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Bruce Museum at Home
STEAM Activities for Children

Lesson # 12: *Slime Time: Polymers*
Week of June 15, 2020

This week's STEAM at Home lesson is a continuation of last week's exploration of states of matter and their physical properties. Learners will experiment with creating a polymer (slime) and explore its physical interactions. The experiments this week do not use difficult-to-source materials but are messy and require specific materials. Please plan accordingly before beginning any of these projects with your learner.

Learners will use their science journals to predict, record, and explore their experiments. If your learner hasn't made a science journal, instructions can be found here. If learners have a notebook, or other paper they prefer to use, that's fine.

In order of appearance, this lesson contains: a materials list for *Slime Time*, instructions for *Slime Time*, ways to add on to the activity, a brief art activity, and NGSS Performance Expectations. Additionally, a list of chemistry vocabulary words is available as a separate document, and can be found here.

A tip for adults: *The materials used in this lesson are not hard to find, or dangerous, but they are messy. You might want to do this project outside, or over a drop cloth or plastic covering. Borax is a detergent, and some people experience skin irritation from prolonged contact. You may want to wear plastic gloves when mixing and handling Borax. Pay attention to your learner's skin as they handle their slime.*

Experiment Materials List: 1 box of borax, 2 containers of school glue (Elmer's is the gold standard of school glues, but any glue labeled "school glue" should work), containers for mixing and stirring, tongue depressors/popsicle sticks for mixing, covering for table or floor, 1 liter of room temperature water, teaspoon and tablespoons, and measuring cups.

Art Project Materials List: food coloring, glitter, small containers for storage, wax paper.

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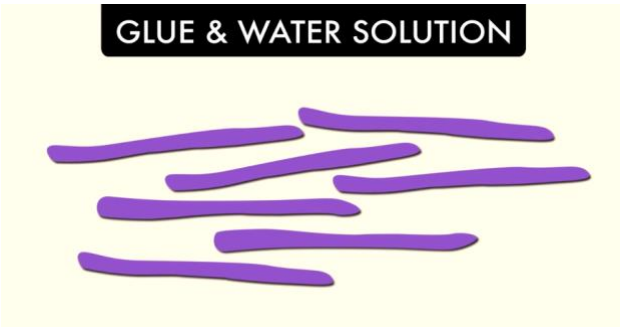
Now It's *Slime Time!*

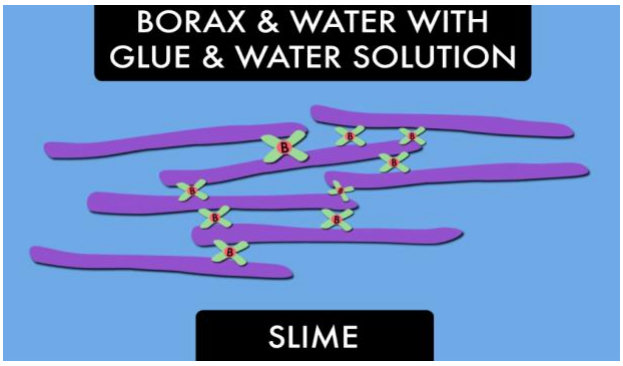
Many of us know of slime from watching Nickelodeon, but did you know you can make slime easily at home using school glue, borax washing powder, and tap water? The secret to this experiment is that school glue is made of polyvinyl alcohol, a **polymer** with interesting physical properties.

There are two different chemical reactions taking place when you make slime.



1) When you mix the water and borax, the borax forms an ion, or negatively charged molecule, called borate ion.
2) When you mix the borate ions and school glue together, the borate ions link up with the long school-glue polymers and "firm up" the polymer to create a non-Newtonian fluid.

- What is a polymer?
    - Polymers are molecules made of extremely long chains of simpler molecules, called monomers.
        - Different polymers have different physical properties; depending on their physical makeup, these can be resistant to electricity, have a slippery texture, be lightweight but comparatively strong, etc.
    - There are naturally occurring polymers, and man-made polymers.
        - Cellulose and plant starch are naturally occurring polymers.
        - Plastics are a form of human-made polymers.
- What are the properties of slime?
    - Slime is a non-Newtonian liquid, like the oobleck we made last week.
        - This means that slime will not maintain its viscosity or texture when subjected to friction and pressure.



    - Borax slime is created by the chemical reaction between the borax ion (sodium tetraborate decahydrate, $Na_2B_4O_7 \cdot 10H_2O$) and the school glue.
    - School glue is primarily made of polyvinyl alcohol (C_2H_4O), which combines with the borax ion to form long molecular chains that "stick" together and give slime its signature bouncy, yet stretchy, texture.

- The layers, or cushion, of water molecules between the borax and PVA chains are what give slime its flowy and drippy properties- this is a physical interaction.

Make Some Slime!

- Gather your materials for slime making: measuring and mixing cups, measuring spoons, at least 3 stirrers, the borax powder, room temperature water, and school glue.
- This is the basic recipe for borax slime, using white school glue; for other recipes, check out the links at the bottom of the lesson.
    - In a mixing container, place ½ cup of room temperature water.
    - Add ¼ teaspoon of borax to the water.
        - Mix until the borax is as dissolved as possible; you may still be able to see some borax grains.
    - In a second cup, add ½ cup of room temperature water and ½ cup of school glue.
        - Mix until the glue and water are combined.
    - Using a clean stirrer, slowly mix the borax mixture into the glue mixture, stirring the whole time.
        - There should be an immediate change in the texture of the glue mixture; it will start clumping together and sticking to the stirrer.
    - When the slime seems to be a good, thick texture, remove it from the container.
        - There may be some water leftover, and that's ok.
        - The slime should stick mostly to the stirrer, and not the sides of the container. That's how you know it's ready.
- Now your slime is ready for you to play with it!
    - You and your learner may observe that, similar to oobleck, slime will display different physical characteristics, depending on how you interact with it.
        - Your learner should use their science journal to take notes on their slime's characteristics.
        - Your learner should also use their journals to write down any questions they have about their slime.
    - Ask you learner, what can they do with their slime?
        - Does the slime bounce?
        - Can the slime be stretched from shoulder to shoulder?
        - How tightly can the slime be squeezed?
            - How does the slime change when it is squeezed?
        - What texture does the slime have?
        - If you put a cup upside down and put the slime on top, what will it do?

        - Can the slime roll down an angled surface?
        - What happens if the slime is dropped from a high height?
    - To make the slime you followed a specific recipe; what would happen to the slime if your learners changed the recipe?
        - What if they left out the water?
        - What would happen if they added more borax or more glue?
        - What if they changed the ratio of borax to glue to water?
    - To make the slime we used room temperature water. What would change if the water temperature changed?
        - Try making slime with ice water.
        - Try making slime with warm water (not too hot!).

Slime as Art

To give color or texture to slime, you can add things like glitter, food coloring, small beads, confetti, small Styrofoam balls, figurines, etc. In fact, there are whole websites dedicated to things you can do with and to slime. The art project in this lesson relies on food coloring, glitter, and time to make art, but there are lots of other fun things to do with slime.

- Make several new batches of slime, or as many batches as you would like to make with different colors of slime.
    - To add color to slime, mix a few drops of food coloring into the borax and water solution before adding the glue.
        - You will need only a drop or two of color, as it is very strong.
    - To add glitter or confetti to slime, mix the add-ins to the borax powder before adding the water and stir until well mixed.
- When you add the borax and glue together, stir thoroughly so that the color and/or other add-ins are mixed evenly.
- Now you have colored slime!
- When you have made as many different types of slimes as you want, choose a clean, non-porous surface and press your different slimes down into a pattern or picture.
- Leave your slime pattern, or picture, out for 2-4 days, until it is completely dry.
    - The amount of time that this will take depends on humidity levels. You may want to aim a fan at your slime to dry it out faster.
- Once your slime is dry, you should be able to pick it up, and even hang it in a window as a suncatcher if you wish!
    - Consider making a hole in the top of your dried slime so that you can hang it.

- If you want to keep your slime wet you will need to store it in a small tight container or a sealed Ziploc bag.

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Want to explore more? Check out these other resources:

Basic Recipe & Science Behind the Slime
Experiments with Slime
Slime for Under 5s
More Experiments
17 Art Projects with Slime
Elmer's Official Slime Recipes

NGSS Performance Expectations

2-PS1-2 Matter and Its Interactions: Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.

5-PS1-4 Matter and Its Interactions: Conduct an investigation to determine whether the mixing of two or more substances results in new substances.

5-PS1-3 Matter and Its Interactions: Make observations and measurements to identify materials based on their properties.