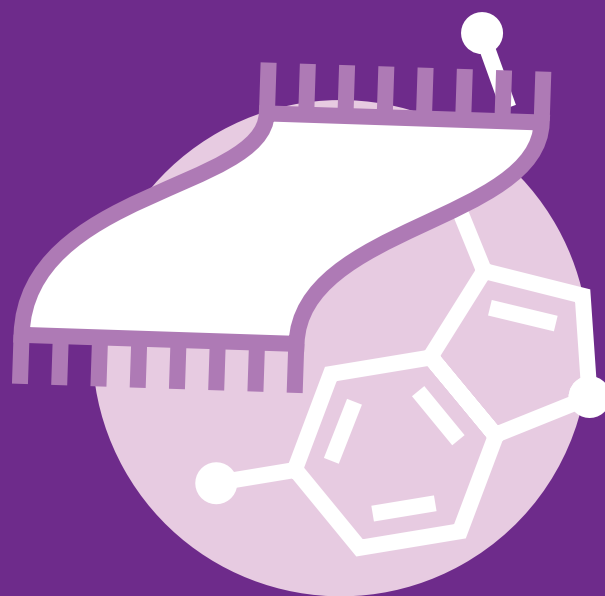


Be a Chemist!

# Be a Materials Chemist

Educator Guide



**Big Question:**

How can materials chemists create stronger, stretchier slime for a new toy?

# Table of Contents

Use the list below to help you navigate this guide!

**03** *Be a Chemist!* Big Ideas

*Find this year's main themes and the Core Four facilitation strategies.*

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**04** **Be a Materials Chemist**

*Find detailed instructions for facilitating this activity.*

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**10** **Be a Materials Chemist Quick Guide**

*Find a summary of the content, as well as a QR code to the *Be a Chemist!* webpage.*

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# Be a Chemist! Big Ideas

These are the themes you'll find running through all five *Be a Chemist!* activities.

**Chemistry is the “study of stuff”—what things are made of, how they behave, and how they change.**

- What chemicals make up the materials in the world around us?
- How are substances alike or different?
- What happens when we mix substances together—do they stay the same or create something new?

**All substances in our world are made of chemicals—and chemists help us understand and use them safely and effectively.**

- How can we use chemistry to solve problems or invent something new?
- How can we test products to make sure they are safe for us to use?

**To learn more about the materials chemist career and the science behind this activity, look for the “Background” section at the end of the activity procedure.**

## Core Four Strategies

Use the Core Four Strategies as you guide your learners through this activity.

- **Ask questions** to spark curiosity and encourage new ideas
- **Encourage scientific thinking** with chances to observe, make predictions, and test ideas
- **Cultivate rich dialogue** with chances to talk together, share ideas, and use science words
- **Make connections** between learners' experiences, science careers, and this activity



**Ask Questions**



**Encourage Scientific Thinking**



**Cultivate Rich Dialogue**



**Make Connections**

# Be a Materials Chemist



**Big Question:** How can materials chemists create stronger, stretchier slime for a new toy?



## Materials:

### Per class:

- Materials Chemist career card
- 2-3 types of slime toys, such as silly putty, cloud putty, and/or stretchy fidget toys (1 toy per group)
- Borax (¼ cup)
- White glue (½ -1 gallon)
- Cornstarch (½ cup)
- 32 oz container with lid
- ¼ cup measure

- Warm water
- Food coloring dropper bottles, 2-3 colors
- Chart paper or whiteboard (optional)
- Bin or bucket for waste (optional)
- Gloves (optional)
- Lab notebooks
- Pencils
- Science skills stickers

### Per group of 3–4 learners:

- 4 oz paper cups (8)
- 9 oz clear plastic cups (4)
- Pipette (1)
- Craft sticks (4)
- Spoons (3)
- Plastic tray (1)

## ⌚ Prepare:

1. Prepare the borax solution by adding approximately ¼-cup of borax to the 32 oz container. Fill with warm water and stir or shake until no more will dissolve. Some solid borax should remain at the bottom of the container. Label the container "Borax solution." Once made, the borax solution is stable and can be stored for long periods of time.
2. Prepare the following materials and set up on a plastic tray (one set per group):
  - Fill a 9 oz clear plastic cup about halfway with borax solution and label it with both the scientific and common name: "borax liquid (sodium tetraborate)." Place a spoon in the cup.
  - Fill a 9 oz clear plastic cup about halfway with water and label it "water (dihydrogen monoxide)." Place a spoon in the cup.
  - Fill a 9 oz clear plastic cup about halfway with glue and label it with both names: "glue (polyvinyl acetate)." Place a spoon in the cup.
3. For each group, add ¼ cup of cornstarch to a 9 oz clear plastic cup and label it with both names: "cornstarch (amylopectin)." Place a spoon in the cup and set aside for Part 3.

## Safety Note



Cornstarch is a potential allergy trigger. Anyone with known allergies to corn or corn products should avoid contact with cornstarch during this activity, and/or it could be left out of the activity altogether. At the start of the lesson, ask your learners if anyone has an allergy to corn or can't eat foods with corn products in them.

In high doses, borax can cause irritation to the skin and eyes. The solution used in this activity is safe to handle, but learners should avoid excessive skin contact and wash their hands after use. In case of contact with eyes, rinse thoroughly with water.



## Engage (10 min)

Describing the career photo out loud assists learners who are blind or low vision, provides vocabulary support for language learners, and helps with visual processing.

**Example:** "This photo shows a scientist wearing gloves and safety glasses holding up a rectangular piece of something that is see-through. There are some flasks and other lab equipment behind them."

1. Introduce the materials chemist career by showing the group the career card and describing the photo on the card. Ask questions to encourage learners to think about what a materials chemist might do:
  - ❓ What do you notice about this picture? What do you think the person is doing?
  - ❓ Where do you see chemicals in this picture? Where do you see science tools?
  - ❓ What does the name "materials chemist" make you think of?
  - ❓ What do you think a materials chemist does? What makes you think that?
2. Explain that a materials chemist studies what things are made of and creates new materials with special properties depending on their purpose. They help design everything from stronger sports gear and safer helmets to flexible, waterproof, phone screens and medical implants doctors use in surgery.
  - ❓ What materials do you use every day? What do you think they're made of?
  - ❓ How are some materials alike? How are they different?
  - ❓ What do you think materials chemists do to make new kinds of materials?

### 3. Introduce the storyline like this:

- We are a team of materials chemists who work for a toy company. We've been assigned to create a new slime toy that is stronger and stretchier than other models.
- Ask:
  - ❓ Where have you encountered slime or other stretchy materials before?
  - ❓ What does it look and feel like? How does it behave?



## Explore (40 min)

### Part 1: Researching Slime Toys

For some learners with sensory sensitivities, touching the slime toys may be difficult. Offer gloves to anyone who is uncomfortable handling the toys; they can also use them later during the slime-making process as needed. If they're still not comfortable touching the toys, let them know it's OK to rely on the rest of their team for those observations!

1. Divide your learners into groups of 3-4 and give each group one example slime toy. Guide learners to discuss:
  - ❓ What does the material feel like? Is it smooth, wet, or sticky?
  - ❓ What happens if you squeeze it into a ball? Does it stay in a ball shape, or bounce back to its original shape?
  - ❓ When you pull it apart, does it stretch or break? Can you make it do both?
  - ❓ How far does it stretch? What happens when you let go?
2. As a group, guide them to compare the characteristics of each toy's material. If possible, record their ideas on a whiteboard or chart paper. Ask:
  - ❓ How are the materials the same? How are they different?
  - ❓ Which toy is the stretchiest and strongest?
  - ❓ What would you change to make it an even better toy?

**Activity Extension:** For older learners, create stations to test different properties of each toy:

- **Elasticity Test:** How far can it stretch before breaking?
- **Bounce Test:** How does it bounce when dropped from different heights?
- **Friction Race:** How fast does it move down a ramp?
- **Temperature Test:** Does it behave differently when it's warm or cold?



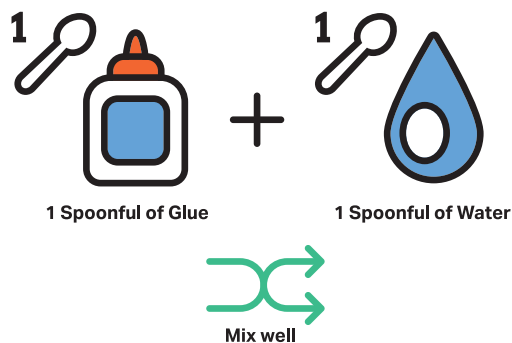
## Part 2: Testing Slime Formula

### 1. Establish safety guidelines.

Explain that while all the materials in this activity are safe to touch, it's still important to follow basic lab safety rules:

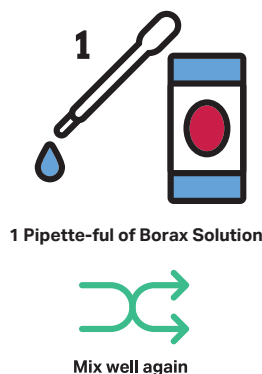
- Don't touch your face and eyes. Some materials might cause irritation if they get into your eyes.
- Wash your hands with soap and water when you're finished.
- Never taste or put any of the materials in your mouth. These are for experimenting, not eating!
- The plastic tray will be your "lab" space. All the liquids and other materials should stay inside the lab (on the tray).

1. Explain to learners that they will make a slime sample using a basic formula and compare it to the features they want their slime toy to have. Ask them to review the sample slime formula on page 13 of their lab notebooks.
2. Distribute slime-making materials to each group, including paper cups and craft sticks. Ask learners if they recognize any of the materials, then briefly describe them:
  - White glue – an adhesive that helps things stick together
  - Water (H<sub>2</sub>O) - used to mix and dissolve ingredients
  - Borax solution – a household cleaner



3. Instruct learners to follow the recipe to make a sample slime in a paper sample cup. As they add and mix ingredients, pause to ask them:
  - ❓ What do you notice about your mixture so far?
  - ❓ What do you think will happen when you add the borax? What makes you think that?
  - ❓ What do you notice about your mixture now? How has it changed?
  - ❓ How does your sample look compared to your neighbor's? What's similar or different?
4. Ask learners to make observations and compare it to the features they want in the stretchiest and strongest slime toy.
  - ❓ How well does it stretch?
  - ❓ How well does it hold its shape?

You may need to pause here to demonstrate proper pipette use. Show learners how to place the pipette tip into the liquid, then gently squeeze and release the bulb to draw the liquid up. Encourage them to practice a few times to get comfortable before continuing with the activity.



## Part 3: Creating a New Slime Toy

1. Explain that now it's their turn to improve the recipe and design a formula for the stretchiest, strongest slime toy.
2. Encourage them to start by changing one thing about the sample formula that they think will make it stretchier or stronger. Suggest that different members of each group could choose different changes. For example, they could:
  - Use more of one ingredient
  - Use less of one ingredient
  - Change which materials they mix together first
3. Invite learners to test their new recipe in a new paper cup and observe the results.
  - ❓ **How does it compare to your first slime?**
  - ❓ **How does it compare to the slimes your team members made?**
4. Then introduce the new materials they can add to their slime recipes: cornstarch (a thickening agent commonly used in cooking) and food coloring.
  - ❓ **How do you think these ingredients might change your slime?**
5. Guide them to record on page 14 of their notebook what they're adding or changing. Prompt them to ask questions like:
  - ❓ **Is it stretchier? Stronger? Softer?**
6. Have them repeat the testing process a few times to refine their formula and get the results they're aiming for.

For younger learners, or if time is short, you could skip this section (Steps 4-6).



### Reflect (10 min)

1. Bring the group together to discuss their results:
  - ❓ **Which slime recipe worked the best? Why do you think it was the most successful?**
  - ❓ **What changes made the slime stretchier, stronger, or softer?**
  - ❓ **Did any combinations surprise you?**
2. Encourage the group to reflect on how they were like materials chemists during the activity. Refer to the career card and the science skills stickers:
  - ❓ **What are some things you did today that a materials chemist might do?**
  - ❓ **How did you think like a scientist?**
  - ❓ **What did you do today that made you feel like a scientist? What science skills did you use?**
3. Allow time for learners to draw or write their reflections on page 15 of their lab notebooks. Invite them to choose a science skills sticker that reflects a skill they used and add it to their notebooks.

## Cleanup

- Liquid waste can be safely poured down the drain.
- Paper cups, slime, and other solid waste can be disposed of in the trash.
- Plastic cups, pipettes, and spoons can be rinsed thoroughly with water and reused as needed.

## Background

**Materials chemists** study the properties of substances in order to discover new materials and design materials with specific properties for a specific purpose. They might develop paints and coatings that are waterproof, reflective, or heat-absorbing, create materials for medical implants and tools that don't harm human tissue, or discover new lightweight combinations of metals to build lighter, faster vehicles. While materials science incorporates many different disciplines including physics and engineering, chemistry is a key component because the properties of a material are related to its chemical structure. For more information, visit the American Chemical Society's page on materials science careers: <https://www.acs.org/careers/chemical-sciences/fields/materials-and-textiles.html>

**Science of Slime:** White glue is a mixture of water and polyvinyl acetate (PVA), which is a type of polymer—long, string-like molecules made up of shorter molecules joined together. ("Poly" means "many", so PVA is made from many vinyl acetate molecules attached into a long chain.) In the glue solution, the long chains are free to move around and past each other.

When borax solution is added to the glue, the molecules of borate connect the long PVA chains, "tangling" them together in a reaction called **crosslinking**. This makes them less free to move around and changes the mixture from a liquid to a stiffer, more elastic material. The more borate ions that are present in the solution, the more crosslinking will occur, and the stiffer the substance will be. The connections between the borate and PVA are relatively weak. Adding an acidic substance, like vinegar or citric acid, will break the bonds and re-liquefy the glue.

**Cornstarch** is primarily made of a naturally occurring polymer called amylopectin, along with smaller amounts of a related polymer called amylose. Most green plants produce amylose and/or amylopectin as a form of energy storage. **These polymers do not react chemically with borate or with PVA in the slime.** Instead, the cornstarch particles get caught in the tangle of crosslinked PVA chains, which makes the mixture stiffer and even more solid.

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# Be a Materials Chemist Quick Guide

| EDUCATORS DO:  | EDUCATORS ASK:   | LEARNERS DO:   |
|--|--|--|
| <b>ENGAGE</b>  |  |  |
| <p><b>Introduce Career</b></p> <ul style="list-style-type: none"> <li>• Use career card</li> <li>• Ask discussion questions</li> <li>• Explain what materials chemists do</li> </ul>                                       | <p>What do you notice about this picture?</p> <p>What do you think this person is doing?</p> <p>What do you think a materials chemist might do or study?</p>                                       | <ul style="list-style-type: none"> <li>• Make observations about the image</li> <li>• Make connections to their own experience</li> <li>• Share their ideas</li> </ul> |
| <p><b>Introduce Story</b></p> <ul style="list-style-type: none"> <li>• We are a team of materials chemists who work for a toy company</li> <li>• We've been assigned to create a stronger, stretchier slime toy</li> </ul> | <p>Where have you seen or encountered slime or other stretchy materials before?</p> <p>What does it look and feel like?<br/>How does it behave?</p>  | <ul style="list-style-type: none"> <li>• Imagine being a material chemist</li> <li>• Discuss what slime toys feel and behave like</li> </ul>                           |
| <b>EXPLORE</b>   |  |  |
| <p><b>Part 1: Researching Slime Toys</b></p> <ul style="list-style-type: none"> <li>• Guide learners to observe and compare the sample slime toys</li> </ul>   | <p>How do the different slime toys feel? Stretch? Keep their shape?</p> <p>How are the materials the same? How are they different?</p> <p>What would you change to make it an even better toy?</p> | <ul style="list-style-type: none"> <li>• Make observations about how different slime toys look and behave</li> </ul>   |

\*\*Quick Guide continues on the following page.

# Be a Materials Chemist Quick Guide



| EDUCATORS DO:   | EDUCATORS ASK:  | LEARNERS DO:  |
|---|---|---|
| <p><b>Part 2: Testing Slime Formula</b></p> <ul style="list-style-type: none"> <li>Guide learners to create slime using the sample formula</li> </ul>                                     | <p>What do you notice about your mixture so far?</p> <p>How does your sample look compared to your neighbor's? What's similar or different?</p>   | <ul style="list-style-type: none"> <li>Make slime using a sample formula</li> <li>Make observations about how the sample slime behaves</li> </ul> |
| <p><b>Part 3: Creating a New Slime Toy</b></p> <ul style="list-style-type: none"> <li>Encourage learners to create their own slime recipe by changing and adding new chemicals</li> </ul> | <p>What could you add or change? How does it compare to the sample?</p>   | <ul style="list-style-type: none"> <li>Create new slime toys by changing and testing new chemical combinations</li> </ul>                         |
| REFLECT   |   |   |
| <p><b>Share Group Results</b></p>   | <p>Which slime recipe worked the best? Why do you think it was the most successful?</p> <p>What changes made the slime stretchier, stronger, or softer?</p> <p>Did any combinations surprise you?</p> | <ul style="list-style-type: none"> <li>Share and compare results</li> <li>Reflect on the process</li> <li>Draw conclusions</li> </ul>             |
| <p><b>Make Career Connections</b></p>   | <p>What did you do today that made you feel like an materials chemist?</p> <p>How did we think like scientists?</p> <p>What science skills did we use?</p>  | <ul style="list-style-type: none"> <li>Use skills stickers</li> <li>Draw/write reflections</li> </ul>   |

