

Playing with Polymers

Teacher Notes

Introduction

Each year I set aside time during our Chemistry unit to explore the world of polymers and it is always one of my students' favorite units of the year! I usually do this unit before winter break and allow the kids to take home their slimes as a present from me. I joke that I'm probably the only teacher that will give them Boogers and Goobers for Christmas!

I use this unit with a chapter in our textbook about petrochemicals and relate it to the world of plastics. Hands-on Plastics available at http://www.americanchemistry.com/s_plastics/hands_on_plastics/ is a great resource to use with this unit and they provide many extension lessons you can use to introduce the unit or extend it to address additional concepts.

We also tie it into discussions related to chemical reactions (polymerization). You could also consider using the experiments for a unit on the scientific method and process skills (observation, data collection, etc.). Challenge the students to create their own version of Gloop (or another slime) by changing one variable and have them compare it to the original slime.

It will take some time to get the materials set up for the unit the first year, but you can reuse many of the supplies in future years and it will be easier to get ready for slime time. I keep all my slime stuff in a large plastic tote and it only takes a couple hours to set up the lab and prepare the solutions each year.

Resources available on my website include:

Link: <http://sciencespot.net/Pages/classchem.html#Anchor-poly>

- *Playing with Polymers PowerPoint Presentation* - Includes an answer key for the student note worksheet, introduction to using graduated cylinders, and the safety rules. Step-by-step directions for the slimes are also provided and go along with the directions on the recipe card.

- *Playing with Polymers Student Packet* - Includes the note worksheets, puzzle pages, data chart, and slime test descriptions. Students fill in the note worksheet using the information on the first few slides of the presentation and complete the data chart as they finish the slime experiments. I require students to complete the puzzle pages on their own time.

NOTE: The answer keys for the puzzle pages are available by using my contact form on my website. You must provide your school e-mail address and location so I can verify your teaching position.

- *Playing with Polymers Recipe Card* - I print out enough recipe cards to provide 2 copies for each group of 4 students. If possible, laminate the cards to help them last from year to year.

- *Playing with Polymers Online* - Students use various websites to learn about the history of polymers and plastics; I use this at the start of the unit to build background knowledge and refer to the information throughout the unit.

- *Polymer Links* - Links with information about polymers are provided on the Matter & Atoms page of the Kid Zone at <http://sciencespot.net/Pages/kdzchem.html>.

Materials

NOTE: Suggested amounts are based on 100 students working in pairs.

- Cornstarch - 3 boxes (If you choose to do the optional Oobleck activity)
- Mule Team Borax - 1 small box
- Stay Flo Starch - 1 large bottle
- Plastic containers with lids (yogurt size) - One container per group; use for storing starch
- White Glue - 4 oz size - Need enough bottles for each pair of students.
- White Glue - 1 gallon - Use to refill the small bottles; much cheaper to purchase per gallon
- Guar Gum - 60 grams - Available from Flinn Scientific; need 0.6 g per pair/group so one larger container will provide enough powder for several years)
- Film Canisters - Need 1 per group; used for storing guar gum powder
- PVA powder - Available from Flinn Scientific; need 200 grams of powder to make enough solution for 100 students; a large container will provide enough powder for several years)
- Food Coloring - Green, yellow, blue, and red - One set for each group of 4 students
- Plastic cups - 4 oz size - 200
- Styrofoam or plastic plates - 100
- Small plastic ziploc-style bags - 2" x 3" size; need 5 per student; available at many craft stores or purchase from Uline (<http://www.uline.com/>) for \$11 per 1000; may also use snack size ziploc bags.
- Stirring Sticks - 1 large box of wooden craft sticks (at least 400 sticks)
- Graduated cylinders
 - 25 ml - Need 2 per group of 4 students
 - 50 ml sizes - Need 2 per group of 4 students
- Small beakers (or extra plastic cups) to hold water or borax solution - 2 per group
- Eyedroppers - 4 per group
- Triple-beam balance or other scales - 1 per group
- Safety goggles - 1 pair for each student
- Paper towels
- Permanent marker - 1 per group
- Timer/stopwatch - 1 per group
- Metric ruler - 1 per group
- Playing with Polymers recipes - 1 set per group
- Playing with Polymers Data Chart/Slime Tests - 1 per student

Optional Materials

- Film canisters - Use to store the Gloop, Boogers, or Super Slime - make "farting noises!"
- Gel-style Glue - Try substituting gel glue for white glue in some of the recipes.
- Glitter powder - Use to make sparkling Gloop or Boogers; don't add too much!
- Glow Powder - Check out the Steve Spangler website at <http://www.stevespanglerscience.com/product/1586> for a Glow Powder kit. They also offer several slime kits and materials.

Slime Supplies - PVA & Guar Gum
Flinn Scientific, Inc.
P.O. Box 219, Batavia, IL 60510
(800) 452-1261
<http://www.flinnsci.com/>

Don't have money for supplies?
Make a "wish list" and have the students bring in white glue, food coloring, starch, ziploc bags, and other items. You might also consider asking for a donation (50¢ - \$1.00) from each student.

Unit Schedule

- Day 1** Unit Introduction - Discuss #1-6 on note worksheet
Optional: Oobleck - Make a batch and discuss the questions on the unit presentation
- Day 2** Gloop - Make a batch and allow time to complete the slime tests
- Day 3** Boogers - Make a batch and allow time to complete the slime tests
- Day 4** Goobers - Make a batch and allow time to complete the slime tests
- Day 5** Super Slime - Make a batch and allow time to complete the slime tests
- Day 6** Complete puzzles and unfinished slime tests
- Day 7** Mystery Slime Challenge - Provide students with samples of a mystery slime and challenge them to use the observations from their slime tests to identify what type of slime it is

Also available ...

Polymer Basics - Online activity at <http://sciencespot.net/Media/playpolymerscvhunt.pdf> (1-2 class periods)

Preparation

Corn Starch (Optional) - Place 1/2 cup of corn starch into ziploc bags and prepare enough bags for each pair of students in your class. Students will need to add water to create the right consistency. Have additional starch on hand in case they added too much water.

Borax Solution for Gloop, Goobers, & Super Slime - Mix 1 teaspoon (heaping) of borax powder for every cup of water. I mix the borax solution in a 1 gallon container (such as a bucket or milk jug) and usually need to make 2 batches to have enough for all the slimes. Pour the solutions into the small beakers for the students to use.

Liquid Starch - Fill small plastic containers (such as old yogurt cups with lids) with liquid starch. You will need 1 container per group of 4 students. Have extra on hand to refill the containers as needed.

NOTE: If you purchase a different brand than Stay-Flo, be sure to make a test batch first! I've had some problems when using an off brand of liquid starch.

Guar Gum - The guar gum is a powder that comes in a plastic container and will keep very well from year to year. I fill film canisters with powder and label them. Save the extra powder to refill the containers as needed. You will also need to label 6 small plastic cups for use only with the guar gum. I place one film canister of powder into each labeled cup to give to the groups.

PVA Powder/Solution - PVA is available as 4% solutions in 500 ml and 1000 ml bottles, but the powder is much cheaper and is fairly easy to make yourself. I prepare five batches of the solution and store it in 2-liter bottles. For the lab, I fill several 1-liter bottles with clear solution and then add several drops of food coloring to create a variety of colors for the students to use. I usually provide five colors: red, blue, yellow, green, and purple. Students may also use the clear solution to create a neat looking slime! Save the extra solution to refill the smaller bottles as needed.

Follow these directions to make your own PVA 4% solution:

- 1. Pour 1 liter of water into a microwave-safe plastic bowl.*
- 2. Use a triple-beam balance to measure out 40 grams of PVA powder.*
- 3. Sprinkle the powder over the water and stir until well mixed.*
- 4. Cover the bowl with plastic wrap and place in the microwave. Heat on high for 2 minutes.*

5. Remove from microwave and stir well.
6. Return the bowl to the microwave and heat for an additional 2 minutes. Remove from microwave and stir well.
7. Continue to heat the solution (2 minutes and then stir) until the solution is clear. It usually takes about 4 to 5 times before the solution turns clear.
8. Pour the solution into 2-liter plastic bottles to store.

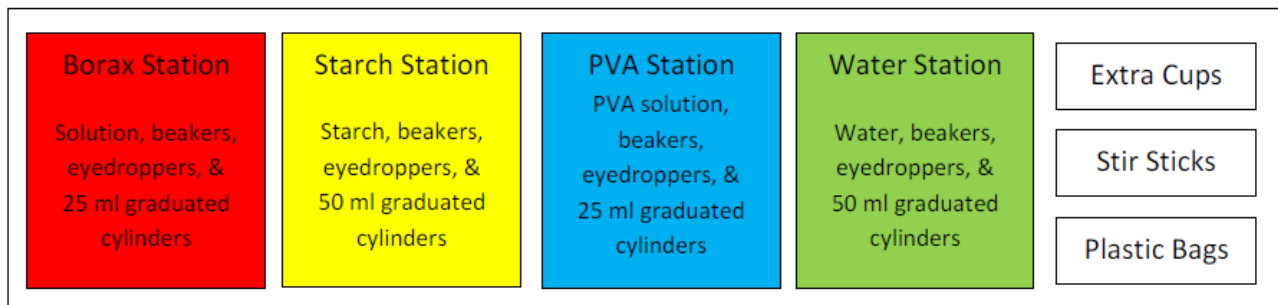
TIP: Make a test batch of Super Slime to see if the amounts work well with your homemade PVA solution. You may need to adjust the amount of borax solution.

Playing with Polymers Recipe Page - Print out the recipe info on card stock (both sides) and laminate if possible. If you can't laminate the pages, consider sealing them inside large ziploc bags to protect them from slime! If you are going to use supply boxes, put one recipe page in each box.

Group Baskets - I use plastic containers (shoe box size) to create a supply basket for each group of 4 students. Each basket contains small plastic cups, rulers, permanent markers, a bag of wooden sticks, a bag of small plastic bags, and a box of food coloring.

Supply Station - I use a counter area in my room next to the 2 sinks I have to set up a supply station. I have plastic baskets filled with extra cups, wooden stir sticks, and small plastic bags students can use to restock their group baskets as needed. I also set aside areas on the counter for each of the slime materials and color code all the glassware to keep the slime materials from "gunking" up in the graduated cylinders, beakers, and eyedroppers. Students are responsible for cleaning all the glassware before putting them back in the correct locations. I remind them to return unused solution or starch to the correct container. Borax solution, starch, and PVA solution should NOT be dumped in the sink.

COLOR CODING NOTE: Everything in the four "slime" stations is color coded to prevent students from "mixing" slime materials in the eyedroppers or beakers and gunking them up. For example, I use a red permanent marker to put red dots on all the beakers, eyedroppers, and cylinders for the borax solution. I use the same procedure to add dots to the materials for the starch and PVA as well as the materials that are to be used with regular water.



Mystery Slimes - You can decide which slimes you'd like to mix up to challenge your students. They will easily identify the Goobers and Super Slime, but have trouble telling the difference between Gloop and Boogers. I only allow students to use their data charts when they are trying to identify the mystery slimes and make sure to hide the other slimes. If the students made good notes during their tests, they will be able to identify the mystery slimes. I provide at least six sets of mystery slime samples, such as Super Slime, Boogers, and Goobers, and label them as Mystery Slime #1, Mystery Slime #2, and Mystery Slime #3. I use different colors with my mystery slimes to make it a bit more challenging.

Teacher Tips

Try the slimes first!

Roll up your sleeves and spend some time playing with the slimes before you attempt to make slime with your students. All the recipes and descriptions of the slime tests are included in the PowerPoint download at <http://sciencespot.net/Pages/classchem.html#Anchor-poly>.

Safety Rules before Slime Time!

Go over the safety rules page with your students before they start making slime. Be sure to emphasize the rule regarding NO SLIME IN THE SINK or you will be faced with a lot of challenging clogs! The best way to clean slime stuff off hands, cups, and plates is by using a dry paper towel. Students may wash their hands only after all the slime gunk and pieces of slime are cleaned off. It is also important to stress the “No slime on carpets, clothing, or other people” rule.

NOTE: Slime (and the food coloring used to make slime) is tough to get out of carpets and clothes. OxyClean helps to get the food coloring stains off hands. It is also a good idea to have the kids wear old clothes or bring in old shirts/sweatshirts to wear during slime time.

Slime not working?

If your slime is too sticky or runny, try adding more borax solution or starch. If your slime is too stringy, add more glue and work it in by kneading it in your hands. Sometimes you will have to add enough glue to get it back to the sticky stage, then add a drop or two of borax or starch to finish it up. Be careful not to add too much borax/starch or the slime may get stringy or crumble depending on the type of slime you are trying to make. It is best to add 1-2 drops at a time and work it in with your hands. If you are having trouble with the goobers, give them time to sit! Sometimes it takes a few minutes for goobers to gel. They won't act like the other slimes, but should gel together to make a slimy ooze.

NOTE: If all else fails and you can't get the goo to slime, pitch it and try a new batch! Sometimes you'll get a bad batch and nothing will work to get it to slime stage.

Allow plenty of time!

It takes my students at least 4 class periods (42 minutes each) to make and test all the slimes. If you have a limited amount of time or supplies, you can have pairs work together. Have one group make one type of slime and the other group make another type. After each group is done with the tests, they can switch slimes and do their own tests. If possible, let every student make their own batch of Super Slime! It is voted the “coolest slime” by my students! You will also need to allow extra time each day for clean up!

Label! Label! Label!

After you mix up the different solutions, use labels to help the kids keep track of the slime supplies! I label each container with the type of solution and the names of the slimes for each. The students should also label their cups, plates, and bags of slime. I encourage students to reuse cups and plates as much as possible.

Organize!

Find some plastic boxes or shoe boxes to create supply boxes to store the materials for each group. At the beginning and end of each class, have the students do an inventory and make sure the box is neat and the materials (graduated cylinder, beakers/cups, eyedroppers, etc.) are clean. I made up 12 boxes for my students, which are divided into 5 different class periods. I also set up a “supply station” on one table in my room with paper towels, small plastic bags, stirring sticks, and triple-beam balances.

Another tip ... Assign a number for each box and use a permanent marker to label the items in each box. When you find stray items, you know where they belong.

Keep the slime in the classroom!

I also set aside space on a counter in my room for the students to use to store their plates, cups, and bags of slime. I provided five “paper” boxes - one for each class period. I was able to get the boxes from our janitor after he stocked up the office with reams of paper. You will want to make sure the students don’t sneak slime out of your room and cause problems in other classrooms! I let my students take home their slimes after we are done with them, but made them stop by at the end of the day to pick them up.

Good to the last drop!

Create a “glue recovery station” by cutting small holes in the lid of a large ice cream container. The holes should be big enough for the opening on a glue bottle. Remove the lids from glue bottles that are almost empty and place upside-down in the lid of the container. You will be able to get quite a few batches of slime out of the leftover glue.

NOTE: I purchase gallons of Elmer's school glue from [Discount School Supply](#). They also offer a pump for under \$17 that makes refilling glue bottles very easy!

Slime Fun

If you have time, challenge your students to create their own recipes for slime by changing the ingredients or amounts. Also give your students a chance to try gel- style glues or add glitter powder to make pretty slime. Check out the Steve Spangler website at <http://www.stevespanglerscience.com/product/1586> for some neat Glow Powder. They also offer several slime kits and materials.

Slime gone bad?

If your slime goes bad, throw it away! Most of the slimes will go bad in 3-4 days. It does help to keep the slime in the fridge, but some will get very slimy and you might even notice some mold!

Other slime questions?

Visit the slime sites listed on my [Chemistry Lesson Plans](#) page of the Science Classroom. Look for a list of slime sites just below the link for this page. You can also e-mail at <mailto:ttomm@sciencespot.net>.

PLAYING WITH POLYMERS

CROSSWORD KEY

Across

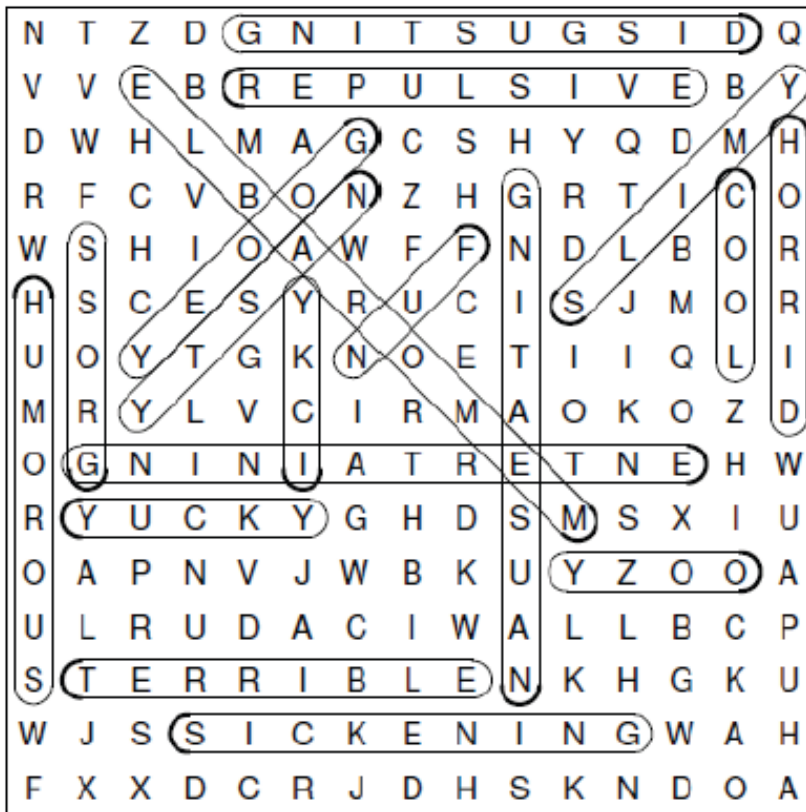
2. GUAR GUM Thickening agent used in many foods (or in goobers)
4. PLASTIC Synthetic polymer used to make many products, such as water bottles and toys
5. SILK A natural polymer created by many caterpillars and spiders
7. MONOMER Links in a polymer chain
9. SYNTHETIC Manmade polymers, such as plastic, nylon, and polyester
12. TRIPLE-BEAM BALANCE Instrument used to measure mass
16. STARCH Used to help prevent wrinkles in your clothes
17. POLYMER Chain of monomers that are chemically bonded together
18. PLASTIC WRAP A synthetic polymer used to cover food to prevent spoilage and contamination
19. DNA The code of life found in each of our cells
22. NATURAL Polymers made from plant and animal products found in nature, such as cotton, wool, silk, and natural rubber
23. NUCLEOTIDE Monomer that makes up the DNA molecule
24. BORAX Used as a laundry agent; sodium tetraborate

Down

1. POLYMERIZATION Process by which polymers are formed
2. GRADUATED CYLINDER Instrument used to measure volume
3. GOOBERS Slime made from laundry starch and white glue
4. POLYVINYL ALCOHOL Substance in white glue; used to make Super Slime
5. SUPER SLIME Slime made from PVA and borax solution
6. GOOBERS A slime made from guar gum and borax solution
8. AMINO ACIDS Building blocks of proteins
10. COTTON A natural polymer used to make "soft" clothing
11. OOBLECK A mixture made from water and corn starch
13. WHITE GLUE A common adhesive used for making slime
14. MEDICINE Polymers may be used in this field as substitutes for human tissues
15. NYLON A synthetic polymer that is used to make silky fabrics, such as pantyhose
18. PROTEIN Polymer made up of chains of amino acids; also called a polypeptide chain
20. WOOL A natural polymer used for clothing, such as coats and socks
21. GLOOP Slime made from white glue and borax solution

PLAYING WITH POLYMERS

WORD SEARCH KEY



COOL

DIGUSTING

ENTERTAINING

FUN

GOOEY

GROSS

HORRID

HUMOROUS

ICKY

MEMORABLE

NASTY

NAUSEATING

OOZY

REPULSIVE

SICKENING

SLIMY

TERRIBLE

YUCKY