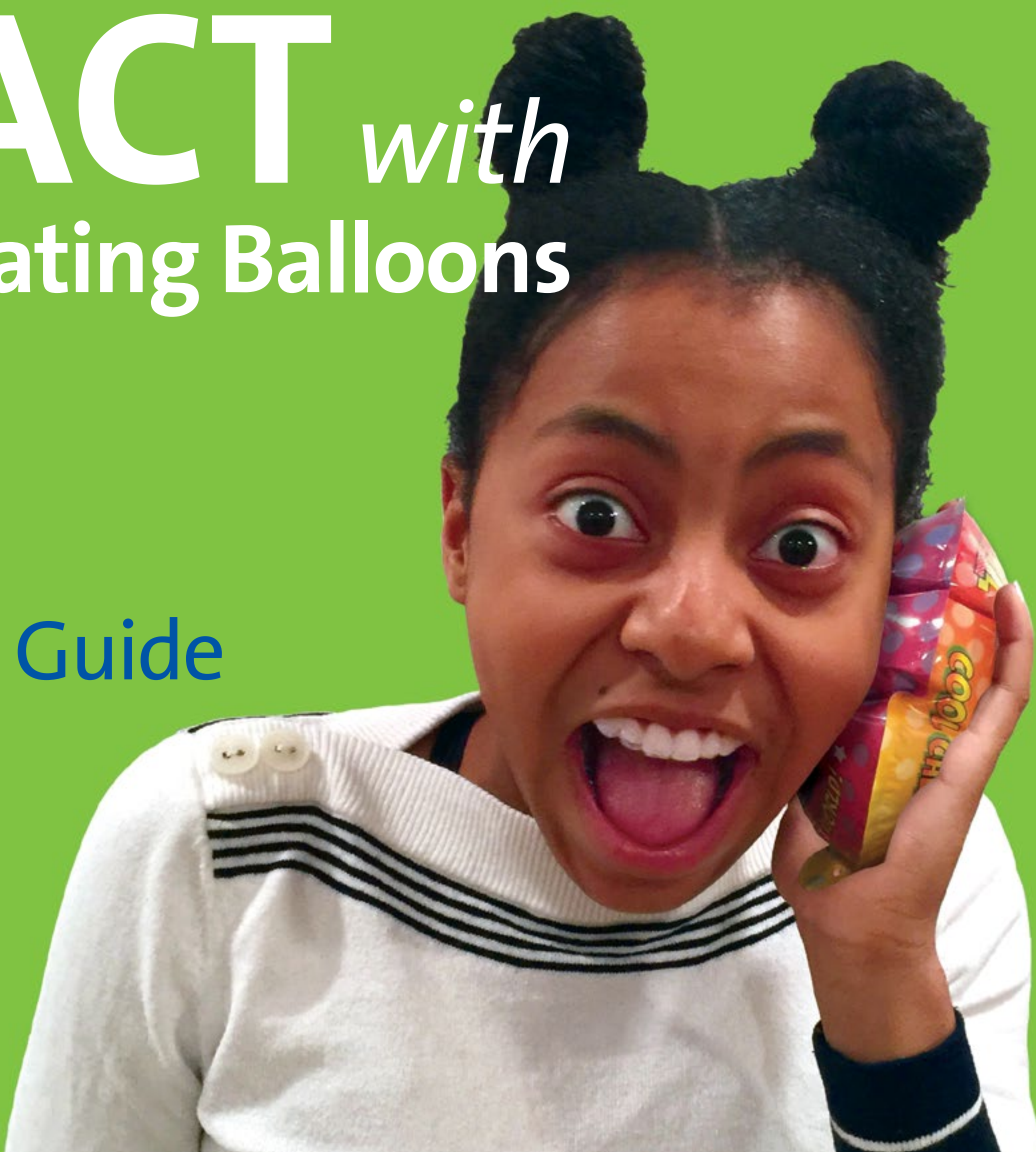
KIDS AND CHEMISTRY

REACT *with* Self-Inflating Balloons



Presenter Guide

ACS Chemistry for Life®

American Chemical Society
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Kids and Chemistry React with Self-Inflating Balloons is a product of the Education Division of the American Chemical Society.

Credits

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Thanks to you!

Thank you for volunteering to share chemistry with students. They will definitely enjoy their time with you. Some will excitedly tell their parents about you and the experiments as soon as they get home. Many will give their families and friends a quick science lesson whenever they see or hear about something you mentioned. Your short visit will make a big impression! After all, how often do students get to learn chemistry concepts from a real chemist?

This presenter guide and the kit were developed by the American Chemical Society to help you share your knowledge and enthusiasm for chemistry with elementary and middle school students. Additional information to help you prepare for your classroom visit is available at **acs.org/kidsandchemistry**.

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About the kit

Lead students on an investigation to find out how self-inflating balloons work. First, cut a balloon open to see what's inside. Then plan to inflate a balloon on a test tube using similar substances. Will one of the four white compounds that you brought with you do the job? Atomic tokens help students gather information about each compound. Can students correctly predict which compound will inflate a balloon? Your demonstration reveals the answer. Finally, celebrate students' success learning chemistry with self-inflating balloons for all.

How many students does this kit serve?

This reusable kit is designed for up to 24 students working in groups of three. It includes one self-inflating balloon and one information card for each participating student to bring home.

How many times can I reuse this kit?

By replacing the consumable items, you can use this kit indefinitely. If you plan to present this lesson to more than one class, order additional sets of 25 self-inflating balloons and cards. After one practice session and four presentations, you will also need to replace the chemicals, latex balloons, small rubber bands, and gloves. Find detailed instructions to help you replenish this kit on the inside back cover.

What is the self-inflating balloon made of?

The outside of the self-inflating balloon is made of aluminum deposited on a polyethylene film. Each balloon contains 3 g of baking soda and 5 mL of a 10% citric acid solution.

Do the balloons contain latex?

The self-inflating balloons for students do not contain latex. The balloons used in the demonstration, and handled by the presenter, do contain latex. The disposable gloves provided in the kit are latex-free.

Does the kit contain everything I need for my presentation?

The kit contains most of the items you will need. Supply the following.

- Roll of paper towels, in the event of spills
- Plastic bag to collect waste and reusable items
- Pair of scissors
- Goggles for you
- Permanent marker
- Steel cookie sheet, if the classroom whiteboard is not magnetic
- Photocopies of the student worksheet and survey, from pages 20 and 22

Plan your visit

Familiarize yourself with this lesson by reviewing this presenter guide and viewing the videos and tips that accompany this kit at **acs.org/kidsandchemistry**. Then practice the hands-on activity and demo yourself. If possible, present the lesson to a child or two to get a sense of the pacing and the developmental level of the students.

What will students learn?

Specifically, this lesson addresses the following key concepts, which are commonly taught at either the fifth- or sixth-grade levels and again in eighth grade. The school you visit may be different, as every state has its own standards, and school districts tailor these further to serve their local community.

Key concepts

- In a chemical reaction, the atoms in the substances you mix together rearrange to form different groups of atoms.
- You can only make CO_2 in a chemical reaction if you start with the atoms you need in the substances you mix together.
- A chemical equation is a summary of what happens in a chemical reaction.

Understandings about chemists and chemistry

- Chemists ask, investigate, and answer questions.
- Chemists use models to predict what will happen in a chemical reaction.
- Kids can learn and do chemistry.

By the end of their time with you, students will know how self-inflating balloons work, along with some big ideas in chemistry. Best of all, these students will have had a wonderful experience learning chemistry!

Safety recommendations

- Review the hazard information for citric acid, magnesium sulfate, sodium bicarbonate, sodium chloride, and calcium carbonate on pages 23 and 24 of this guide.
- You must wear goggles when indicated. Students do not need to wear goggles as they will use atomic tokens and experience a chemical reaction sealed inside a self-inflating balloon.
- Take all waste from the activity out of the classroom and school.
- Distribute the information cards along with the balloons to inform parents and guardians about the contents of the balloon.
- The presenter, teacher, and students must wash hands after handling the components used in the demonstrations and after inflating the balloons.

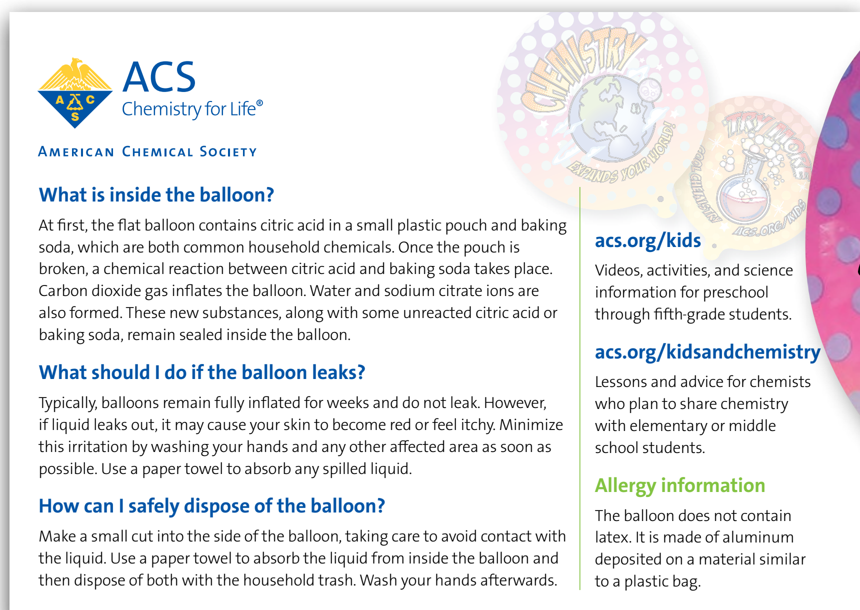
Meet with the teacher

As you make plans, be sure to communicate with the teacher. Send an e-mail containing the link to the video summarizing the lesson at **acs.org/kidsandchemistry**. By letting the teacher know what to expect, you will help him or her connect your lesson to previous learning and help facilitate the lesson.

Also ask for assistance with the following to best utilize the short time you will have with the students:

- Seat students in groups of 3 with a common workspace. This kit contains supplies for up to 8 student groups.
- Provide an area where you can place and conduct the demonstrations so that all students can see.
- Help distribute the materials to every student group efficiently. (The teacher likely has an established routine for this.)
- Provide a space on the white board where you can write a few things and attach small magnetic items called atomic tokens.

Tell the teacher that you will give students a balloon and an information card to take home. The teacher may want to have students place their inflated balloons in their backpacks immediately after you leave. Another option is for teachers to collect the balloons in a large plastic bag or bin and then return the balloons at the end of the school day. Either way, it may be a good idea to have students write their names on their balloons using permanent marker.



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What is inside the balloon?

At first, the flat balloon contains citric acid in a small plastic pouch and baking soda, which are both common household chemicals. Once the pouch is broken, a chemical reaction between citric acid and baking soda takes place. Carbon dioxide gas inflates the balloon. Water and sodium citrate ions are also formed. These new substances, along with some unreacted citric acid or baking soda, remain sealed inside the balloon.

What should I do if the balloon leaks?

Typically, balloons remain fully inflated for weeks and do not leak. However, if liquid leaks out, it may cause your skin to become red or feel itchy. Minimize this irritation by washing your hands and any other affected area as soon as possible. Use a paper towel to absorb any spilled liquid.

How can I safely dispose of the balloon?

Make a small cut into the side of the balloon, taking care to avoid contact with the liquid. Use a paper towel to absorb the liquid from inside the balloon and then dispose of both with the household trash. Wash your hands afterwards.

acs.org/kids

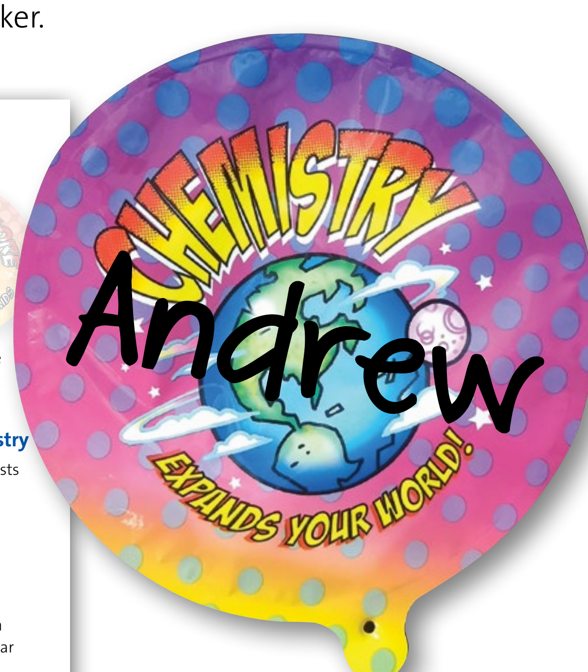
Videos, activities, and science information for preschool through fifth-grade students.

acs.org/kidsandchemistry

Lessons and advice for chemists who plan to share chemistry with elementary or middle school students.

Allergy information

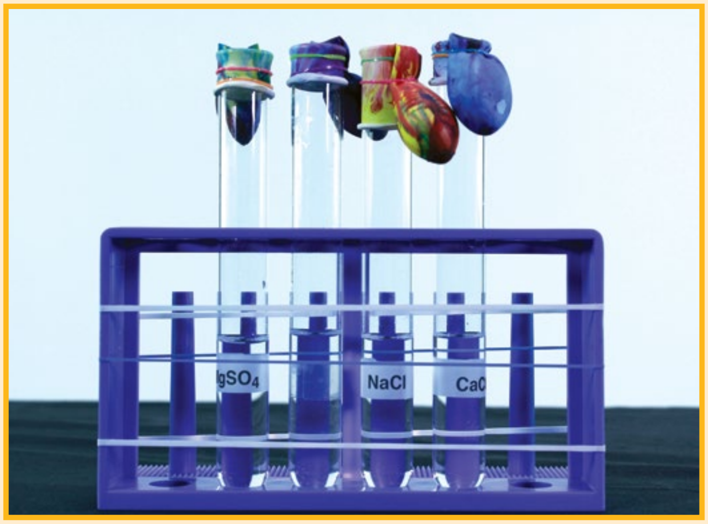
The balloon does not contain latex. It is made of aluminum deposited on a material similar to a plastic bag.



Prepare the demonstration

Set the demonstration up before meeting students. The plastic rack, complete with test tubes, citric acid, powders, and balloons, can be set up a day in advance. It travels well, as long as it is kept upright.

You will need



- Goggles
- Test tube rack
- 5 glass test tubes, 18 x 150 mm
- 5 small latex balloons
- 2 or 3 medium-sized rubber bands
- 8 small rubber bands
- Small scoop, 5 mL
- Powder funnel
- Medicine cup
- Bottle for citric acid solution
- Water
- Citric acid powder
- Magnesium sulfate
- Sodium bicarbonate
- Sodium chloride
- Calcium carbonate

Procedure

1. Stretch two or three rubber bands horizontally across the test tube rack.
2. Label each of four test tubes **$MgSO_4$**, **$NaHCO_3$**, **NaCl**, and **$CaCO_3$**. Place these in the rack in this order. Leave the fifth test tube unlabeled, as this will be the one you show students throughout the lesson.
3. Use the powder funnel to place 2 level scoops of citric acid powder in the bottle for the citric acid solution.
4. Remove the powder funnel and add water to the bottle up to the black line.
5. Secure the lid on the bottle and shake it until the citric acid dissolves.
6. Use the medicine cup to measure 10 mL of citric acid solution. Pour all 10 mL into one of the labeled test tubes. Do the same for the 3 remaining labeled test tubes. Leave the unlabeled test tube empty.

7. Stretch the neck of a balloon over the narrow end of the powder funnel. Pour 1 level scoop of one powder into the funnel and balloon. Make sure all of the powder goes into the rounded portion of the balloon. Carefully remove the balloon from the funnel. Place one small rubber band over the neck of the balloon.
8. Stretch the opening of the balloon over its labeled test tube. Use caution so that the powder remains inside the rounded portion of the balloon. Position the small rubber band so that it rests just under the lip of the test tube.
9. Use another small rubber band to hold the rounded portion of the balloon down, as shown.
10. Do the same for the remaining 3 compounds and labeled test tubes. Stretch an empty balloon over the top of the unlabeled test tube.

Prepare the student activity

Make one double-sided copy of pages 20 and 22 for each student.

During the lesson, students will use the side titled Student Worksheet. After your presentation, have students flip the page over to complete the Student Survey. Collect these so that both you and the teacher can evaluate student learning and attitude as a result of your short visit.

Prepare one activity tray for each group of two or three students.

Set up the trays before you get to the school. Stack them and bring them with you ready-to-go.

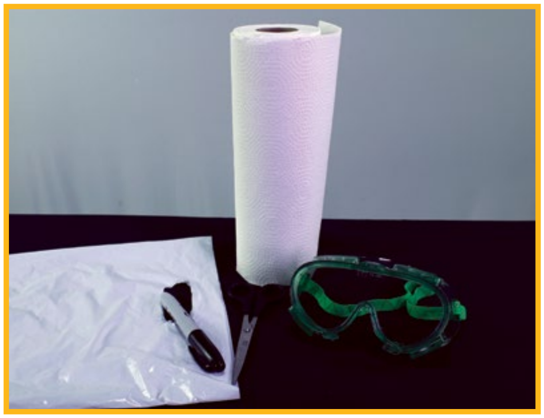
- **One set of 12 cards**
- **One set of atomic tokens**
  - 4 red tokens
  - 3 white tokens
  - 3 green tokens
  - 1 black token
  - 1 yellow token
  - 1 purple token
  - 1 blue token
  - 1 orange token

Gather the instructor's set of tokens and cards.

You will need the same number and color of tokens each student group receives. Each atomic token for the presenter has an adhesive magnet on the back. This will help you show students how to interact with the atomic tokens in the activity. Classroom white boards are often magnetic.

Supply the following items:

- Paper towels in the event of spills
- Plastic bag(s) to collect used items and waste
- One pair of scissors
- One pair of goggles for you to wear as indicated in the lesson
- One steel cookie sheet in the event that the white board in the classroom is not magnetic
- One or more permanent markers



Present the lesson to students

1. Introduce yourself, chemistry, and the term *chemical reaction*.

Tell students your name, where you work, and very simply what you do.

Explain that you are a type of scientist called a chemist. Chemists study what *everything* in the universe is made of down to its tiniest parts, atoms and molecules.

Knowing about atoms and molecules helps chemists predict what will happen when different substances are combined. When substances mix and make new substances, it's called a chemical reaction. I brought an example of a chemical reaction to show you.

Create interest: Inflate one balloon and cut another open

2. Introduce the self-inflating balloon.

Show students one flat self-inflating balloon. Explain that this balloon is special because instead of blowing it up from the outside, it blows itself up from the inside.

You will need

- Flat self-inflating balloon

  Ask the teacher to inflate the balloon by placing the balloon on the desk and pressing down on the bag of liquid as hard as they can with the heel of their hand.

  Expected results: The balloon will inflate slowly. It takes approximately 10 minutes to inflate completely. Do not wait for the balloon to inflate at this point. You will check back on it later in the lesson (page 10).

Ask students

- **How could we find out how this balloon works?** Kids will likely say "cut it open!" Act a little shocked by the suggestion, but then agree to do it modeling safe practices as described in the procedure on the next page.

3. Cut open a self-inflating balloon to find out what is inside.

Question to investigate

What is inside a self-inflating balloon?

You will need

- Flat self-inflating balloon
- Scissors
- Goggles
- Gloves
- 2 small clear plastic cups

Procedure

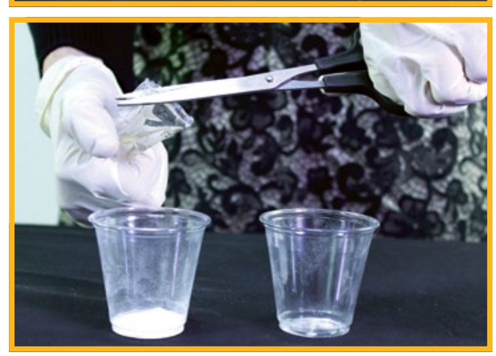
1. Put on your goggles and gloves.
2. Use scissors to cut the balloon open and remove the little pouch of liquid.
3. Hold the pouch up for students to see. Tell students the liquid is an acid, probably citric acid, because it is safe and inexpensive.
4. Place the pouch of citric acid in a clear plastic cup.
5. Pour the white powder from inside the balloon into the other small clear plastic cup.

Note: Do not reveal the identity of this white powder yet! Solving this mystery together is the focus of the lesson.

Ask students

- **What do you think happened to the pouch filled with citric acid when your teacher pressed down on it?** It broke, and the liquid leaked out and into the inside of the balloon.

6. Cut a corner off the pouch of citric acid and pour the liquid into the cup.
7. Hold the cups up for students to see as you pour the citric acid into the cup with the white powder.



Expected results: Bubbles will form and pop in the cup. *Bubbles are a sign that a gas is being made. I have read that the gas inside these balloons is carbon dioxide, one of the gases in the air. It's a good choice to fill balloons because it's easy to make and not flammable.*

Check back on the inflating balloon to show students its progress.

There is definitely a chemical reaction happening inside of here. The atoms that make up the white powder and acid are rearranging to make different substances. One of these new substances is carbon dioxide gas. This gas inflates the balloon.

Place the cups and balloon aside. After your presentation, place a paper towel in the cup to absorb the liquid. Then place this in the bag you brought to carry your waste and reusable items out of the school. The paper towel may be disposed of with household or office trash. After your presentation, rinse the cups so they can be reused the next time you share this lesson with students.

4. Introduce the question students will investigate with you.

I would like to inflate a balloon on top of a test tube. Based on what we found inside the self-inflating balloon, I think we can figure out which chemicals to use.

I have a balloon, a test tube, citric acid, and four white powders that look like the one we found inside the self-inflating balloon. Will any of these powders work? If so, which one?

The mystery I want you to help me answer is:

Which white powder will inflate a balloon on a test tube?

Develop the explanation: Use cards, trays, and atomic tokens

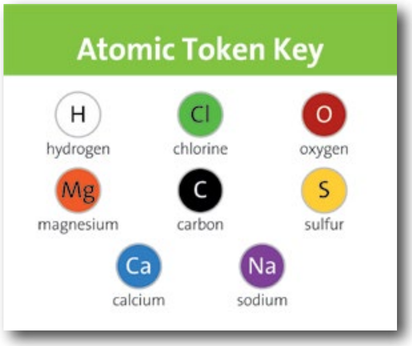
5. Introduce the atomic tokens.

Ask students:

- **We looked inside a self-inflating balloon to learn about how it works. Next, we need to look inside each of the four white powders to find out which atoms each is made of. This poses a problem, though: Can we see atoms?**

No, atoms are too small to see. Not even a microscope will help us see them.

Tell students that in chemistry, we use things we can see to represent things that we can't. Place a few different tokens with the magnetic backing on the board and explain that we are going to use these atomic tokens to represent atoms.



- **Why do you think I have different colors of atomic tokens?**
  Each color represents a different kind of atom.

Show students the atomic token key.

6. Ask the teacher to help you distribute the supplies to student groups and have students prepare their workspaces.

Each student will need:

- Worksheet and survey, copied from pages 20 and 22
- Pencil or pen

Each group will need:

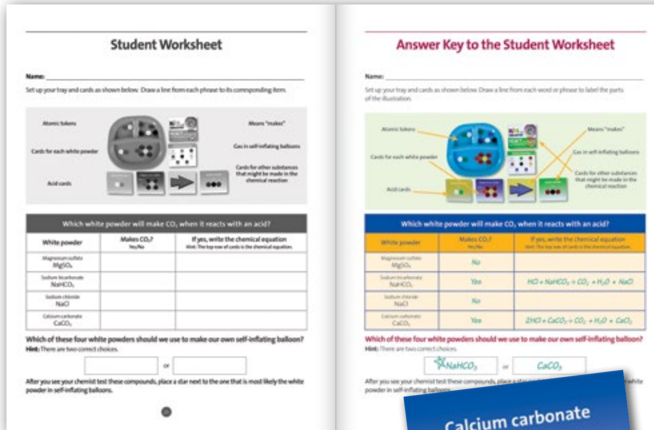
- One divided tray
- One set of 12 cards
- One set of 15 atomic tokens

Place the cards and tokens on the trays before meeting students.

See page 7 for preparation instructions.

When you receive your tray, arrange the cards as shown on your worksheet.

7. Help students arrange their cards in order and understand what each represents.



*A chemical equation is a summary of what happens during a chemical reaction. The cards to the left of the arrow show the substances that are mixed together. The arrow means **make**. And the cards to the right of the arrow show what is made in the chemical reaction.*

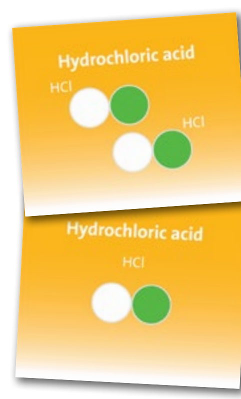
Have students look at the top portion of their worksheet and draw a line from each phrase to the corresponding item.

Let's start with the four *BLUE* cards.

The blue cards show the types of atoms that make up each of the four white powders that I brought with me. Put your cards in the following order. Magnesium sulfate goes on the very top of the stack, then behind it place sodium bicarbonate, then sodium chloride, and finally calcium carbonate on the bottom of the stack.

Note: For simplicity, this activity uses hydrochloric acid rather than citric acid. This is because citric acid ($C_6H_8O_7$), and the citrate ion ($C_6H_5O_7^{-3}$) contain the atoms needed to make carbon dioxide. At this level, this could cause some confusion.

The *YELLOW* cards show the atoms in an acid.



Citric acid, which is the kind of acid I brought with me, is made up of 21 atoms! Different acids will work similarly in this chemical reaction, so we are going to use a simpler acid. It's made up of only 2 atoms and is called hydrochloric acid. Make sure you have the card on top that shows just one white circle and one green circle.

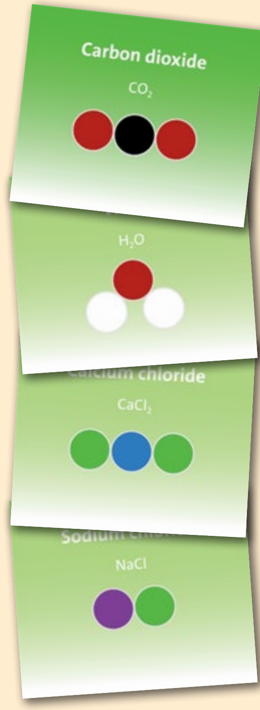
Ask students:

- **Look at your atomic token key. Which two kinds of atoms make up hydrochloric acid? How do you know?** Hydrochloric acid is made up of hydrogen and chlorine atoms. The key says that the white circle represents hydrogen and the green circle represents chlorine.

Look at the row of three cards. These are the start of a chemical equation. You can read it like this: "Magnesium sulfate and hydrochloric acid make …?"

- **What is the name of the gas we hope will be made when these two compounds mix?** Carbon dioxide.

- **Which atoms make up carbon dioxide?**
  The black circle means one carbon atom, and the two red circles mean two oxygen atoms.



The *GREEN* cards show what is made in the chemical reaction.

The dark green card shows our goal for the chemical reaction—to make carbon dioxide gas. This is important because this is the gas that fills store-bought self-inflating balloons.

If we can make carbon dioxide gas, we might have enough atoms left on the tray to make other substances, too. Three light-green cards are turned over next to your tray. If you can make carbon dioxide in a chemical reaction, look through the light-green cards to see what else you can make.

Show the empty test tube again. Remind students that you want to find out, “Which white powder will inflate a balloon on a test tube?”

I want to know which white powder (blue card) I should put in the balloon. I’ll put an acid (yellow card) in the test tube. Then when I tip the balloon up, the powder will fall down into the acid. If we chose wisely, the balloon will inflate with carbon dioxide gas (dark-green card).

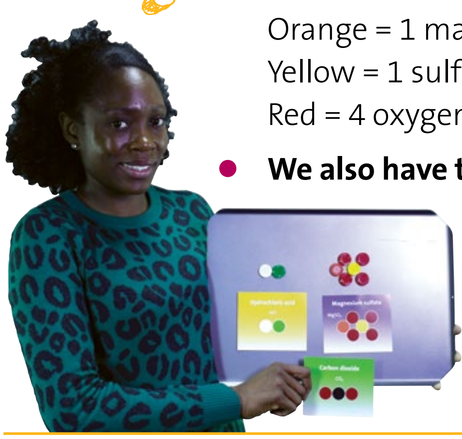
8. Use atomic tokens to model what happens as each white powder mixes with an acid.

Magnesium sulfate

Arrange your cards and magnetic tokens on a white board or a cookie sheet as shown.

Ask students:

- **What are the atoms that make up magnesium sulfate?**
  Orange = 1 magnesium atom
  Yellow = 1 sulfur atom
  Red = 4 oxygen atoms



- **We also have the atoms that make up hydrochloric acid in the tray. Look at all of the atoms in the large section of your tray. Do we have the atoms we need to make carbon dioxide gas?**
  No. We have the oxygen (red) we need, and some extra atoms, but we are missing one carbon (black) atom.

- **If we mix magnesium sulfate with an acid, will the balloon inflate?** No.

Which white powder will make CO_2 when it reacts with an acid?		
White powder	Makes CO_2? Yes/No	If yes, write the chemical equation Hint: The top row of cards is the chemical equation.
Magnesium sulfate $MgSO_4$	*No*	

Bring students' attention to the chart on the worksheet. Have them write "No" in the chart to answer the question "Makes CO_2?" for magnesium sulfate.

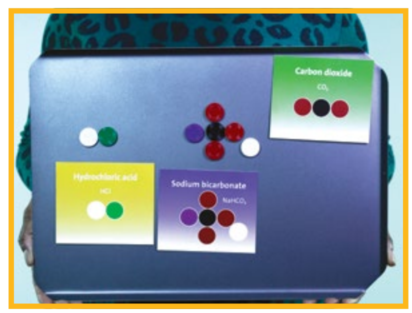
Then tell them to place their tokens back in the upper sections of their tray. The tokens for hydrochloric acid go in the upper-left section of the tray, and the tokens for the magnesium sulfate go in the upper-right section of the tray. Move the magnesium sulfate card to the bottom of the stack of blue cards.

Sodium bicarbonate

Use the cards as a reference to build sodium bicarbonate and hydrochloric acid in the large area on your tray.

Ask students:

- **What are the atoms that make up sodium bicarbonate?**
  Purple = 1 sodium atom
  Black = 1 carbon atom
  Red = 3 oxygen atoms
  White = 1 hydrogen atom



- **Look at all of the atomic tokens in the large rectangular area in your tray. Do we have the atoms we need to make carbon dioxide gas?**
  Yes. We have one carbon (black) and two oxygen (red).
  There are extra atoms in the tray, too.

Move your tokens so that three are arranged like the circles on the card representing carbon dioxide. Move the carbon dioxide card just to the right of the arrow.

Return students' attention to the chart on the worksheet. Have them write "Yes" in the chart to answer the question "Makes CO_2?" for sodium bicarbonate.

Which white powder will make CO_2 when it reacts with an acid?		
White powder	Makes CO_2? Yes/No	If yes, write the chemical equation Hint: The top row of cards is the chemical equation.
Magnesium sulfate $MgSO_4$	*No*	
Sodium bicarbonate $NaHCO_3$	*Yes*	$HCl + NaHCO_3 \rightarrow CO_2 + H_2O + NaCl$

The atoms that were not used to make carbon dioxide cannot be tossed away. They form other compounds. Look at the light-green cards and arrange your tokens to find out what else is made in this chemical reaction.

Ask students:

- **Which other compounds can we make?** Water and sodium chloride.

Place the cards showing water and sodium chloride in the row next to the carbon dioxide card. This row of cards is the chemical equation. It is a summary of what happens in the chemical reaction.

Have students write the full chemical equation on their worksheet, using the cards arranged along the top row as a guide. Encourage students to use the chemical formulas written on the cards rather than the full name of each compound. Also tell them to use plus signs between compounds.

White powder	Makes CO_2? Yes/No	If yes, write the chemical equation Hint: The top row of cards is the chemical equation.
Magnesium sulfate $MgSO_4$	*No*	
Sodium bicarbonate $NaHCO_3$	*Yes*	$HCl + NaHCO_3 \rightarrow CO_2 + H_2O + NaCl$

Ask students:

- **If we mix sodium bicarbonate with an acid, will the balloon inflate?** Yes.
- **After the chemical reaction, is the sodium bicarbonate still there?** No, but the atoms that made it are grouped together differently.
- **Would it be better to call what happened with the atoms disappearing-and-appearing or rearranging?** Rearranging.

We did not make new atoms or lose atoms. The atoms are arranged in different groups, and these new groups are different compounds. This is an important thing to know about chemical reactions:

Atoms rearrange to form different groups of atoms.
These new groups are different compounds.

Place your tokens back in the upper sections of your tray, and place the sodium bicarbonate card on the bottom of the stack of blue cards. Turn over the light-green cards. Keep the carbon dioxide card next to the arrow.

Sodium chloride

Use the cards as a reference to build sodium chloride and hydrochloric acid in the large section of your tray.

Ask students:

- **Look at all of the atomic tokens in the large section of your tray. Do we have the atoms we need to make carbon dioxide?** No.
- **If we mix sodium chloride with an acid will the balloon inflate?** No.

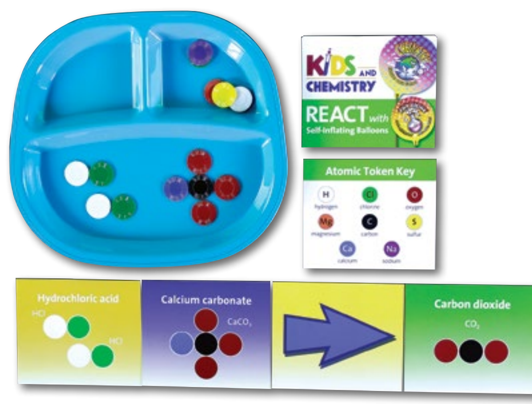
Place your tokens back in the upper sections of your tray, and place the sodium chloride card at the bottom of the stack of blue cards.

Sodium bicarbonate $NaHCO_3$	*Yes*	$HCl + NaHCO_3 \rightarrow CO_2 + H_2O + NaCl$
Sodium chloride NaCl	*No*	

Return students' attention to the chart on the worksheet. Have them write "No" in the chart to answer the question "Makes CO_2?" for sodium chloride. Then tell them to place their tokens back in the upper sections of their tray and move the sodium chloride card to the bottom of the stack of blue cards.

Calcium carbonate

For this one, let's switch to the other acid card, which shows two pairs of hydrochloric acid atoms. Now use your blue card and this yellow card as a reference to build calcium carbonate and hydrochloric acid in the large section of your tray.



Ask students:

- **Look at all of the atomic tokens in the large section of your tray. Do we have the atoms we need to make carbon dioxide?** Yes.
- **Look at the light-green cards and move your tokens to see what else is made in this chemical reaction. Besides carbon dioxide, what other compounds can we make?** We can make water and calcium chloride.
- **If we mix calcium carbonate with acid in a test tube, will the balloon inflate?** Yes.

Place the cards showing water and calcium chloride in a row next to the carbon dioxide card. Here we have the chemical equation. Write the full chemical equation in your chart.

Explain that students should write 2HCl for the acid because they used the atoms in two units of HCl.

Sodium chloride NaCl	*No*	
Calcium carbonate $CaCO_3$	*Yes*	*$2HCl + CaCO_3 \rightarrow CO_2 + H_2O + CaCl_2$*

Raise the stakes: Students choose the winning compounds

Have students write their recommendation for the white powder that would inflate a balloon on a test tube. Let them know that there are two possible correct choices.

As students finish up, have them put all of the tokens back in the upper sections of their tray. Then they should collect all of the cards and place them in the large section of the tray.

I have the compounds that the atomic tokens represent already set up in balloons. The test tubes contain citric acid. Do you think you could correctly predict which balloons will inflate?

Show students the test tube rack you prepared before your presentation. Point out that each white powder is in the round part of each balloon. Citric acid is the acid in each test tube.

Reveal the truth: Combine each compound with citric acid

9. Combine each white powder with citric acid so that students can see whether or not their predictions are correct.

Question to investigate

Which powder will inflate the balloon?

You will need

- Goggles
- Prepared test tubes and rack

Note: The preparation instructions for the citric acid, test tubes, and balloons are on pages 5 and 6. Complete this before you meet the students. This demonstration will travel well provided the test tubes remain upright.

Procedure

1. Lift the test tube and balloon containing magnesium sulfate out of the rack and hold it up for all students to see.
2. Ask students: *Will magnesium sulfate react with citric acid to make the CO_2 we need to inflate the balloon?*
3. While securely holding the neck of the balloon onto the test tube with one hand, use your other hand to lift the balloon. One rubber band will pop off, while the other should remain just under the lip of the test tube. You may need to shake the balloon gently so that all the powder falls into the citric acid.
4. Follow steps one through three for each of the three remaining balloon-covered test tubes. Be sure to hold the neck of the balloon firmly on the test tube as two of the four balloons inflate and may launch off.

Expected results: Neither magnesium sulfate nor sodium chloride will inflate the balloon. Calcium carbonate inflates the balloon partially, and sodium bicarbonate inflates the balloon fully.

Ask students:

- **Which white powder is likely the one that is inside self-inflating balloons like the kind I showed you earlier?**
  It could be either calcium carbonate, sodium bicarbonate, or some other compound we didn't test that has both carbon and oxygen atoms. However, sodium bicarbonate worked the best in the demonstration and is most likely the white powder in the balloon.

Which white powder will make CO_2 when it reacts with an acid?

White powder	Makes CO_2? Yes/No	If yes, write the chemical equation Hint: The top row of cards is the chemical equation.
Magnesium sulfate $MgSO_4$	*No*	
Sodium bicarbonate $NaHCO_3$	*Yes*	$HCl + NaHCO_3 \rightarrow CO_2 + H_2O + NaCl$
Sodium chloride $NaCl$	*No*	
Calcium carbonate $CaCO_3$	*Yes*	$2HCl + CaCO_3 \rightarrow CO_2 + H_2O + CaCl_2$

Ask students to flip their worksheets over and answer the questions on the Student Survey. Give them a couple of minutes to complete this.

Celebrate with a souvenir: Give each student a self-inflating balloon

10. Give each student a self-inflating balloon and inflate them together.

In exchange for the completed worksheet and survey, give each student one self-inflating balloon and one information card. Be sure to tell students that they must wait to activate their balloon until you indicate that it is time. This way the entire class can experience the chemical reaction together.

Note: If the teacher plans to collect balloons after your presentation and distribute them again at the end of the school day, have students write their name on their balloon with a permanent marker.

Stand up and place your balloon on your desk. Feel your balloon until you find the little pouch of citric acid. Place your hands one on top of the other.

Then, on the count of three, press down on the pouch to break it. One ... two ... three!

Tell students that as soon as the pouch breaks, they should give the balloon a little shake and hold it over one ear.

Note: If the children are approximately 9 years old or younger, have them place the balloon on the floor and step on it.

Ask students:

- **Do you hear the chemical reaction?** Yes. The sound of the bubbles of carbon dioxide gas as it is being produced is magnified when students hold the balloon to their ears.
- **Chemical reactions change temperature. Is the chemical reaction making the liquid feel warmer or cooler?** The liquid will feel cold.

Expected results: The balloon will inflate slowly. It takes approximately 10 minutes to inflate completely. The fizzing sound is a sign that the chemical reaction is still occurring. The balloons will remain fully inflated for about one month.

Note: Either you or the teacher may want to identify the bubbles, production of a gas, and change in temperature as clues that a chemical change is happening. *Clues of chemical change* is commonly taught in middle school.

Request the teacher's help in transitioning the class from the balloon chaos (which will ensue) into a calmer environment, especially if you would like to offer students an opportunity to ask questions about you and your career.

Proper disposal

After your presentation, leave the demonstration intact and bring it with you for proper disposal and cleaning later. At that time, pour the contents of the test tubes in a small plastic cup. Then add a paper towel to absorb the liquid. Dispose with the regular household trash. Rinse the test tubes with tap water.

Student Worksheet

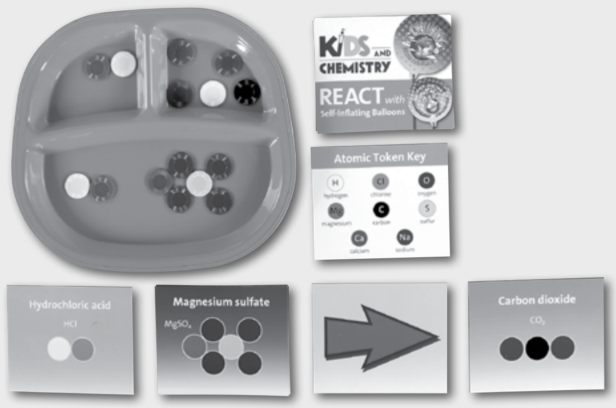
Name: ____

Set up your tray and cards as shown below. Draw a line from each phrase to its corresponding item.

Atomic tokens

Cards for each white powder

Acid cards



Means “makes”

Gas in self-inflating balloons

Cards for other substances that might be made in the chemical reaction

Which white powder will make CO_2 when it reacts with an acid?		
White powder	Makes CO_2? Yes/No	If yes, write the chemical equation Hint: The top row of cards is the chemical equation.
Magnesium sulfate $MgSO_4$		
Sodium bicarbonate $NaHCO_3$		
Sodium chloride $NaCl$		
Calcium carbonate $CaCO_3$		

Which of these four white powders should we use to make our own self-inflating balloon?

Hint: There are two correct choices.

	or	

After you see your chemist test these compounds, place a star next to the one that is most likely the white powder in self-inflating balloons.

Answer Key to the Student Worksheet

Name: ______________________________

Set up your tray and cards as shown below. Draw a line from each word or phrase to label the parts of the illustration.

Which white powder will make CO_2 when it reacts with an acid?

White powder	Makes CO_2? Yes/No	If yes, write the chemical equation Hint: The top row of cards is the chemical equation.
Magnesium sulfate $MgSO_4$	*No*	
Sodium bicarbonate $NaHCO_3$	*Yes*	$HCl + NaHCO_3 \rightarrow CO_2 + H_2O + NaCl$
Sodium chloride $NaCl$	*No*	
Calcium carbonate $CaCO_3$	*Yes*	$2HCl + CaCO_3 \rightarrow CO_2 + H_2O + CaCl_2$

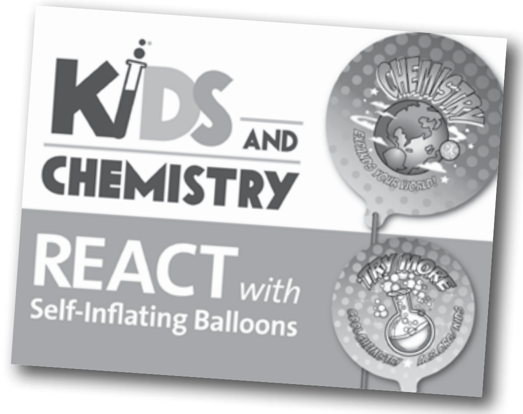
Which of these four white powders should we use to make our own self-inflating balloon?

Hint: There are two correct choices.

☆ $NaHCO_3$ or $CaCO_3$

After you see your chemist test these compounds, place a star next to the one that is most likely the white powder in self-inflating balloons.

Student Survey



Which gas inflated the self-inflating balloon shown at the start of the lesson?

a. sodium bicarbonate

b. oxygen

c. carbon dioxide

d. helium

What happens in a chemical reaction?

a. Substances mix and stay exactly the same.

b. Some atoms are taken away and new ones are added.

c. Atoms change color when they become different compounds.

d. Atoms rearrange to form different compounds.

Circle the emoji that represents your feelings for each of the following statements:

If I had the right atomic tokens and cards, I could figure out whether or not gym chalk ($MgCO_3$) makes CO_2 when it mixes with an acid.

1 2 3 4 5

I learned enough today that I can tell my family how self-inflating balloons work.

1 2 3 4 5

This emoji represents how I feel about my experience learning chemistry today.

1 2 3 4 5

Hazard information

In addition to following the safety recommendations in this guide, prudent laboratory practices must also be observed.

Magnesium sulfate

Health hazards
May be a slight skin and eye irritant.

Physical data
White crystals, soluble in water

Reactivity: Stable

Materials and conditions to avoid

Fire hazards
Not flammable

Chemical name and synonyms
Magnesium sulfate, Epsom salt

Formula $MgSO_4$

Unit size 30 grams

CAS Number 7487-88-9

Spills and leaks and disposal method
Sweep up and flush down the drain with a large amount of water.

Special precautions
None needed. Prudent laboratory practices should be observed.

First aid
Wash with water. Eye contact: Wash with water for 15 minutes.

Sodium chloride

Health hazards
May be a slight skin and eye irritant.

Physical data
White crystals, soluble in water

Reactivity: Stable

Materials and Conditions to avoid

Fire hazards
Not flammable

Chemical name and synonyms
Sodium chloride, table salt

Formula $NaCl$

Unit size 30 grams

CAS Number 7647-14-5

Spills and leaks and disposal method
Sweep up and flush down the drain with a large amount of water.

Special precautions
None needed. Prudent laboratory practices should be observed.

First aid
Wash with water. Eye contact: Wash with water for 15 minutes.

Calcium carbonate

Health hazards
Warning: Serious eye irritant.

Physical data
White powder, soluble in water

Reactivity: Stable

Materials and conditions to avoid

Reacts with acids, releasing carbon dioxide gas

Fire hazards
Not flammable

Chemical name and synonyms
Calcium carbonate, chalk, limestone

Formula $CaCO_3$

Unit size 30 grams

CAS Number 471-34-1

Spills and leaks and disposal method
Sweep up and flush down the drain with a large amount of water.

Special precautions
Wear eye protection. Prudent laboratory practices should be observed.

First aid
Wash with water. Eye contact: Wash with water for 15 minutes. Contact a physician.

Hazard information (cont.)

In addition to following the safety recommendations in this guide, prudent laboratory practices must also be observed.

Sodium bicarbonate

Health hazards
Considered non-hazardous

Physical data
White powder, soluble in water

Reactivity: Stable

Materials and conditions to avoid

Acids cause decomposition releasing a gas, carbon dioxide.

Fire hazards
Not flammable

Chemical name and synonyms
Sodium bicarbonate, baking soda, sodium hydrogen carbonate

Formula $NaHCO_3$

Unit size 30 grams

CAS Number 144-55-8

Spills and leaks and disposal method
Sweep up and place in trash. Wash residue with water.

Special precautions
None needed. Prudent laboratory practices should be observed.

First aid
Wash with large amounts of water. Eye contact: Wash with water for 15 minutes.

Citric acid

Health hazards
Warning: Skin and eye irritant

Physical data
White crystals

Reactivity: Stable

Materials and conditions to avoid

Strong oxidizing agents, reducing agents, and bases. Keep container covered, will absorb moisture.

Fire hazards
Slightly flammable near an open flame.

Chemical name and synonyms
Citric acid anhydrous

Formula $C_6H_8O_7$

Unit size 60 grams

CAS Number 77-92-9

Spills and leaks and disposal method
Sweep up and place in trash. Wash residue with water.

Special precautions
None needed. Prudent laboratory practices should be observed.

First aid
Wash with large amounts of water. Eye contact: Wash with water for 15 minutes. See a physician.

Carbon dioxide

Health hazards
May be harmful if inhaled. High concentrations in the air cause a deficiency of oxygen with the risk of unconsciousness or death.

Physical data
Odorless, colorless gas

Reactivity: Stable under 2000 °C

Materials and conditions to avoid

Confined unventilated areas

Fire hazards
Not flammable

Chemical name and synonyms
Carbon dioxide, carbonic acid gas

Formula CO_2

Unit size
Produced in small quantities in the chemical reactions conducted in this lesson

CAS Number 124-38-9

Spills and leaks and disposal method
Ventilate the area.

Special precautions
No odor warning if toxic concentrations are present.

First aid
Fresh air, rest. Artificial respiration may be needed. Contact a physician.

Restore your kit

Students

8 sets of atomic token cards
- 4 white powders (blue)
- 4 products (green)
- 2 acid (yellow)
- 1 arrow
- 1 atomic token key

8 sets of atomic tokens
- 32 red for oxygen
- 24 white for hydrogen
- 24 green for chlorine
- 8 purple for sodium
- 8 black for carbon
- 8 yellow for sulfur
- 8 blue for calcium
- 8 orange for magnesium

25 self-inflating balloons
25 balloon information cards
8 divided trays

Presenter

Test tube rack
Magnesium sulfate
Sodium bicarbonate
Sodium chloride
Calcium carbonate
Citric acid
Bottle to mix and store solution
5 glass test tubes, 18 x 150 mm
4 test tube labels
2 self-inflating balloons
2 small clear plastic cups
1 scoop, 5 mL
1 medicine cup
1 powder funnel
1 bag of small latex balloons
24 small rubber bands
2 or 3 rubber bands
4 pairs of disposable gloves
1 set of atomic tokens with magnetic backing

Replenish consumables

Self-inflating balloons

Purchase additional self-inflating balloons from the American Chemical Society through **acs.org/store**. These balloons are sold in packs of 25 and come with 25 information cards for students to take home. You can also find self-inflating balloons at various discount stores. If you use balloons from anywhere other than ACS, make your own information sheets using the download from **acs.org/kidsandchemistry**.

Chemicals

Replenish the chemicals with their corresponding household product. Use Epsom salt for magnesium sulfate, baking soda for sodium bicarbonate, and table salt for sodium chloride. Calcium carbonate is a dietary supplement and citric acid is used in home canning of fruits and vegetables. Therefore, these compounds are available in powder form through various online outlets.

Small rubber bands

These are the same rubber bands used in hair. Find them wherever barrettes and hair ties are sold.

Balloons

Most small latex balloons will work. Test the balloons you plan to use as some tear easily when stretched over a test tube.

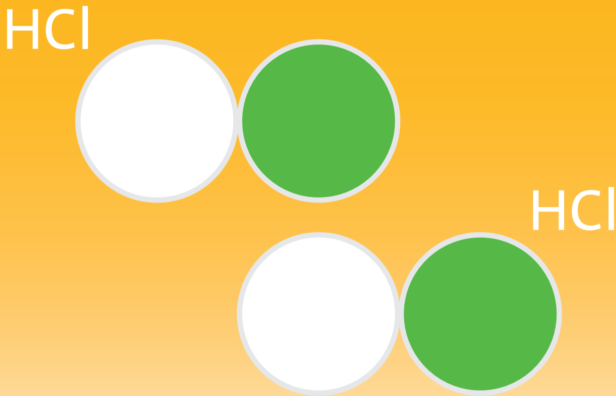
Disposable gloves

Form-fitting exam gloves are preferable to the looser food service gloves.

KIDS AND CHEMISTRY

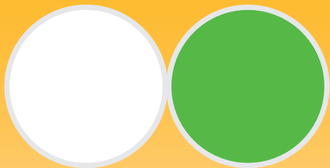
1155 16th Street, NW | Washington | DC 20036
www.acs.org/outreach

Hydrochloric acid



Hydrochloric acid

HCl

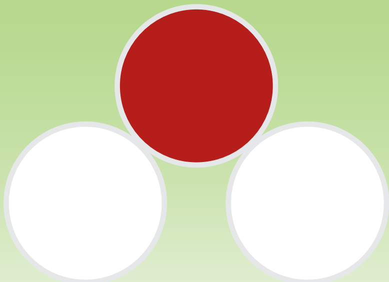


Carbon dioxide

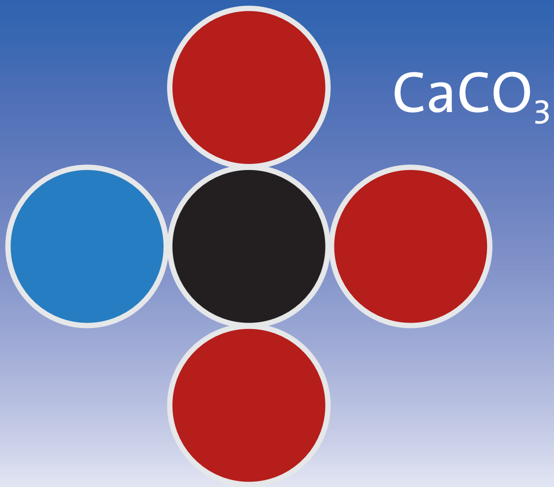
CO_2

Water

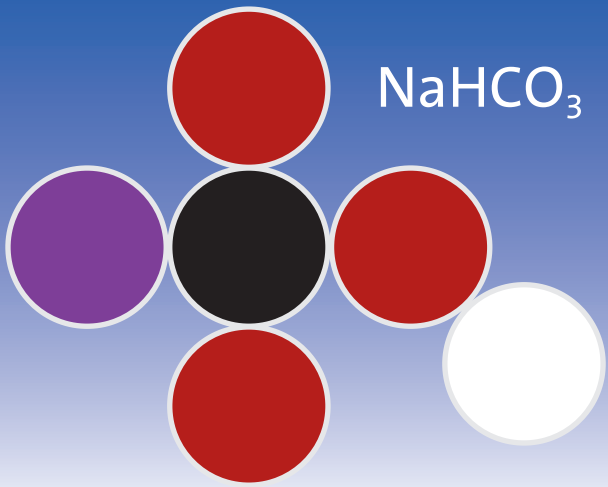
H_2O



Calcium carbonate

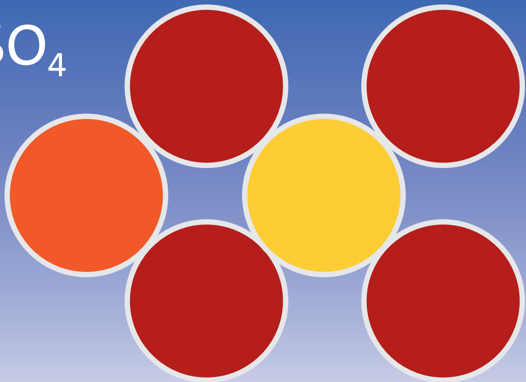


Sodium bicarbonate



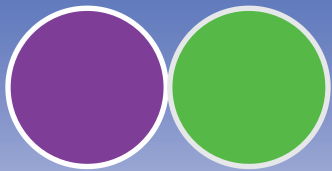
Magnesium sulfate

$MgSO_4$



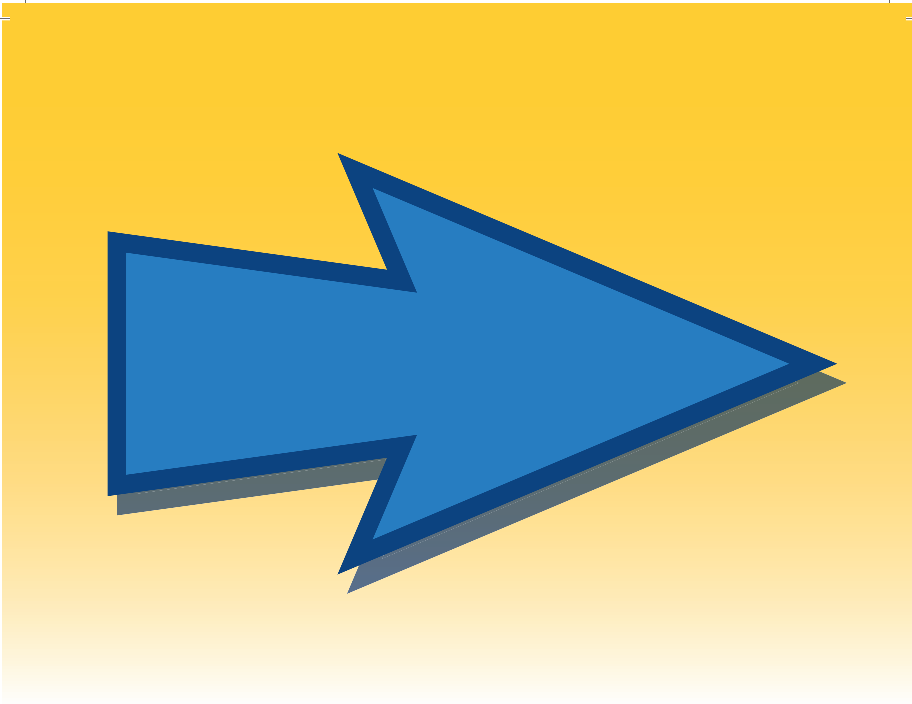
Sodium chloride

$NaCl$



Calcium chloride

$CaCl_2$



Atomic Token Key

H	hydrogen
Cl	chlorine
O	oxygen
Mg	magnesium
C	carbon
S	sulfur
Ca	calcium
Na	sodium