

Toy Chemistry

Activity 1

By mixing two liquids together, kids produce a chemical reaction that results in a stretchy, slippery polymer. Then they test and observe what happens when they bounce it, twist it, jiggle it, and perform other experiments.

Prepare Ahead

- Assemble your paper clip chains for the demonstration (see step 6 and the accompanying diagram).
- For each kid, fill a cup with 2 tsp. of glue and a second cup with $\frac{1}{4}$ tsp. borax.
- Set up tables: Put a bowl of water and a roll of paper towels at each table. Each kid's work area should have the 2 cups, pre-filled with glue and borax, as well as 2 spoons and a knife.
- The activity sheet instructs kids to add the food coloring themselves. You may prefer to add it instead, to minimize the potential for spills and staining.

Safety Tips

Tell kids to keep mixtures away from their clothes, eyes, and mouth. The goop should not touch fabric or paper, only hard surfaces, since it sticks to things easily.

Lead the Activity

- 1 Introduce Ruff's challenge and make predictions.** (5 minutes) Tell kids that today's challenge is to learn more about chemical reactions. Explain that they are going to cause a chemical reaction by adding a mixture of borax and water to a mixture of glue and water. (*Borax is a mineral used as a cleaning agent.*) Ask kids to make predictions about what they think will happen when they combine the mixtures. Record their predictions on chart paper.
- 2 Make goop and test it.** (20 minutes) Distribute the activity sheets and have kids mix the ingredients (step 2 of the activity sheet). Have them add the food coloring carefully (or do it for them). Next, they'll combine the mixtures (step 3 on the activity sheet) to make the goop. Some excess water may remain in the cup after the goop forms. Invite kids to experiment and make observations. Ask them to test the goop by trying out the different ideas listed in step 4 of the activity sheet, and encourage them to come up with their own experiments.
- 3 clean up.** (5 minutes) Have kids put their goop in ziplock plastic bags to keep it moist. It can be stored in a refrigerator for a few weeks. They should wash their hands when finished.

Materials

- Activity sheet for each kid
- 1 bottle of white glue (7.6 fl. oz. bottle is enough for 15 kids)
- 1 box of borax (found in the detergent section of many supermarkets)
- 1 package assorted food coloring
- Clear plastic cups (2 per kid)
- Bowls with water, 1 per work table
- Measuring spoons
- Plastic spoons (2 per kid)
- Plastic knife (1 per kid)
- Plastic ziplock bag (1 per kid)
- Paper towels (1 roll per work table)
- Paper clips for a polymer demonstration
- Chart paper and marker
- Examples of polymers: a CD, plastic bag and bottle, stick of gum, balloons, an eraser, and rubber bands

National Science Education Standards

Grades K-4

Science as Inquiry: abilities necessary to do scientific inquiry; understanding about scientific inquiry

Physical Science: properties of objects and materials

Grades 5-8

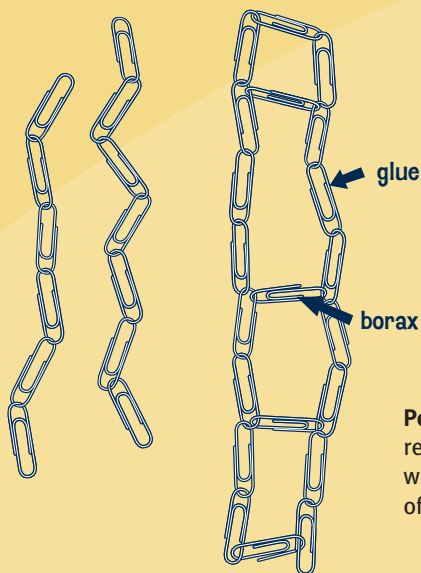
Science as Inquiry: abilities necessary to do scientific inquiry

Physical Science: properties and changes of properties in matter

4 Discuss what happened.

(10 minutes) Gather as a group, and ask:

- What happened when you combined the mixtures? Is it what you predicted? *(Answers will vary.)*
- When you tested the goop, what observations did you make? *(Answers will vary.)* Did it seem like a liquid or a solid? *(A little like both: it's like a liquid that moves or flows very slowly; it's also like a solid because you can hold it in your hand or slice it with a knife.)*
- Combining the two mixtures resulted in a chemical reaction. From your observations, what do you think that means? *(When a chemical reaction happens, a new substance is formed. In this case, combining two liquids resulted in the semi-solid goop.)* Explain that chemical reactions happen to the molecules of a substance. When you combined the borax and glue mixtures, the structure of their molecules was altered, forming a substance different from the two you started with.



Polymer Chains. Make two chains of paper clips to represent glue. Make two more chains, connected with additional paper clips. These represent chains of glue linked together by the borax.

- 5 Explore polymers.** (5 minutes) Tell kids that the goop they just made is called a *polymer*. Many polymers are plastics, like rubber bands or plastic bottles. Show them the examples of polymers you brought in, and ask kids to think of others. *(Kids might point out their sneakers, the plastic spoons and cups, and the glue. Note: glue is a polymer; when mixed with borax, it forms a polymer compound.)* Ask kids how polymers differ from each other. *(Some are hard and strong like a CD, and some are flexible and stretchy, like chewing gum.)*

- 6 Demonstrate the chemical reaction.** (5 minutes) Tell kids you're going to explain a little more about the chemistry that produced their polymer.
- *(Hold up the two separate chains of paper clips to represent the glue polymer, and dangle them around.)* Tell kids that glue is a very fluid and flexible polymer (until the glue hardens), like these paper clips.
 - Explain that borax is what scientists call a "cross-linking" agent. It links the long chains of glue molecules together in a web, making it harder for them to move around as much. *(Hold up the cross-linked paper clips to show how the borax binds the long chains together.)* The cross-linked chains are stronger and denser, yet still flexible, just like your polymer.

- 7 Award points.** (5 minutes) Time to rack up some points! Review the activity's key ideas by asking the following questions, worth 50 points each:
- What did you think might happen when you mixed the glue and borax? *(Answers will vary.)*
 - Did a chemical reaction occur? When? How did you know? *(It happened when the glue and borax mixtures came in contact with each other. They were liquids, and then a more solid substance formed.)*
 - Tell me three different observations you made about the polymer you created. *(Answers will vary.)*
 - Name two other things that are polymers. *(See list on activity sheet or the items you brought in.)*
 - Science involves making predictions. What do you predict would happen if you made another batch of goop using more glue? *(It would be slimier and more fluid.)* What would happen if you added twice the amount of borax? *(It would be harder and more rubbery.)* Why do you think this would happen? *(More borax would bind the glue together in a tighter web so it couldn't move around so much.)*

Toy chemistry

Today's challenge is to mix two liquids together to form a gooey solid that you can mold and stretch into weird shapes. This is chemistry at its craziest!



1 Get what You need.

- 2 tsp. white glue • ¼ tsp. borax • 4 tsp. water
- Measuring spoons • Food coloring • 2 clear plastic cups • Plastic spoons • Plastic knife
- Plastic ziplock bag for storage • Paper towels

2 Mix the ingredients.

In a cup, mix 2 tsp. of water with 2 tsp. of glue. Then add 2 drops of food coloring. In another cup, mix 2 tsp. of water with ¼ tsp. of borax.

3 combine the mixtures.

Pour the borax mixture into the glue mixture and stir. When the two are mixed, what happens? Take the goop into your hands and play with it.

4 Experiment and make observations.

Does your slimy goop act more like a liquid or a solid—or a little like both? Find out all the things it can do: try to stretch it, bounce it, flatten it, twist it, roll it, jiggle it, rip it apart, or use your knife to cut it into shapes. Does it keep its shape if you leave it alone for a while?

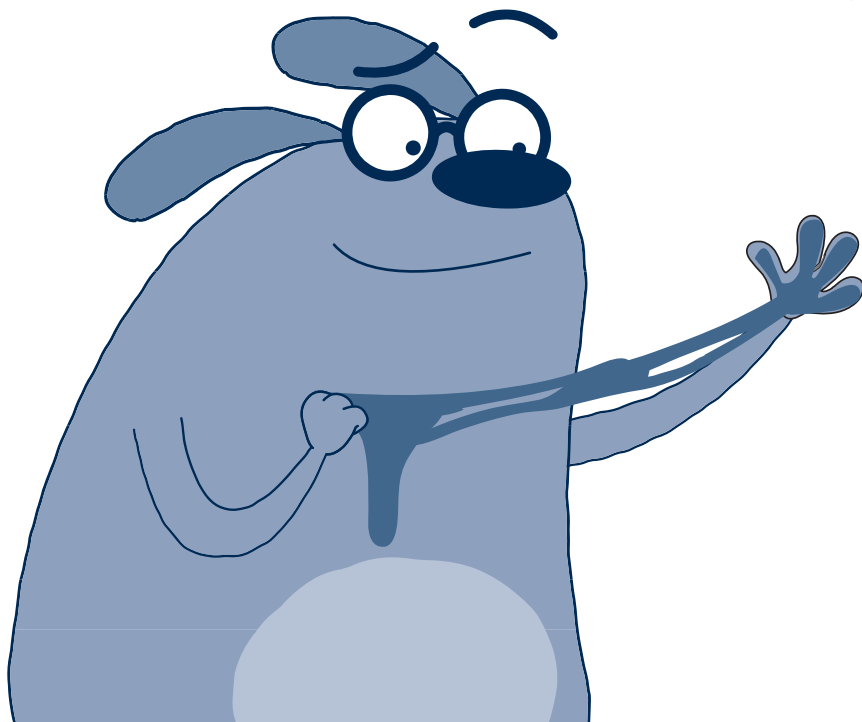
chew on This!

You just created a *polymer*. Many polymers are flexible plastics, like balloons, plastic water bottles, and the soles of your sneakers. But so are gelatin and nylon windbreakers. Some polymers, like a skateboard wheel, are strong and hard, yet flexible enough to absorb shocks and allow for a smooth ride. Other polymers, like chewing gum or the slimy goop you just made (which contains mostly water), are soft and stretchy.

How did you make a polymer? Combining the borax and glue mixtures caused a chemical reaction. By themselves, glue molecules move about freely (until they dry). But when you add borax, it binds the slippery glue molecules together in a web, so they can't move around as much. Borax turns the watery glue into a denser, more rubbery substance.

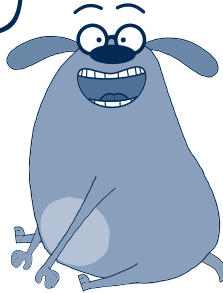
safety Tips

- Keep mixtures away from clothes, eyes, and mouth.
- Goop should not touch fabric or paper, only hard surfaces, since it sticks to things easily.



cool science Jobs!

Like making goop and playing with polymers? Then you might love one of these jobs.



POLYmer scientist

The sky's the limit for polymer scientists. They design everything from sandwich bags to satellites. They even help the environment. Did you know that polymer scientists have discovered ways of turning recycled plastic milk jugs into park benches, picnic tables, and yes, even DOG houses? Now, that's creative—and good for the planet!

TOY chemist

Who puts the bounce in a ball, the color in a crayon, and makes all kinds of things glow in the dark? Chemists do! Some of the best toys ever invented were created by chemists—and polymers are one of their favorite materials. What a job—playing with toys all day!



Watch the related FETCH! episode, "Just Toying with Ruff," on PBS KIDS GO! (check local listings) or visit the FETCH! Web site at pbskidsgo.org/fetch.



FETCH! is produced by WGBH Boston. Major funding for FETCH! is provided by the National Science Foundation and public television viewers. Corporate funding is provided by Greendog®. This FETCH! material is based upon work supported by the National Science Foundation under Grant No. 0714741. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation. © 2008 WGBH Educational Foundation. All rights reserved. FETCH!, the characters and related indicia are trademarks of the WGBH Educational Foundation. All third party trademarks are the property of their respective owners. Used with permission.

Fold

Fetch!

TOY chemistry

Blossom's been hinting that she'd like a cute catnip toy for her birthday—something fluffy and pink. But I like to give presents of the stranger, slimier variety.

Hmmm . . . I've got it! Design a weird, sticky, stretchy toy for Blossom.

And if she doesn't like it, well, I know I sure will!

GOOO
FETCH!

