



Lesson 1

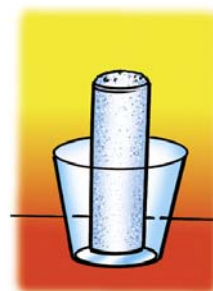
Production of a gas



T E A C H E R G U I D E

Lesson summary

Students meet volcanologist Victor Helguson, who is studying the gases released by volcanoes in Iceland. Students conduct a chemical reaction to produce one of the primary volcanic gases—carbon dioxide. Then students will use this chemical reaction to make a column of foam rise to the top of a vial without spilling over.



Key concepts

- Production of a gas is a clue that a chemical reaction may have occurred.
- The substances that combine in a chemical reaction are called *reactants*.
- The substances that are produced in a chemical reaction are called *products*.
- Changing the amount of reactants affects the amount of products produced in a chemical reaction.

Safety

Be sure you and the students wear properly fitting goggles. Read and follow all safety warnings on the labels of the citric acid and sodium bicarbonate containers. Have students wash their hands after the activity.



Proper disposal

At the end of the lesson, have students pour their used solutions in a waste container. Dispose of this waste down the drain or according to local regulations. The leftover citric acid and sodium bicarbonate powders can be disposed of with the classroom trash. Wipe up spills with paper towels and dispose of them with the trash.

Introduction

1. Introduce students to the over-arching story that connects the lessons in this unit to the first scientist.

Distribute the student activity sheets for Lesson 1. Be sure students understand the premise of the story and the idea that in chemical reactions, substances combine to make something new.



In this first lesson, students meet chemist and volcanologist, Victor Helguson, who explains that volcanoes release gases dissolved in magma. He goes on to say that carbon dioxide gas is one of the main gases released. Nobody can control the amount of carbon dioxide gas released from volcanoes. But students can use chemistry to make carbon dioxide gas, and they can actually control the amount they produce.

Teacher demonstration

2. Do a demonstration to introduce students to the idea that during a chemical reaction something new is made.

Tell students that volcanoes release carbon dioxide that had been trapped in magma deep within the earth. As the magma gets closer to the surface, pressure is reduced and the gas is released. Tell students that gases can be produced in other ways, like with chemical reactions. As you watch this demonstration, look for signs that a chemical reaction is taking place.

You will need

- Goggles for you and the students
- Citric acid
- Sodium bicarbonate
- Water
- Plastic test tube
- Rubber stopper
- Graduated dropper
- 2 small plastic scoops



Procedure

1. Place one level scoop of citric acid in the test tube.
2. Use a graduated dropper to add 1 mL of water to the test tube.
3. Add 1 scoop of sodium bicarbonate and quickly place the rubber stopper in the test tube.
4. Hold the test tube straight up. Be sure to point it away from yourself or students.

Expected results

There will be bubbling, and the rubber stopper will pop out of the test tube.



Ask students

- **The citric acid and baking soda reacted and made new chemicals.**

How do you know that something new was made?

Bubbles form that weren't there before and something pushed the stopper out of the test tube.

- **What type of gas is formed in this reaction?**

The gas that makes the bubbles is carbon dioxide.

- **Where do you think the carbon dioxide gas comes from?**

It is made from atoms from the citric acid and baking soda.

Teacher demonstration

3. Do a demonstration to introduce students to their chemistry challenge.

Tell students that you will make an acid solution using citric acid and add it to baking soda. Tell them that you will also add a drop of detergent so that the bubbles formed during the reaction will last longer. This will create a foam that will give you a sense of how much carbon dioxide gas is produced. Tell students that you are using certain amounts citric acid and baking soda so that the foam doesn't rise too high in the vial.

Student activity

Question to investigate

How can you make just the right amount of foam so that it rises all the way to the top of a vial without overflowing?

You will need

- Goggles
- Detergent solution
- Sodium bicarbonate
- Citric acid
- Water
- Small metric measuring cup
- 2 small plastic scoops
- 2 small clear plastic cups
- Clear plastic vial



Preparation instructions

Make a detergent solution by adding 5 mL of liquid dish detergent to 30 mL of water. You will need only one drop of this solution for the demonstration. Divide the rest of the detergent solution equally into one portion cup for each group for the student activity. After the activity, rinse and dry these cups for use in a later activity.

Procedure

1. Measure about 5 mL of water and pour it into a small plastic cup.
2. Add 1 scoop of citric acid and swirl.
3. Add 1 drop of detergent solution and swirl.
4. Place 1 scoop of sodium bicarbonate in the plastic vial.
5. Pour the citric acid and detergent solution into the vial so that it mixes well with the baking soda.
6. Stand the vial up inside a small clear plastic cup as shown.



Expected results

A white foam will rise part way up the vial.

Student activity

4. Have students vary the amount of reactants to create a level of foam that rises to the top of the vial.

Remind students that the foam in your vial only rose about halfway up.



Ask students

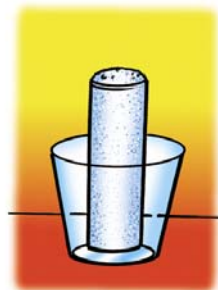
- If you wanted to make more carbon dioxide gas, what would you do?
Add more citric acid or more baking soda or more of both.

Activity summary

Information on how to conduct this activity is included on the student activity sheet. Students will conduct three trials to test different quantities of citric acid and baking soda. Each group should decide how much of each reactant they will use for each trial and record this amount in the chart on their activity sheet.

Preparation instructions

- Use the pre-made stickers to label one portion cup *citric acid* and another portion cup *sodium bicarbonate* for each group. These cups will be reused for other lessons in this kit.
- Place about $\frac{1}{2}$ tsp citric acid and $\frac{1}{2}$ tsp sodium bicarbonate in their labeled cups.



Expected results

Two scoops of citric acid in 5 mL of water and one scoop of sodium bicarbonate should make an amount of foam that gets close to the top of the vial or goes slightly above. Results will vary.

Class discussion

5. Discuss student observations and introduce the terms *reactants* and *products*.

Ask students

■ **How did you make just the right amount of carbon dioxide gas?**

Students will give their winning amounts of citric acid and baking soda. The answers may vary from group to group.

Tell students that *reactants* are the chemicals that combine together and rearrange to become different chemicals. The new and different chemicals are called *products*.

Ask students

■ **Which chemicals are the reactants?**

Citric acid and baking soda are the reactants. Detergent and water are not reactants because they remain the same.

■ **What is the name of the product that formed the tiny bubbles in the foam?**

Carbon dioxide gas is in the bubbles.

Explain to students that atoms from the citric acid and atoms from the baking soda rearrange during the chemical reaction and form carbon dioxide gas and other substances that were not there before.

Teacher demonstration

6. Do a demonstration with the enclosed self-inflating balloon to show how a chemical reaction that produces a gas can be used to inflate a balloon.

Tell students that producing a gas can be very useful and being able to control the amount produced is very important, as they will see in the next demonstration. Explain that the balloon contains baking soda and that a small inner bag contains citric acid solution. Tell students that you are using this to model how an airbag in a car works. In an airbag, different chemicals are used and a different gas is produced, but the idea that chemicals combine to produce a gas is the same.

Ask students

■ How can I get this chemical reaction started?

Students should realize that you will have to somehow combine the citric acid and baking soda because reactants cannot react unless they touch each other.

■ What do you think will happen when I break the citric acid packet?

The chemicals will react and produce carbon dioxide gas.

You will need

- Self-inflating balloon containing baking soda and citric acid



Procedure

1. Place the balloon on a flat surface.
2. Press down on the liquid-filled pouch with your hand until the pouch breaks.
3. Shake the balloon to help the reactants combine.



Expected results

The balloon will inflate until it is completely full.

Application

Have students read the real-world application page of the student activity sheet. Explain that airbags in cars inflate when two chemicals are allowed to combine. One of the products is nitrogen gas, which inflates the airbag. Nitrogen is a great choice for an airbag because it is a gas that is naturally in air and is not flammable.

