PRESENTER'S GUIDE

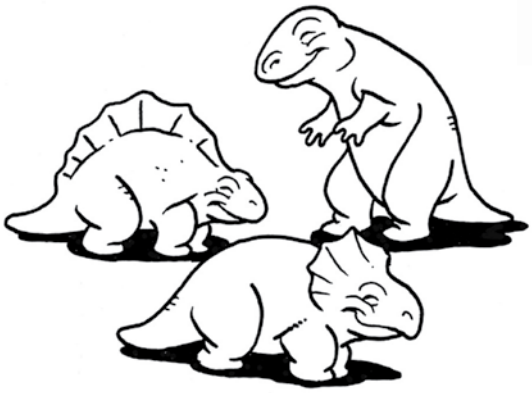
JIGGLE GELS

EXPLORE PROPERTIES OF POLYMERS

TABLE OF CONTENTS

PLAN FOR SUCCESS

Thank you for volunteering to share chemistry with students. They will definitely enjoy their time with you. Some will excitedly tell their parents all 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 definitely make an impact!



The teacher will appreciate your efforts, too. After all, your visit gives students the opportunity to learn chemistry concepts from a real chemist! In order to make your visit as beneficial as possible, give the teacher the Teacher's Guide included in this kit before your visit. Also be sure to discuss the information presented on these two pages with the teacher. Planning together will ensure that you, the teacher, and the students all have a wonderful experience.

Learning objectives

Teachers must make sure that their students have a variety of experiences covering concepts outlined by their district. So it is best if your lesson introduces, reinforces, or relates to one or more of these required concepts.

The teacher will be pleased to know that as a result of the Jiggle Gels lesson, students will meet the following learning objectives:

- Identify characteristic properties of different materials as they observe a variety of physical changes.
- Use a dropper to add single drops of a liquid.
- Measure using a metric ruler (mm), beaker (mL), and graduated dropper (mL).

Vocabulary words

After completing this lesson with you, students will be familiar with the following terms:

- Chemistry
- Property
- Polymer
- Absorb/Absorbent

Ask the teacher to…

- 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 you can set up the demo immediately before your presentation.
- Provide access to water before your presentation. Each group of 4 students will need about a half cup of water.
- Provide safety goggles for each student and adult. (You may need to help with this.)
- Arrange to have all students wash their hands and desks after your visit.

Safety plan

- Review the MSDSs (page 20) for sodium polyacrylate, sodium chloride, sodium borate, and polyvinyl alcohol.
- Let the teacher know that the activities in this kit have been reviewed by the ACS Committee on Chemical Safety.
- Students must wear safety goggles during the activities when indicated. They may take "goggle breaks" between activities but they should take care not to place their hands on their faces or in their mouths at this time.
- Take all waste with you so that students are not tempted to play with the materials in the trash can after you leave. The sodium polyacrylate and slime can be placed in the regular household, office, or lab trash. They should not go down a sink!
- Warn students that slime must be kept away from young children, pets, fabrics, and carpets.
- Tell the teacher that slime can be cleaned from carpets and fabrics using warm soapy water.

Bring

- Kit with all materials
- Sharpened pencil for the Grand Finale demonstration
- Bucket or plastic bag to collect waste
- Roll of paper towels

Most importantly… have fun! When students experience your enthusiasm for science, they can't help but enjoy science, too. After your presentation, please send a quick e-mail to the staff in the Kids & Chemistry Office at *kids@acs.org* to let us know what you did and how it went. We'd love to hear from you!

THE DAZZLING DEMO

1. Prepare for the activities and demonstration before you meet the students.

If possible, set this demonstration up immediately before your presentation. Be sure that students do not see what you are up to. They should think that you have three empty cups and a small amount of water.

Prepare for the activities

1. Fill 8 opaque plastic cups (9-ounce size) about halfway with water. These will be for the student groups to use in the activities.
2. Place labels that say PVA solution on 16 small clear plastic cups.
3. Pour 30 mL of PVA solution into each cup.

Prepare for the demonstration

1. Place 3 scoops of sodium polyacrylate into an opaque cup.
2. Arrange this cup, along with two identical empty cups, in a row.
3. Pour 30 mL of water into a beaker. Place this beaker near the 3 cups.
4. Hide the 3 clear plastic cups, sodium polyacrylate, and small scoop nearby.

2. Introduce yourself, chemistry, and the activity.

Introduce yourself and let students know that you like doing experiments, making discoveries, and solving problems. Tell students: *Chemistry* is the science that explores everything! Chemists figure out what everything is made of down to its tiniest bits. They study what makes different materials special, and then they make new useful materials that have certain characteristics. Today you will explore some amazing materials developed by chemists. One is so useful that it is used by movie-set designers, gardeners, firefighters, and babies! Today you will do chemistry!

Distribute the Student Lab Guide and have students read the paragraphs on page 2. When students finish, they may flip through the Student Lab Guide to get a quick overview of the lesson. During this time, move your opaque cups and beaker so that all students can see them.

Jiggle Gels

EXPLORE PROPERTIES OF POLYMERS

You know how to make things. You can glue things together, paint, string beads together, shape clay, and build with blocks. You know how to take something ordinary and turn it into something better. This is what chemists do. But instead of using beads or clay, they use the very tiny parts that all things are made of—atoms and molecules. They study how things are made, down to these very tiny parts, and change them to make materials that are useful.

With the help of your visiting scientist, you are going to explore a few materials invented by chemists. These materials all seem different and have very different uses, but they have one important thing in common—they are all *polymers*.

Polymer is a name chemists use to describe a material whose molecules are made up of many small repeating parts hooked together like a long and skinny chain. You can't see these chain-like molecules, so you will have to trust us on this one. But as you will see in the coming activities, this unusual shape makes polymers amazing!

Today you will explore some polymers invented by chemists to find out what makes them special and useful. Today, you will do chemistry!

Your visiting scientist performed a trick for you. What was surprising about the trick?

What is the secret to this trick?

2

Jiggle Gels: Explore Properties of Polymers
© American Chemical Society, 2009

Student Lab Guide, Page 2

3. Conduct a demonstration to reveal the water-absorbing property of sodium polyacrylate.

Tell students: Do you think you are very observant? Has anyone ever told you that you notice everything? Scientists are very observant people. To see if you are ready for the activities that we'll do today, I'm going to test your observation skills.

1. Pour 30 mL of water into the cup with the sodium polyacrylate. Tell students that you will rearrange the cups and that their job is to tell you which cup has the water in it.
2. Move any two cups so that the two cups switch places. Rearrange different pairs of cups in this manner 3 to 5 times.
3. Ask students: Which cup contains the water? When they choose a cup, turn that cup over. No matter which cup they select, the water will not spill out! Have students select another cup and hold this cup upside down. Finally, turn the last cup over.

Expected results
The sodium polyacrylate will absorb all of the water.

4. Show students the secret with clear plastic cups.

Ask students how they think you were able to do this. Tilt all three cups so that students can see inside. Then do the activity again, but use clear plastic cups. Tell the students that you are using a chemical called sodium polyacrylate that absorbs water.

1. In full view of students, place 3 scoops of sodium polyacrylate into a clear plastic cup.
2. Place this cup, along with two identical empty cups, in a row.
3. Pour 30 mL of water into a beaker. Then pour this water into the cup with the sodium polyacrylate.
4. Rearrange the cups as you did in the demonstration.

Expected results
The sodium polyacrylate will absorb all of the water forming a gel. This gel appears white or cloudy-looking from the side.

5. Introduce the terms absorb, property, and polymer.

Ask students:

- Where did the water go when I poured it into the cup with the sodium polyacrylate powder?
- Would you say that the sodium polyacrylate *absorbed* the water?
- What does absorb mean?

Students should realize that even though it appears cloudy and doesn't flow, the water remains in the cup with the sodium polyacrylate powder. Students should agree that the powder absorbed the water. They may define absorb as soaking up a liquid. Students may be familiar with the idea that paper towels can absorb spilled juice and kitty litter can absorb chemicals that cause odors.

Explain that the ability to absorb a great deal of water is a *property* of sodium polyacrylate. A property is a special characteristic. For example, a property of water is that it is clear and colorless.

Explain that sodium polyacrylate powder is a *polymer*. Polymer is a name chemists use to describe a material whose molecules are made up of many small repeating parts hooked together like a long and skinny chain. This special shape gives sodium polyacrylate and the other polymers we will explore today their amazing properties.

6. Distribute materials as students answer questions about the demonstration.

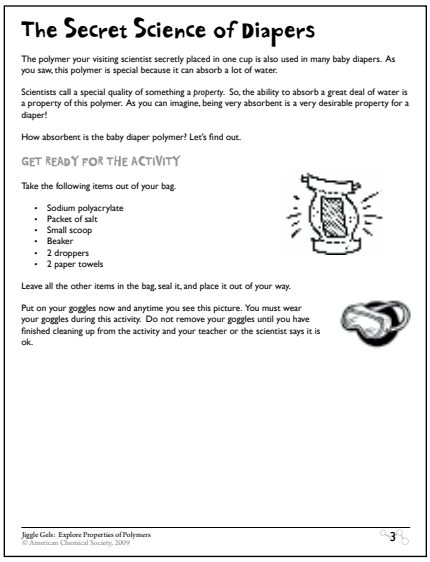
Have students go back to the first page of the student lab guide and answer the questions. During this time, distribute one source cup of water and one bag of materials to each student group.

1. Have students remove only the materials needed for this activity from the materials bag.

Tell students that they will need to remove the following items from their materials bag.

- Sodium polyacrylate powder
- Packet of salt
- Small scoop
- Beaker
- 2 droppers
- 2 paper towels

Everything else should remain sealed inside the bag until later. Groups of 4 students will share the sodium polyacrylate, packet of salt, small scoop, and beaker. Each pair of students within a group will be able to conduct their own activity. This is why there are 2 droppers and 2 paper towels.



The Secret Science of Diapers

The polymer your visiting scientist secretly placed in one cup is also used in many baby diapers. As you saw, this polymer is special because it can absorb a lot of water.

Scientists call a special quality of something a *property*. So, the ability to absorb a great deal of water is a property of this polymer. As you can imagine, being very absorbent is a very desirable property for a diaper!

How absorbent is the baby diaper polymer? Let's find out.

GET READY FOR THE ACTIVITY

Take the following items out of your bag.

- Sodium polyacrylate
- Packet of salt
- Small scoop
- Beaker
- 2 droppers
- 2 paper towels

Leave all the other items in the bag, seal it, and place it out of your way.

Put on your goggles now and anytime you see this picture. You must wear your goggles during this activity. Do not remove your goggles until you have finished cleaning up from the activity and your teacher or the scientist says it is ok.

Jiggle Gels: Explore Properties of Polymers
© American Chemical Society, 2009
3

Student Lab Guide, Page 3

2. Explain that goggles must be worn during this activity.

Tell students that everyone should wear their goggles during this hands-on activity. They should not remove their goggles until they have finished cleaning up from the activity and you or the teacher tells them that they can remove them. Have students put on their goggles. With the teacher's help, walk around helping students adjust their goggles so that they fit properly.

3. Have students practice using the dropper.

Show students how to squeeze the bulb of the dropper in order to pick up water. Then point out how to gently squeeze the dropper so that only one drop is released at a time.

Give students a couple of minutes to practice using the dropper. Tell them that each student in the group should have a chance to pick up water at least once and then release a few single drops. As students practice, walk around the room to check on their progress. Ask the teacher to help you with this, so that the two of you can check on all students. Be sure to praise students when you notice them using the dropper properly, and help those who have not yet mastered the skill.

4. Have students investigate the super-absorbing property of sodium polyacrylate.

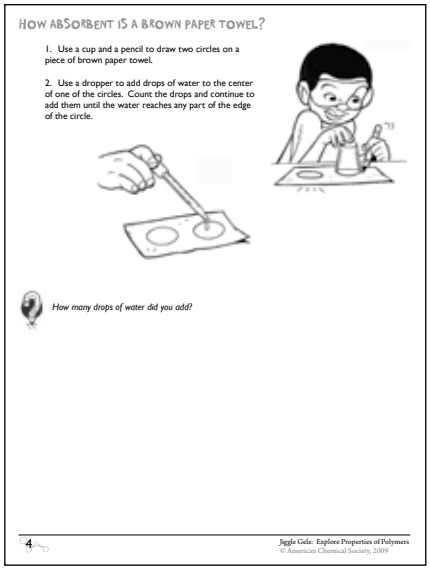
Have students record their observations as they do the following activity.

How absorbent is a brown paper towel?

1. Use a cup and a pencil to draw two circles on a piece of brown paper towel.
2. Use a dropper to add drops of water to the center of one of the circles. Count the drops and continue to add them until the water reaches any part of the edge of the circle. How many drops of water did you add?

Expected results

The number of drops will vary depending on how fast the students add the drops.



HOW ABSORBENT IS A BROWN PAPER TOWEL?

1. Use a cup and a pencil to draw two circles on a piece of brown paper towel.

2. Use a dropper to add drops of water to the center of one of the circles. Count the drops and continue to add them until the water reaches any part of the edge of the circle.

How many drops of water did you add?

4

Jiggle Gels: Explore Properties of Polymers
© American Chemical Society, 2009

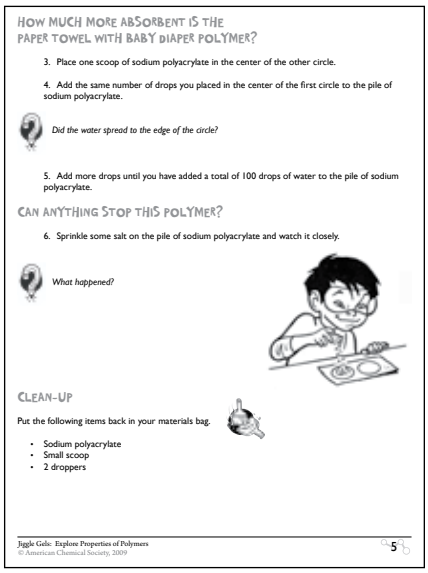
Student Lab Guide, Page 4

How much more absorbent is the paper towel with baby diaper polymer?

3. Place one scoop of sodium polyacrylate in the center of the other circle.
4. Add the same number of drops you placed in the center of the first circle to the pile of sodium polyacrylate. Did the water spread to the edge of the circle?
5. Add more drops until you have added a total of 100 drops of water to the pile of sodium polyacrylate.

Expected results

The pile will get bigger as the sodium polyacrylate absorbs the water. Very little, if any, water will soak into the brown paper towel.



HOW MUCH MORE ABSORBENT IS THE PAPER TOWEL WITH BABY DIAPER POLYMER?

3. Place one scoop of sodium polyacrylate in the center of the other circle.

4. Add the same number of drops you placed in the center of the first circle to the pile of sodium polyacrylate.

Did the water spread to the edge of the circle?

5. Add more drops until you have added a total of 100 drops of water to the pile of sodium polyacrylate.

CAN ANYTHING STOP THIS POLYMER?

6. Sprinkle some salt on the pile of sodium polyacrylate and watch it closely.

What happened?

CLEAN-UP

Put the following items back in your materials bag.

- Sodium polyacrylate
- Small scoop
- 2 droppers

Jiggle Gels: Explore Properties of Polymers
© American Chemical Society, 2009

5

Student Lab Guide, Page 5

Can anything stop this polymer?

6. Sprinkle some salt on the pile of sodium polyacrylate and watch it closely.

Expected results

The pile of sodium polyacrylate will begin to collapse, and water will be released, which students will see absorbing into the paper towel.

5. Clean-up from the activity while continuing to wear goggles.

Have students place the sodium polyacrylate, scoop, and droppers back in the bag. Walk around with a bucket or bag and collect the wet paper towels and used sodium polyacrylate.

6. Discuss uses for super-absorbent sodium polyacrylate.

Explain that chemists invented sodium polyacrylate powder. Many chemists create useful materials that improve people's lives. Ask students:

- What uses can you think of for sodium polyacrylate powder?

In your discussion, share some common ways people use sodium polyacrylate.

Babies

Sodium polyacrylate is inside the lining of most disposable baby diapers.

Gardeners

Outdoor potted plants can dry out quickly. Sodium polyacrylate (or similar super-absorbent polymers) mixed in the soil will keep the water in the soil longer.

Movie-set designers

A version of sodium polyacrylate looks like fluffy snow when you add water. This is sometimes used on movie sets for snowy scenes.

Firefighters

Foams and gels made with sodium polyacrylate are sprayed on buildings that are in the path of a wildfire. The layer of foam or gel on the building keeps it safe. After the fire passes, the coating can be sprayed off with more water, but watch out because it's very slippery.

THE THIRSTY DINOSAUR

In this activity, each pair of students measures a dinosaur and then places it in a plastic bag filled with water. Within a couple of days, the dinosaur will increase to about 6 times its size! You will work with students to set this activity up, but the teacher will finish the activity with the students. The Teacher's Guide and Student Lab Guide will help them complete the activity without you.

1. Distribute rulers and labels as students prepare for the activity.

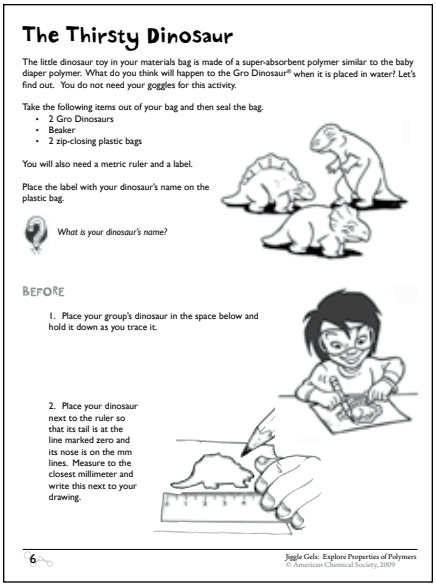
Distribute the laminated paper rulers that came with this kit or have students use their own metric rulers.

To help students keep track of their dinosaurs as they grow, students will need to name their dinosaur. Labels with dinosaur names are included with this kit to help make this easy. With the help of the teacher, randomly distribute one label to each pair of students.

Tell students that they will need to remove the following items from their materials bag. Let students know that each pair of students will have their own dinosaur. Instruct students to place the label on the zip closing plastic bag as shown in the illustration.

- 2 Gro Dinosaurs
- Beaker
- 2 zip-closing plastic bags

Goggles are not needed for this activity.



The Thirsty Dinosaur

The little dinosaur toy in your materials bag is made of a super-absorbent polymer similar to the baby diaper polymer. What do you think will happen to the Gro Dinosaur® when it is placed in water? Let's find out. You do not need your goggles for this activity.

Take the following items out of your bag and then seal the bag.

- 2 Gro Dinosaurs
- Beaker
- 2 zip-closing plastic bags

You will also need a metric ruler and a label.

Place the label with your dinosaur's name on the plastic bag.

What is your dinosaur's name?

BEFORE

1. Place your group's dinosaur in the space below and hold it down as you trace it.

2. Place your dinosaur next to the ruler so that its tail is at the line marked zero and its nose is on the mm lines. Measure to the closest millimeter and write this next to your drawing.

6

Jiggle Gels: Explore Properties of Polymers
© American Chemical Society, 2009

Student Lab Guide, Page 6

2. Explain how to use the beaker.

Have students take a look at the markings on their beakers. Tell students that "mL" stands for milliliters and "cc" stands for cubic centimeters. The numbers next to the lines tell you the number of milliliters you have if you fill the container to that line. Tell students that in the procedure they will add 90 mL of water to the bag. Ask students to point to the line on the beaker that marks 90 mL. Quickly look around the room to make sure students have found this line.

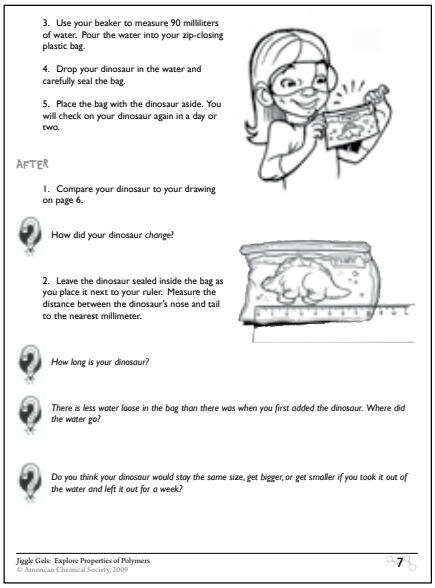
3. Discuss the properties of the dinosaur and how they might change when it is placed in water.

Tell students that the dinosaur used in this activity contains two polymers. One polymer has a water-absorbing property like sodium polyacrylate. The other polymer helps the dinosaur keep its shape.

Ask students:

- What properties does your dinosaur have?
- How might your dinosaur change if we place it in water?
- What can we do to find out how much the dinosaur changes?

Students should identify the dinosaur's shape, color, size, and hardness as properties. Based on their experience with the baby diaper polymer, they may guess that the dinosaur will get bigger as it absorbs water. Students should suggest that they measure the dinosaur to find out how much it changes. Be sure to praise students who use words like polymer, property, or absorb in their responses.



3. Use your beaker to measure 90 milliliters of water. Pour the water into your zip-closing plastic bag.

4. Drop your dinosaur in the water and carefully seal the bag.

5. Place the bag with the dinosaur aside. You will check on your dinosaur again in a day or two.

AFTER

1. Compare your dinosaur to your drawing on page 6.

How did your dinosaur *change*?

2. Leave the dinosaur sealed inside the bag as you place it next to your ruler. Measure the distance between the dinosaur's nose and tail to the nearest millimeter.

How long is your dinosaur?

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

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?

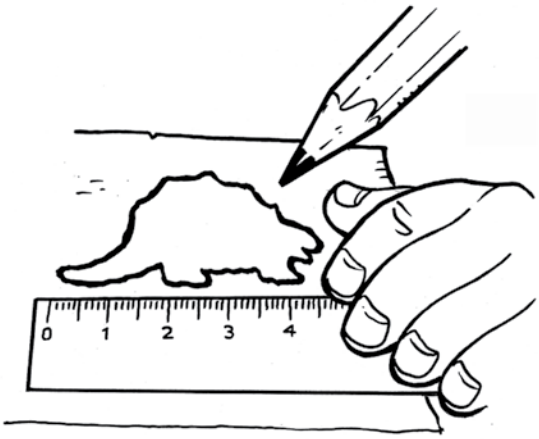
Jiggle Gels: Explore Properties of Polymers
© American Chemical Society, 2009
7

Student Lab Guide, Page 7

4. Have students measure their dinosaurs.

Have students follow the procedure titled "Before." Students will complete the "After" procedure another day with their teachers.

1. Place your group's dinosaur in the space provided in the Student Lab Guide and hold it down as you trace it.
2. Place your dinosaur on the ruler so that its tail is at the line marked zero and its nose is on the millimeter lines. Measure to the closest millimeter and write this next to your drawing.
3. Use your beaker to measure 90 mL of water. Pour the water into your zip-closing plastic bag.
4. Drop your dinosaur in the water and carefully seal the bag.
5. Place the bag with the dinosaur aside. You will check on your dinosaur again in a day or two.



5. Collect the dinosaurs and let students know that they will check on them in a day or two with their teacher.

Students should place their beaker back in the materials bag. With the help of the teacher, collect the dinosaurs and place them aside where they can lie flat for a couple of days.

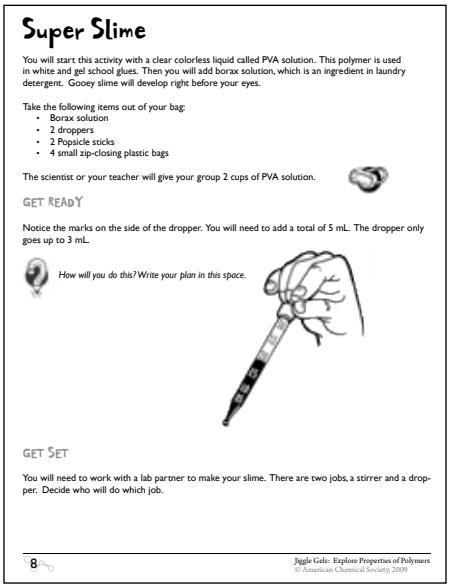
Expected results

Within a couple of days, the dinosaur will increase to about 6 times its original size. There will also be about half the amount of water left unabsorbed in the bag.

1. Distribute PVA solution as students prepare for the activity.

Have students get the following items out of their materials bags as you and the teacher distribute a cup of PVA solution to each pair of students.

- Borax solution
- 2 droppers
- 2 Popsicle sticks
- 4 small zip-closing plastic bags



Super Slime

You will start this activity with a clear colorless liquid called PVA solution. This polymer is used in white and gel school glues. Then you will add borax solution, which is an ingredient in laundry detergent. Gooey slime will develop right before your eyes.

Take the following items out of your bag:
- Borax solution
- 2 droppers
- 2 Popsicle sticks
- 4 small zip-closing plastic bags

The scientist or your teacher will give your group 2 cups of PVA solution.

GET READY

Notice the marks on the side of the dropper. You will need to add a total of 5 mL. The dropper only goes up to 3 mL.

How will you do this? Write your plan in this space.

GET SET

You will need to work with a lab partner to make your slime. There are two jobs, a stirrer and a dropper. Decide who will do which job.

8 Jiggle Gels: Explore Properties of Polymers © American Chemical Society, 2009

Student Lab Guide, Page 8

Let students know that the cups you are giving them contain polyvinyl alcohol mixed with water. Tell students that PVA is short for polyvinyl alcohol. PVA is a polymer, but it has different properties from the polymers they have explored so far.

2. Explain how to use the dropper to measure 5 mL.

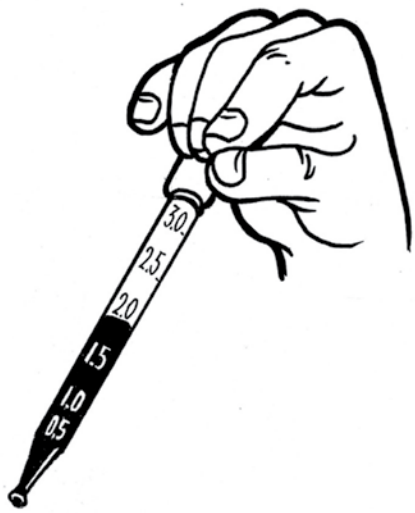
Point out the markings on the side of the dropper.

Ask students:
- How many milliliters can you measure using this dropper?
- You will need to slowly add a total of 5 mL of borax solution to the PVA solution. How can you measure 5 mL using this dropper?

Students should see that the top mark on the dropper is 3 mL. In order to add a total of 5 mL, students have a variety of options. They may add 3 mL and then 2 mL, or 2.5 mL + 2.5 mL, or 2 mL + 2 mL + 1 mL.

Have students practice using the dropper to pick up and slowly squeeze out a total of 5 mL. They may use the water in their source cup for practice. Have students drop the water back into the source cup.

After practicing with the dropper, have students write their plan to get a total of 5 mL of borax solution into the PVA solution.



As students practice using the dropper and writing their plans, walk around and ask them how they will get a total of 5 mL of borax solution. Check to see that students can use the dropper.

3. Model how to work with a partner by making slime with the teacher.

Tell students that it takes 2 people working together to make good slime. Each partner has a special job. The stirrer stirs the PVA solution constantly. The dropper picks the borax solution up in the dropper and slowly squirts 5 mL into the PVA solution.

Demonstrate how to make slime with the teacher. Have the teacher stir while you slowly add the borax solution. Model the entire procedure so that students understand what to do. Be sure to make a point of slowly squirting 5 mL of borax solution into the PVA solution. Once the slime is stuck on the Popsicle stick, show students the difference between squirts and drops as you add 5–10 single drops of borax solution.

Give students a minute to figure out who will be the stirrer and who will be the dropper and then give them the go-ahead to follow the procedure on pages 9 and 10 of the Student Lab Guide.

GO!

1. Stir continuously while your partner slowly squirts borax solution into the cup. Be sure to add a total of 5 mL of borax solution.

2. Pull the Popsicle stick up out of the cup and touch the slime. If some liquid remains in the bottom of the cup, or the slime feels very sticky, add 5–10 drops of the borax solution. Stir to mix the drops into the slime.

Jiggle Gels: Explore Properties of Polymers
© American Chemical Society, 2009
9

Student Lab Guide, Page 9

4. Have students work together to make their slime.

As students make their slime, walk around to make sure that partners are working together and students are using the droppers properly. Praise students whenever you see them doing something well.

Once students successfully have a clump of slime on their Popsicle stick, you may need to help them determine how many additional drops of borax solution they should add.

1. Stir continuously while your partner slowly squirts borax solution into the cup. Be sure to add a total of 5 mL of borax solution.
2. Pull the Popsicle stick up out of the cup and touch the slime. If some liquid remains in the bottom of the cup, or the slime feels very sticky, add 5–10 drops of the borax solution. Stir to mix the drops into the slime.
3. Pull the slime off the stick and divide it in half so that you and your lab partner each have a piece.
4. Play with your slime to explore its properties. When you are finished, place your slime in a zip-closing plastic bag and seal it.

Expected results

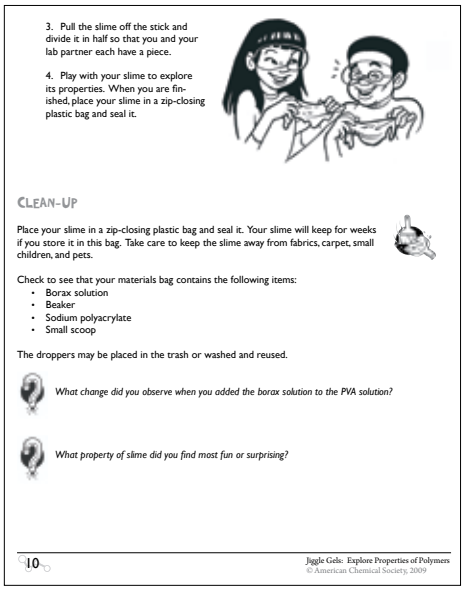
The PVA solution clumps onto the Popsicle stick as it cross-links with the borax solution. Because the borax solution is green, the cross-linked areas are colored green, while the plain PVA solution remains colorless. Once everything is green, cross-linked, and attached to the Popsicle stick, the slime will be slightly sticky. Students may choose to add several more drops of Borax solution at this point. However, it might not be necessary to add additional drops because the slime will become less sticky as students play with it.

5. Clean up, have students complete page 10, and prepare for the final demonstration.

Have students place their slime in zip-closing plastic bags. Each student should have a bag and piece of slime to take home. Tell students to look at page 10 of the Student Lab Guide for a list of what should be sealed in each materials bag.

When they are finished cleaning up, students should answer the questions about the slime activity on page 10 and read page 11.

As students answer questions and read, collect the sealed materials bags and trash. The droppers, cups, and Popsicle sticks may all be thrown away with the ordinary trash. However, to prevent students from playing with these items after you leave, place these in a bucket or bag along with the paper towels from the first activity and carry everything out of the school. Collect the source cups of water. You will need some of this water for the demonstration. When you are finished with your presentation, these cups can be emptied and reused.



3. Pull the slime off the stick and divide it in half so that you and your lab partner each have a piece.

4. Play with your slime to explore its properties. When you are finished, place your slime in a zip-closing plastic bag and seal it.

CLEAN-UP

Place your slime in a zip-closing plastic bag and seal it. Your slime will keep for weeks if you store it in this bag. Take care to keep the slime away from fabrics, carpet, small children, and pets.

Check to see that your materials bag contains the following items:

- Borax solution
- Beaker
- Sodium polyacrylate
- Small scoop

The droppers may be placed in the trash or washed and reused.

What change did you observe when you added the borax solution to the PVA solution?

What property of slime did you find most fun or surprising?

10 Jiggle Gels: Explore Properties of Polymers
© American Chemical Society, 2009

Student Lab Guide, Page 10

You will need the following for the Grand Finale demonstration:

- Sheet of PVA plastic
- Storage-grade zip-closing plastic bag
- Sharpened pencil
- Clear plastic cup ⅔ filled with water
- About 2 cups of water

WHAT'S GOING ON HERE?

If you could look at the polymer molecules in the PVA solution, you would see that the long polymer chains slide past each other very easily through the water. This is why the PVA solution acts like a normal liquid.

But when borax solution is added, things change! This is because the borax molecules connect parts of one long skinny polymer molecule to parts of other long skinny molecules. With the borax holding on, the polymer chains can't move past each other as easily anymore. This is why the liquid clumps up.

As you may notice when you play with slime, it can flow like a liquid does, but much more slowly. The polymer chains do still slide around a bit, even with the borax holding on. If you are patient, you will see that slime flows, pours, and takes the shape of its container just like a liquid does.

THE AMAZING PROPERTIES OF POLYMERS

What do baby diaper powder, growing dinosaur toys, slime, and plastic bags all have in common?

The materials you worked with today were all invented by chemists. They have something else in common, too. They are all polymers. Because of their special properties, these materials also have a wide variety of uses.

Polymers are everywhere. Some are invented by chemists and others are found in nature. Plastics, glue, clothing, balls, rubber, feathers, fur, turtle shells, and even your skin and hair are made of polymers. The list can go on and on because polymers make up so many different things. No matter where you find them or how you use them, polymers have amazing properties!

Congratulations!
YOU DID CHEMISTRY!

Visit **www.acs.org/kids** for more science activities you can do at home.

Jiggle Gels: Explore Properties of Polymers
© American Chemical Society, 2009 11

Student Lab Guide, Page 11

6. Discuss the properties of slime.

When the clean-up and reading are complete, ask students the following questions:

- What did you observe when you added the borax solution to the PVA solution?
- What are your favorite properties of slime?

Students may say that at first the PVA solution was thin and looked a lot like water, but with borax solution it became thick and clumped up on the Popsicle stick. Students' favorite properties may be that slime is sticky, stretchy, or a little bouncy. They may say that it flows very slowly, can be formed into a ball, or that it flattens out into a circle if you leave it alone.

Tell students that slime will keep for weeks if it is stored in the sealed bag. Warn them that they should keep the slime away from carpet, fabrics, dirty surfaces, pets, and small children. Slime can be cleaned up with warm soapy water, but it's best to not get it stuck on something in the first place! Let students know that they can safely throw the slime away in the regular trash at home when they are done with it.

1. Compare two types of clear plastic with a demonstration.

1. Tell students that you will do a demonstration with two types of plastic that are used to make clear plastic bags.
    - Show students the piece of clear plastic PVA. Let them know that this sheet of plastic is made out of PVA just like the PVA solution they used to make the slime.
    - Hold up the zip-closing plastic bag and tell students that this bag is made of a different polymer (low-density polyethylene, LDPE).

2. Ask students: Which properties do these two types of plastic have in common?

3. Place most of the PVA sheet in the cup of water. Leave the top of the PVA sheet hanging up over the edge of the cup so that you can pick it up later.

4. Pour about 2 cups of water into a quart-size zip-closing storage bag so that it is a little less than half-filled with water. Seal the bag securely.

5. Hold up the bag so that all can see. Then poke the sharpened pencil through the side of the bag, through the water, and all the way through the other side of the bag. Explain that the bag does a nice job holding water by making a seal around the pencil.

6. As you continue to hold the bag with the pencil with one hand, pull the PVA sheet out of the water with the other.

7. Ask students: How are these plastic bags different?

Students may say that one type of plastic is destroyed by water, while the other type is so strong that it can even hold water with a pencil poked through it.

Expected results

The sheet of PVA plastic dissolves in water while the common plastic bag made of low-density polyethylene does not. It is flexible enough to form a tight seal around the pencil so that water does not leak out.

2. Discuss uses for the two types of clear plastic.

Ask students:

- How do you use clear plastic bags?
- Would a PVA bag work for all of these uses?
- Which type of plastic would be best to store the slime or hold the dinosaur in water?

Students may use clear plastic bags to hold sandwiches, cookies, or grapes. Slightly wet foods should not be stored in PVA bags. Bags that dissolve in water would not work for storing slime or the super-absorbing dinosaur.

Tell students that plastic bags that dissolve in water can be quite useful, though. For example, in hospitals, dirty sheets and blankets from a sick person's bed are placed in one of these special bags. Someone takes the filled bag to the laundry room. Then the entire bag is placed in the washing machine. When the wash cycle is finished, the clean sheets and blankets are removed and placed in the dryer. The bag is gone!

Ask students:

- What do you think happens to the bag in the washing machine?
- How does the bag protect hospital workers as the laundry is taken from the bed to the washing machine?

You may choose to tell students that the dissolving bags are also used in fishing for carp that live at the river bottom. Imagine throwing bait in the water and different fish taking a bite as it sinks down to the area where the carp live. By the time the bait gets down to the carp, it is long gone! Now imagine putting bait in a PVA bag. The bait sinks to the river bottom protected from hungry fish. At the river bottom the bag dissolves so that the carp can get to the bait.

3. Reinforce the ideas presented in the lesson.

Tell students that you want to find out how much they learned during your visit.

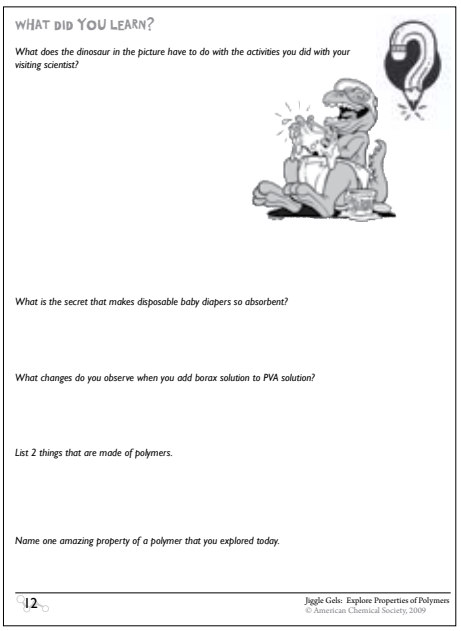
- What does the picture of the dinosaur on the cover of your Student Lab Guide have to do with the activities we did together today?
- What is the secret that makes disposable baby diapers so absorbent?
- List two things that are made of polymers.
- Name one amazing property of a polymer that you explored today.

Explain that like chemists, the students investigated the properties of different materials.
They did chemistry!

4. Conclude the lesson.

If time allows, give students the opportunity to ask you questions. They may ask you about the activities or they may choose to ask about you and your work. Students are always curious about visitors and getting to know you will give them a positive view of chemists and chemistry.

Let the teacher know that after you leave, students may answer the questions on the last page of the Student Lab Guide as an assessment.



WHAT DID YOU LEARN?

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

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

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

List 2 things that are made of polymers.

Name one amazing property of a polymer that you explored today.

12

Jiggle Gels: Explore Properties of Polymers
© American Chemical Society, 2009

Student Lab Guide, Page 12

MATERIALS LIST FOR JIGGLE GELS

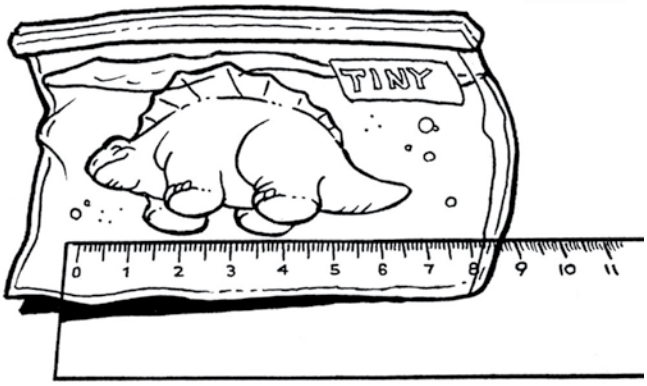
This kit is designed for up to 32 students working in groups of 4 and contains:

- 1 Presenter's Guide
- 1 Teacher's Guide
- 32 Student Lab Guides
- 1 bag of materials for the presenter
- 8 bags of materials for the students

Download and copy additional Presenter's Guides, Student Lab Guides, and basic metric rulers from the Kids & Chemistry pages of *www.acs.org/education*.

Materials for the presenter

- Sodium polyacrylate
- 1 liter of PVA solution, 4%
- Small scoop
- Beaker
- 2 sheets of PVA
- 1 storage-grade zip-closing plastic bag, quart-size
- 3 clear plastic cups, 9–10 ounce size
- 11 opaque plastic cups
- 16 small clear plastic cups, 3.5 ounce size
- 16 PVA solution labels
- 16 dinosaur name labels



Materials for each student group

- Sodium polyacrylate
- Borax solution, 4%
- Packet of salt
- Small scoop
- Beaker
- 2 Gro Dinosaurs
- 2 droppers, with 3 mL markings
- 2 brown paper towels
- 2 Popsicle sticks
- 6 zip-closing plastic bags, snack-size
- 2 metric rulers

Goggles are not included in this kit but must be worn when conducting all activities, except The Thirsty Dinosaur activity.

MATERIAL SAFETY DATA SHEETS

Borax Solution

Universe of Science
6079 Brushy Mountain Rd.
Moravian Falls, NC 28654
(336) 667-9397

Material Safety Data Sheet
MSDS # 6002-1
EMERGENCY ASSISTANCE CALL
CHEMTREC 800-424-9300

Chemical Name & Synonyms
sodium borate solution, borax solution, Cross-Linker

Formula $Na_2B_4O_7$ in water
Unit Size 1 ounce
CAS No. 1330-43-4

Hazard Rating

Health	1
Fire	0
Reactivity	0

Least Slight Moderate High Extreme
0 1 2 3 4

Health Hazards
Ingestion may cause vomiting and diarrhea.

Physical Data
4 % borax in water, colored green with food coloring.

Incompatibility (Materials and Conditions to avoid)

Reactivity
Stable

D.O.T.
Not regulated

Fire Hazards
None

Spills and Leaks and Disposal Method
Absorb with suitable material and dispose of in trash.
Wash remaining material 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.
If swallowed: Induce vomiting. Call a physician.

Sodium Polyacrylate

Universe of Science
6079 Brushy Mountain Rd.
Moravian Falls, NC 28654
(336) 667-9397

Material Safety Data Sheet
MSDS # 6002-2
EMERGENCY ASSISTANCE CALL
CHEMTREC 800-424-9300

Chemical Name & Synonyms
Super Water Absorber, sodium polyacrylate

Formula mixture of polymers
Unit Size 5 grams
CAS No. 9003-04-7

Hazard Rating

Health	0
Fire	0
Reactivity	0

Least Slight Moderate High Extreme
0 1 2 3 4

Health Hazards
May be skin or eye irritant to some people.
Can absorb moisture from nasal membrane and eyes.

Physical Data
White granular powder.

Incompatibility (Materials and Conditions to avoid)
Strong oxidizing agents and reducing agents.
Binds with water to from a slippery gel.

Reactivity
Stable

D.O.T.
Not regulated

Fire Hazards
Not flammable.

Spills and Leaks and Disposal Method
Absorb with suitable material and dispose of in trash.
Wash remaining material 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.

Polyvinyl Alcohol

Universe of Science
6079 Brushy Mountain Rd.
Moravian Falls, NC 28654
(336) 667-9397

Material Safety Data Sheet
MSDS # 6002-3
EMERGENCY ASSISTANCE CALL
CHEMTREC 800-424-9300

Chemical Name & Synonyms
sodium carbonate, soda ash

Formula mixture of polymers
Unit Size 5 " x 7" film, 1 liter solution
CAS No. 9002-89-5

Hazard Rating

Health	1
Fire	0
Reactivity	0

Least Slight Moderate High Extreme
0 1 2 3 4

Health Hazards
Not considered hazardous.

Physical Data
Off-white plastic film, soluble in warm water and 4 % aqueous solution.

Incompatibility (Materials and Conditions to avoid)
Binds with water to form a slippery viscous liquid.

Reactivity
Stable

D.O.T.
Not regulated

Fire Hazards
None

Spills and Leaks and Disposal Method
Wipe up and dispose of in trash.

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.