tables.
- Only one waste container is needed per group if sinks are readily available.

Preparing Materials

- Label 2 small cups vinegar and baking soda.
- Place about 3 tablespoons of vinegar and about 1 tablespoon of baking soda in their labeled cups.
- Label one small cup detergent for each group.
- Make enough solution for the class by adding 1 teaspoon of liquid dish detergent to 2 tablespoons of water. Stir gently until well-mixed.
- Place 1 teaspoon of the detergent solution you made into each labeled cup.
- Put the Fizz-inflator and Lemon Fizz instructions in the sign stand.

Activity Sheet

Print the activity sheet and distribute one per student/group when specified in the activity.

Procedure

1. **Introduce the activity.**

   Students know that baking soda and vinegar produce a gas. Explain that in chemical reactions, the change resulting from the reaction can be controlled by the amount of each substance used. Tell students that they will investigate how the amount of baking soda and vinegar used in a reaction influences the amount of gas produced.

2. **As a demonstration, combine vinegar, detergent, and baking soda in a graduated cylinder so that the foam overflows.**

   Procedure

   1. Use a graduated cylinder to measure 10 ml of vinegar.
   2. Pour the vinegar in a small cup and add 1 drop of detergent. Swirl gently to mix.
   3. Add ½ teaspoon of baking soda to the empty graduated cylinder.
   4. Stand the graduated cylinder in the center of a plastic waste container.
   5. Pour the vinegar and detergent from the cup into the graduated cylinder. Have students observe the level of foam in the graduated cylinder.
6. Rinse the graduated cylinder over a sink, bucket, or separate waste container.

Expected results: A white foam will rise up and overflow from the graduated cylinder.

3. **Discuss with students what they might change to create a foam that rises to the top of the graduated cylinder without overflowing.**

Ask students what they could change to create a foam that does not overflow.

Students might mention variables such as:

- The amount of vinegar, detergent, or baking soda.
- The order in which the substances are added to the graduated cylinder.

Explain that the amount of detergent is not varied in this activity because it is used as an indicator to help *measure* the amount of gas produced in the baking soda and vinegar reaction.

4. **Have a class discussion to help groups plan their testing strategies.**

Remind students that 10 ml of vinegar and ½ teaspoon of baking soda caused a reaction that flowed over the top of the graduated cylinder. Students should consider these amounts as they plan how much of each reactant they will use as they start their trials.

- Every test should be conducted the same way. For example, in the demonstration baking soda was placed in the graduated cylinder before the vinegar and detergent were added. This method mixes the baking soda and vinegar better. All new trials should be conducted this same way.
- Discuss with students the importance of thoroughly rinsing the graduated cylinder between trials.
- Ask students how they will remember the amounts of vinegar and baking soda they used in each trial. Point out the necessity of making and recording accurate measurements since they may need to reproduce their results. It is easy to forget how much of each reactant was used for each test and how high the foam rose.

5. **Have students conduct their trials.**

Distribute the student activity sheet. Tell students that they should try to get the foam to go as high up in the graduated cylinder as possible without overflowing. It is fine for the foam to rise above the rim in a dome as long as it does not drip down the outside. You may choose to limit students to a maximum of three tries or let them experiment further if time and supplies allow.
Procedure

Students should follow the same procedure as in the demonstration but with different amounts of baking soda and vinegar. They should use 1 drop of detergent in each trial.

On the activity sheet, students will describe the level of foam either by the number of milliliters it reaches or using words such as almost to the top, a little overflow, etc.

**Expected results**: Using 1/8 teaspoon of baking soda, 5 ml of vinegar, and 1 drop of detergent will cause foam to rise to the top of the cylinder without overflowing. Results may vary.

6. **Have students report on their trials.**

   Have groups share their findings about the amounts of baking soda and vinegar that came closest to reaching the top of the cylinder. Did each group use similar amounts of baking soda and vinegar? Ask students if the amount of baking soda and vinegar used affects the amount of carbon dioxide gas produced. They should agree that it does.

**Takedown**
- Rinse the flasks, glasses, graduated cylinders in the sink.
- Clean the waste container.
- Return all equipment and supplies to the storage.

**Source**
How can you control the amount of gas produced in a baking soda and vinegar reaction? The amount of baking soda and vinegar used in the demonstration caused the foam to overflow. You will need to adjust the amounts to create a column of foam that rises to the top of the graduated cylinder without overflowing.

**Procedure**

1. Record the amount of vinegar and baking soda you plan to use.
2. Use a graduated cylinder to measure the vinegar. Remember that the bottom of the meniscus should touch the line.
3. Pour the vinegar in a small cup and add 1 drop of detergent. Swirl gently to mix.
4. Add baking soda to the empty graduated cylinder.
5. Stand the graduated cylinder in the center of a plastic waste container.
6. Pour the vinegar and detergent from the cup into the graduated cylinder.
7. Describe the level the foam reached either by the number of milliliters it reaches or using words such as *almost to the top*, *barely overflowed*, etc.
8. Use a sink or a squirt bottle held over a waste container to rinse out the graduated cylinder.

**Observations**

1. Be sure to record the amounts you used and your results in the chart below.

<table>
<thead>
<tr>
<th>Trials</th>
<th>Demonstration</th>
<th>1st Trial</th>
<th>2nd Trial</th>
<th>3rd Trial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vinegar</td>
<td>10 ml</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baking Soda</td>
<td>½ Teaspoon</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Detergent</td>
<td>1 Drop</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How close did the foam get to the top of the cylinder?</td>
<td>It overflowed a lot.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. What amount of vinegar and baking soda created a foam that rose to the top of the graduated cylinder without overflowing?

Vinegar ________________________________
Baking soda ________________________________
Detergent ________________________________