TEACHER'S GUIDE

JIGGLE GELS

EXPLORE PROPERTIES OF POLYMERS

Thanks for the opportunity to work with your students. Our goal is to teach developmentally appropriate chemistry concepts that support your science curriculum. We hope that this experience of doing hands-on activities and learning science from a real scientist will inspire your students to pursue further studies in science.

This lesson is part of the Kids & Chemistry program developed by the American Chemical Society (ACS) to support science professionals who want to share their love and knowledge of science with elementary and middle school students. As a group of volunteers, these science professionals are valuable community partners who serve individual classrooms, schools, museums, science resource centers, and departments of education. Kids & Chemistry volunteers are amazing people!

ACS is a professional organization for chemists. It is the world's largest scientific society and one of the world's leading sources of authoritative scientific information. The Society publishes numerous scientific journals and databases, convenes major research conferences, and provides educational, science policy, and career programs in chemistry.

ACS also produces resources for elementary and middle school teachers and students. Turn to the last page of this Teacher's Guide or visit *www.acs.org/education* to learn about these excellent resources. You can rely on ACS education resources to provide safe activities and accurate explanations that are just right for you and your students.

We wish you the best as you strive to educate your students. And we hope that our efforts help you and your students enjoy learning science.

Education Division Staff
American Chemical Society

What will happen?

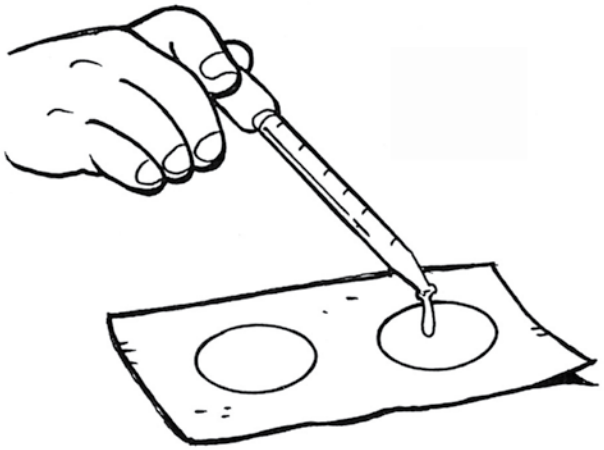
You agreed to have a guest speaker come into your classroom, and you wonder what your visiting scientist will do. Basically, the scientist will conduct an introductory demonstration and then guide students through a series of related hands-on activities. Each student will receive a Student Lab Guide that includes procedures, science information, a place to record data, and questions about the content. The following descriptions of the demonstrations and activities will give you an idea of what the presentation will be like.

The Dazzling Demo

The presenter pours water into one of three identical cups and then, as students watch closely, rearranges the cups. When students correctly guess which cup contains the water, the presenter holds the cup up and inverts it. Thanks to the polymer, sodium polyacrylate, which the presenter secretly placed in the bottom of the cup, the water does not spill out!

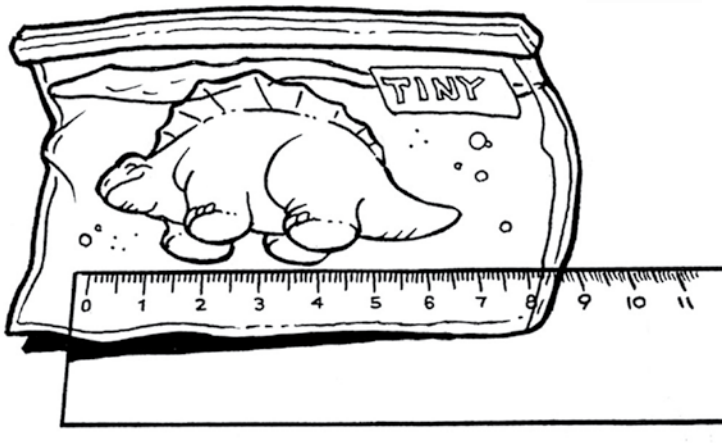
The Secret Science of Diapers

In this activity, students explore the absorbency of sodium polyacrylate, which is the powder found inside the lining of most disposable baby diapers. Students begin by adding drops of water to a plain paper towel. Then they add drops of water to a small pile of sodium polyacrylate to find that this polymer absorbs a great deal of water. After adding enough water to make an impressive gel, students add salt to see the polymer release a large amount of the water into the surrounding paper towel.



The Thirsty Dinosaur

Students measure a small dinosaur, made with another super-absorbing polymer, and then place it in water. After a couple of days, the dinosaur increases about six times in size. Plan to have students measure the dinosaur again anytime between one and seven days after the presenter visits your class. There is more information about how to complete this follow-up activity on pages 7–8 of this Teacher's Guide.



Super Slime

Working in pairs, one student slowly adds borax solution while the other stirs the polyvinyl alcohol (PVA) solution continuously. Students observe a dramatic change: The water-like liquid becomes thick and gooey slime! Students split the slime in two so that each student can observe the characteristic properties of slime as they play with it. Each student may take a piece of slime home.

The Grand Finale

The presenter concludes the lesson with a demonstration comparing the properties of a sheet of polyvinyl alcohol (PVA) to a common zip-closing plastic bag. Both plastics look alike and are used to make commercial plastic bags, but the way they interact with water is very different. PVA dissolves in water, while the plastic bag is so water-resistant that it can hold water even with a pencil pierced through it.

What will students learn?

The goal of this presentation is to support your science curriculum in a fun and special way. As your students do science with a real chemist, we hope they realize that they can do science, too.

Learning objectives

- Students will be able to identify characteristic properties of different materials as they observe a variety of physical changes.
- Students will be able to use a dropper to add single drops of a liquid.
- Students will gain experience measuring with a metric ruler (mm), beaker (mL), and graduated dropper (mL).

Vocabulary words

After completing this lesson, students will be very familiar with the following words. This lesson can be used to introduce or reinforce these words.

- Chemistry
- Property
- Polymer
- Absorb/Absorbent

Assessment

As students complete each procedure, they will answer questions about the activity in their own Student Lab Guide. You can check to see that students were on task by reviewing these pages. The last page of the Student Lab Guide provides a more summative assessment. Have students answer the five questions on this final page after the presenter leaves. This way you can evaluate how well each student understands the concepts presented during the lesson. The questions and answers are provided on the following page.

WHAT DID YOU LEARN?

What does the dinosaur in the picture have to do with the activities you did with your visiting scientist?

We placed a dinosaur in water in one of the activities. The dinosaur is wearing a diaper, using goggles, and playing with slime because we explored the polymer inside diapers, wore goggles to protect our eyes, and made slime.

What is the secret that makes disposable baby diapers so absorbent?

The polymer sodium polyacrylate is found inside many diapers.

What changes do you observe when you add borax solution to PVA solution?

PVA solution starts out thin, but the borax makes it clump up and stick to the Popsicle stick.

List two things that are made of polymers.

Students may select any two of the following: baby diapers, Gro Dinosaurs, slime, plastic bags, balls, rubber, glue, clothing, turtle shells, feathers, skin, or hair. They may also select other items that the presenter told them about.

Name one amazing property of a polymer that you explored with your visiting scientist.

Students may say that polymers can absorb water, dissolve in water, or hold water. Some polymers can get bigger or stretch. Other polymers can connect with special chemicals to become thick and flexible. Students should select one property that they explored with the presenter.

How can I help?

Please stay involved every step of the way. The presenter needs your help to make this lesson go smoothly and ensure that your students learn as much as possible from this experience.

To ensure a successful lesson, please do the following:

- Place students in groups of 3 or 4 around a shared workspace.
- Divide groups of 4 students into 2 sets of lab partners who will conduct activities together.
- Provide a space where the presenter can set up the demo immediately before the presentation.
- Provide access to water. Each group of 4 students will need about half a cup of water.
- Provide a space to store up to 16 snack-sized zip-closing plastic bags filled with water and a dinosaur toy for a couple of days after the lesson.
- Provide safety goggles for every student and yourself. (If you do not have goggles, contact your visiting scientist.)
- Review with students how to use a metric ruler to measure the length of an object to the nearest mm.
- Arrange to have all students wash their hands and desks after the lesson.
- Help with classroom management. You are an expert in this area, and the visiting scientist is not. Use each other's strengths to make this lesson a wonderful experience for everyone.

Prepare to send a piece of slime home with each student

The students will make enough slime so that each student has a piece to take home. In order to prevent a mess, the presenter will provide a small zip-closing plastic bag for each student. The slime may be safely stored in this sealed bag for weeks.

So that students are not distracted by their slime during the school day, you may choose to have students place their bags of slime in their backpacks right away. Another option is to have students write their names directly on the plastic bags with a permanent marker. Then collect the bags of slime. You can redistribute the slime when it's time to go home.

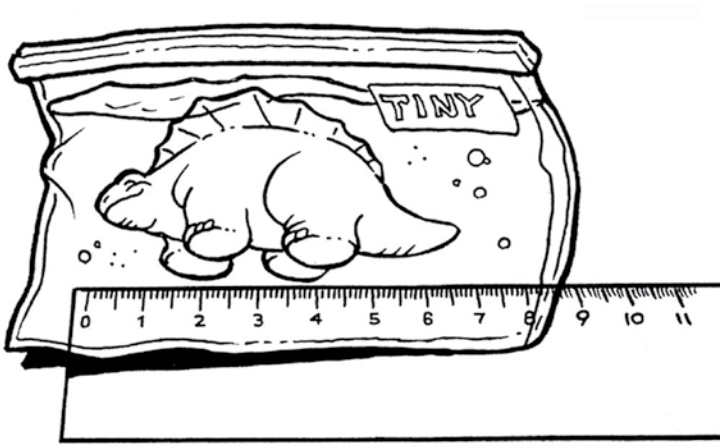
Before sending the slime home, be sure to warn students that slime must be kept away from pets and young children, especially those who place objects in their mouths. Slime also must be kept away from fabrics and carpets. If for any reason slime does get stuck in fabrics or carpets, it can usually be removed using warm soapy water.

Please complete *The Thirsty Dinosaur* activity

With the presenter, students measure a small dinosaur and place it in a zip-closing plastic bag with some water. This is only the beginning of the activity. The presenter cannot finish this activity with your students because it takes a couple of days for the dinosaur to reach its full size. Please help students complete this activity any time between one and seven days after the presenter's visit. This follow-up activity will probably take less than one class period.

Have students measure the dinosaur and answer the 4 questions on page 7 of the Student Lab Guide

1. Have a representative from each group get their dinosaur. In the event of a mix-up, remind students that they wrote the name of their dinosaur in their Student Lab Guide.



2. In order to prevent a mess, instruct students to keep their dinosaur and remaining water sealed in the bag as they measure the distance between the dinosaur's nose and tail.

3. Students should place the sealed bag directly over the ruler and measure the dinosaur to the nearest mm. Choose how you want students to record their measurements. For example, students may write that their dinosaur is 6 cm 8 mm, 6.8 cm, or 68 mm.

4. Have students answer the following questions:

- *Compare your dinosaur to your drawing on page 6. How did your dinosaur change?*
  The dinosaur is much bigger.

- *Leave the dinosaur sealed inside the bag as you place it on your ruler. Measure the distance between the dinosaur's nose and tail to the nearest millimeter. How long is your dinosaur?*
  Answers will vary but it isn't unusual for a dinosaur to go from about 45 mm to about 70 mm.

- *There is less water loose in the bag than there was when you first added the dinosaur. Where did the water go?*
  Some water is absorbed in the dinosaur.

- *Do you think your dinosaur would stay the same size, get bigger, or get smaller if you took it out of the water and left it out for a week?*
  The dinosaur will get smaller.

Clean-up

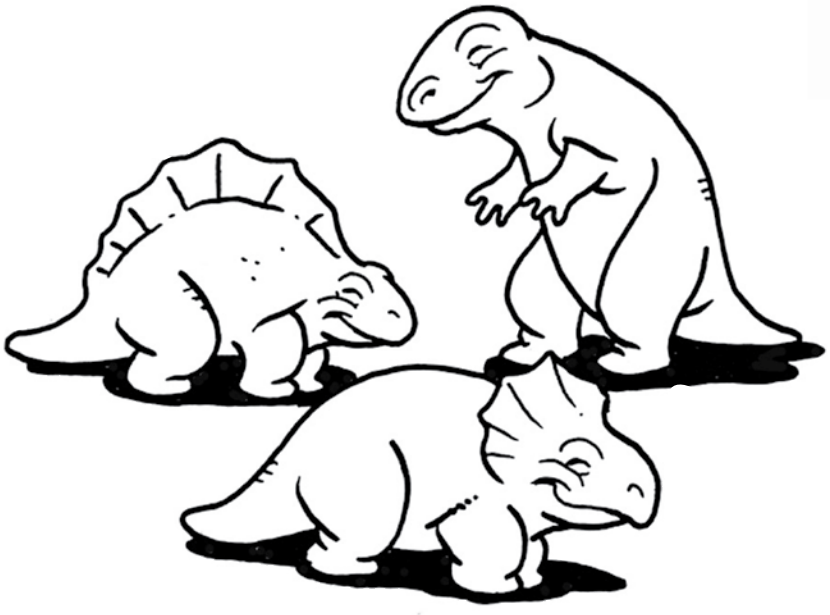
After students finish measuring their dinosaurs, you may remove the dinosaurs from the bags, dry them slightly with a paper towel, and allow them to dry over the next couple of weeks. As the water absorbed by the dinosaur evaporates, the dinosaurs will return to nearly their original size. The dinosaurs can be placed in water and dried over and over. When you are finished with the dinosaurs, they may be disposed of with the regular classroom or household trash.

The bag and remaining water may be disposed of with the regular classroom trash, too. We recommend that you do not pour the remaining water down the sink because it contains some of the super-absorbing polymer and may clog the sink. Another disposal option is to pour the remaining water outside or in the soil of some potted plants. The polymer will prevent water from evaporating as fast as normal and will eventually biodegrade. The super-absorbing polymer in the dinosaurs is sold by garden centers for this specific use.

Optional: Do More with Dinos

If your students are captivated by the Gro Dinosaurs, you may encourage them to conduct some related inquiry investigations. Students may want to investigate questions such as the following:

- How much water does the Gro Dinosaur absorb?
- Will a Gro Dinosaur shrink back to its original size if we take it out of the water? If so, how long will it take?
- Would a Gro Dinosaur grow faster in hot, cold, or room temperature water?
- What would happen if we sprinkle salt on a Gro Dinosaur that has already absorbed water?
- Would the Gro Dinosaur grow as much in salt water?



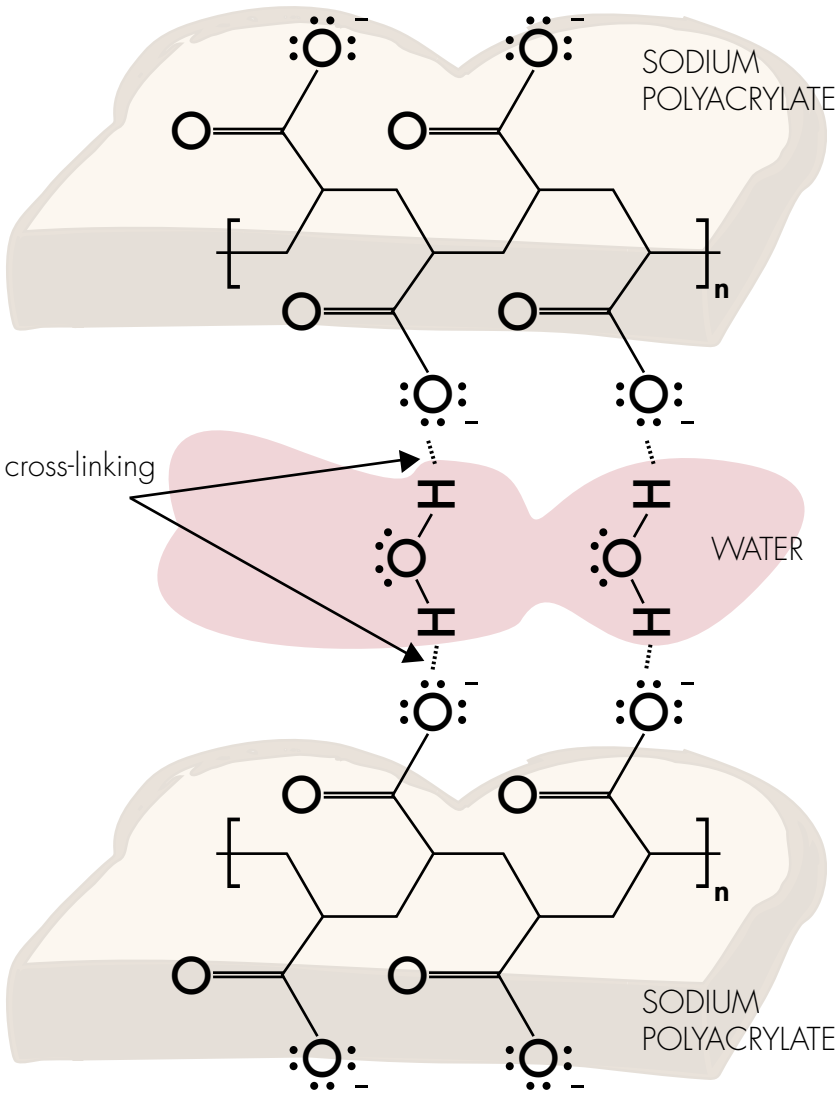
What if students ask a chemistry question after the presenter leaves?

You and your students may have some questions about the activities and the polymers you explored with your visiting chemist. This guide provides a little background to help you confidently answer these questions. Feel free to contact your visiting chemist or the message board at *www.inquiryinaction.org* with other questions. ACS Education Division staff moderate this message board.

It is important to note that these explanations are written for you, the teacher. They go above and beyond chemistry concepts taught at the elementary and middle school level. We understand that you know better than anyone how to properly convey these ideas to your curious students who want to learn more.

Why does the baby diaper polymer absorb water so well?

The baby diaper polymer, or sodium polyacrylate, absorbs water well because of its structure. All polymers are molecules that are made of small, repeating units that form long chains. In its dry crystal form, sodium polyacrylate is coiled. When water is added, the long chains of sodium polyacrylate stretch out. This happens because each repeating unit in sodium polyacrylate contains an area that can support a negative charge. When water is added to the polymer, these areas form negatively charged ions that repel one another and cause the polymer to stretch out. As the polymer stretches, more water molecules can associate with its areas of negative charge.



Also, because of water's unique shape, it is capable of associating with two polymer chains. For this reason, two polymer chains surround each layer of water molecules, with each row of water molecules forming a bridge between the two chains. Imagine the polymer–water complex as something of a molecular sandwich, where the polymer chains are the "bread" and the water molecules are the "jam." This ability of water to link between chains is called cross-linking, and it is what allows the polymer to absorb so much water.

Why does salt make the water leak out of the sodium polyacrylate?

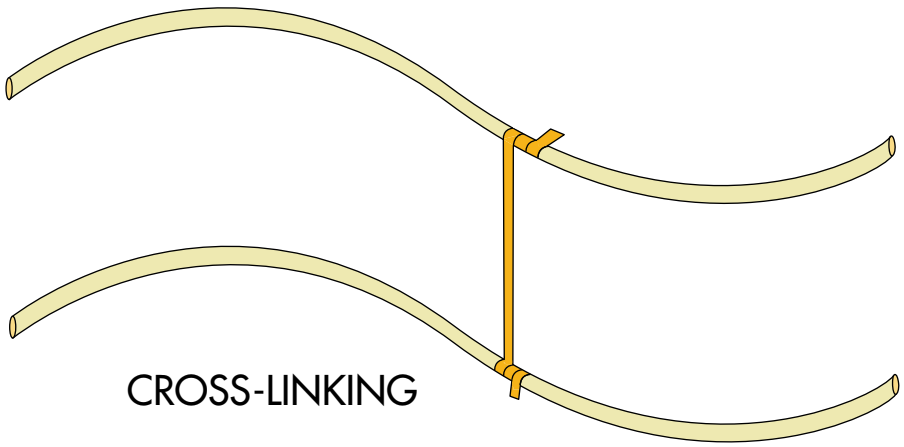
Salt causes water to leak out of the sodium polyacrylate because it disrupts the attraction between water and the polymer chain. When salt is added, it breaks up into negative and positive ions, which are also attracted to the water molecules. In fact, each ion attracts several water molecules to it. Eventually, when enough salt is added, the water molecules become more attracted to the ions than the polymer chains, and water leaks out of the mixture.

What is the Gro Dinosaur made out of?

The Gro Dinosaur is made of another kind of super-absorbent polymer, called polyacrylamide, and a starch. The starch helps the Gro Dinosaur to keep its shape while absorbing water, whereas polyacrylamide works like sodium polyacrylate by absorbing many times its own weight in water.

Why does the PVA solution clump up when borax is added?

The PVA solution clumps up when borax is added because borax crosslinks the PVA. Before the PVA solution is combined with borax, the polymer chains of PVA are stretched out, but also capable of moving around, like strands of spaghetti in a pot full of boiling pasta. Adding borax to this solution restricts the movement of the polymer by bonding to adjacent polymer chains, which prevents them from moving around freely. It is as though individual strands of spaghetti are connected in certain spots to other pieces of spaghetti. Because the polymer chains can no longer move freely, the solution clumps up, forming slime.



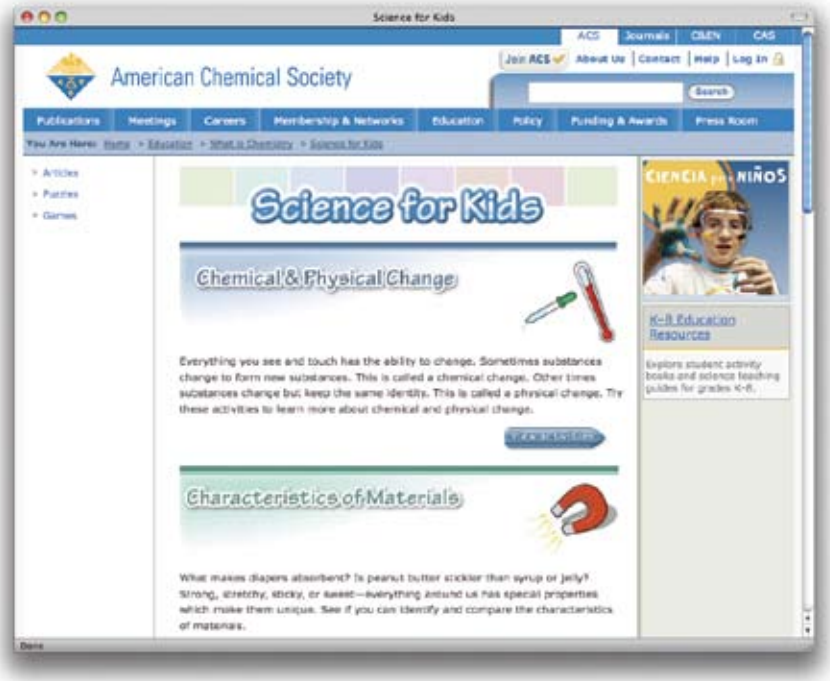
Why does PVA dissolve in water while LDPE doesn't?

Polyvinyl alcohol (PVA) dissolves readily in water because its molecular structure makes it attracted to water. Conversely, the other plastic used, called low-density polyethylene (LDPE), does not dissolve in water because its molecular structure makes it not attracted to water.

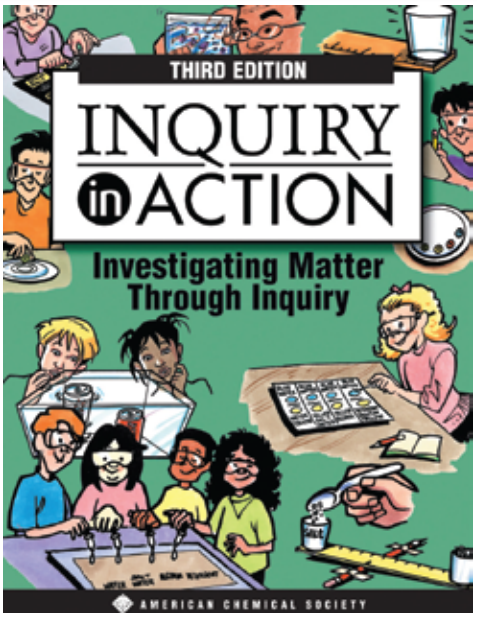
Does ACS produce materials for teachers?

The American Chemical Society produces resources specifically for teachers. Check out *www.acs.org/education* or e-mail us at *kids@acs.org* to find out more.

Science for Kids
This collection of hands-on activities, at *www.acs.org/kids*, uses common household materials and is organized by science topic to help you easily find activities that supplement your curriculum.



Inquiry in Action
Inquiry in Action is a book filled with hands-on activities, demonstrations, student activity sheets, and assessments. The activities use inexpensive household materials and address both physical science and inquiry content. The entire 480-page book can be downloaded at *www.inquiryinaction.org*. The website also includes explanations of the chemistry content along with helpful molecular model animations and a message board.



Books for Pre-K to 2
The book *Apples, Bubbles, and Crystals* features a poem and a science activity for each letter of the alphabet. *Sunlight, Skyscrapers, and Soda Pop* shows students that science is all around them as they spend a day with two cute characters and do hands-on activities with them.

The Best of WonderScience
Help your students better understand science concepts with this comprehensive collection of over 600 activities using household materials.

Kids & Chemistry
This program provides resources for chemists who volunteer to work with elementary and middle school students. But you certainly can do the activities the presenter did with your class with next year's students. Download the instructions from *www.acs.org/education*. Follow the Kids & Chemistry link to find the free PDF files for this and other Kids & Chemistry kits.

Thank you for participating in the Kids & Chemistry program!