



## Curiosity Guide #501

### Polymers

Accompanies Curious Crew, Season 5, Episode 1 (#501)

#### Designing Slimes

STEM Challenge

#### Description

Let's get slimy! Make three slimes in this slippery challenge.

#### Materials

- Polyvinyl alcohol
- Borax
- Water
- Stove
- Measuring cup
- Food coloring
- Pot
- 3 clear dishes with lids
- Rubber bands
- Thermometer
- Digital scale
- Spoon
- Refrigerator
- White glue
- Liquid starch
- Plastic cups
- Popsicle stick
- Safety Goggles
- Wax paper

PLEASE USE SAFETY GOGGLES TO PREPARE SLIMES.

#### Procedure 1: *Glurch Slime*

Please note: This slime needs overnight refrigeration.

- 1) Measure 5 grams of polyvinyl alcohol on a digital scale and set aside.
- 2) Measure and heat 100 milliliters of water in a pot on the stove until the water reaches 80 degrees Celsius.
- 3) Slowly stir in the polyvinyl alcohol. Stir until dissolved.
- 4) Add a small amount of food coloring to the polyvinyl alcohol.
- 5) Remove from heat and set aside. Let cool and then cover the mixture.
- 6) In a separate container measure 20 milliliters of water.
- 7) Measure and add 1 gram of borax to the water. Stir.
- 8) Add the borax solution to the polyvinyl alcohol solution. Stir.
- 9) Seal the container and refrigerate overnight.

#### Procedure 2: *Gluep Slime*

- 1) Combine 8 ounces glue with 8 ounces water in a plastic cup. Stir with a popsicle stick.
- 2) Add 3 drops of food coloring.
- 3) In a separate container, combine 1  $\frac{1}{2}$  cups of water with 1  $\frac{1}{2}$  teaspoons of borax. Stir.
- 4) Scoop the mixture out and work it with your hands.

#### Procedure 3: *Starch Putty*

- 1) Combine 2 cups white glue with one cup liquid starch.
- 2) Work the mixture together until it is no longer wet.

#### Procedure 4: *Test*

- 1) Put on safety goggles and prepare the three slimes.
- 2) Compare the slimes by rolling each on wax paper. Which can be rolled into the longest cylinder without breaking?

- 3) Make a pancake of each on wax paper. How big can you make it and still peel it off the paper without breaking.
- 4) Roll a sample of each into a ball and drop it from a similar height. Which one bounces the best?
- 5) Which slime can be stretched the furthest? Measure the distance.

## My Results

## Explanation

Polyvinyl alcohol and glue water are polymers. Polymers are big molecules made of a chain of the same chemical units that are bonded together. The chemical units perform covalent bonding, which happens when the different chemicals share electrons.

Imagine these polymer molecules are long, wet spaghetti noodles. Although the molecules can slide past each other, they easily get tangled up. The borax and starch solutions act as cross linkers that combine those long molecular chains. The borax and starch cause the mass to thicken up and change the way the substances behave. The new substances may become more stretchable; have more elasticity when they bounce; or increase in viscosity, which is the ability to lose shape and flow.

**Want to know more?** The Crew noticed how each of the slimes changed when we added the cross-linker ingredients, but why does it do that? Imagine those long polymer molecules are wet spaghetti noodles that could slip past each other. When we add the cross linkers, the polymers connect in many different places. The new connections make the substance clump together and make the material stronger and more rigid. The same thing happens with different plastics. Those without a cross linker like a soda bottle can be melted and reshaped. However, when a polymer has an added cross linker, like in a car tire, the polymer sets up and can't be reshaped or recycled. Polymer chemistry is really interesting!

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