Matter Mayhem!

Mix, Squish, & Discover the Science of Stuff

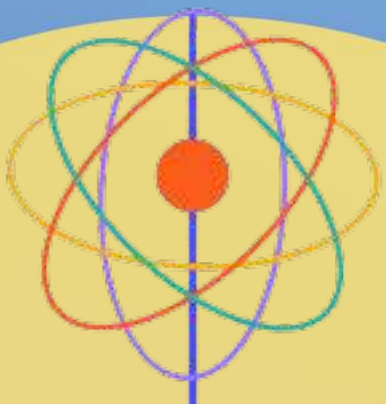
the Shoebox Lab

WHAT WILL YOU LEARN?

- Use your senses to observe and measure a material's properties
- Find out what happens when you mix things together
- Find out the difference between a physical change and a chemical change

YOUR ACTIVITIES AT A GLANCE

	YOU WILL EXPLORE ...
#1: SQUISH IT! – STRESS BALL	Does mixing change what something is made of?
#2: STRETCH IT! – SLIME	Did a brand-new substance appear?
HISTORY – TIMELINE OF POLYMERS	How do tiny pieces link up to make our world?
#3: BOUNCE IT! – BOUNCY BALL	Can the same ingredients make something totally different?
SCIENCE SPOTLIGHT – WHAT'S GOING ON?	The science behind your experiments!
CHALLENGE – CRACK THE CASE!	Can you use science to figure out different mystery powders?



SCAN FOR THIS KIT'S VIDEOS!
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SAFETY FIRST!

READ THIS BEFORE YOU OPEN THE KIT

SAFETY FIRST!

This kit is full of fun — and a little mess! Follow these rules to stay safe:

DO NOT EAT OR TASTE ANYTHING IN THIS KIT. The powders and liquids are safe to touch, but they are NOT food.

WASH YOUR HANDS with soap and water after every activity. Make sure you do it before you eat or touch your face.

KEEP MATERIALS AWAY FROM YOUR EYES. If anything gets in your eyes, rinse with clean water right away and tell an adult.

ALWAYS WORK WITH AN ADULT NEARBY. Some steps need a helper!

USE THE TABLE COVER! Spread the plastic table cover over your table before you start. Your table will thank you.

WORD WATCH

OBSERVE— means to look at something closely and carefully, using your senses. Scientists observe with all their senses — they watch, listen, smell, and feel. *TRY IT:* Pick up your cup of cornstarch and observe it. What do you notice?

MEET YOUR KIT

Hey there! Welcome to Matter Mayhem. This is your own science lab! You will mix, squish, and bounce your way through real experiments. You will explore the stuff all around you. Get ready to make a big MESS — and some big discoveries too!

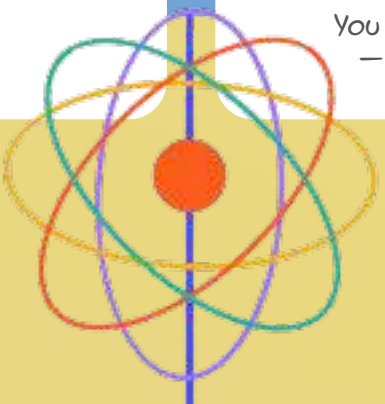
MEET BOLT, YOUR LAB PARTNER!

Hi there! I'm Bolt the Bear, your science partner! I love experiments, surprises, and getting my paws messy. I will pop up in this book to cheer you on and share tips. Ready to mix things up? Let's go!

WHAT'S IN YOUR KIT?

- 5 balloons (round, 9-inch)
- Small funnel
- Cornstarch
- Clear school glue
- Linker solution
- Two measuring cups with lids
- 6 labeled vials: Baking soda, Cornstarch, Salt, Powder A, Powder B, Powder C
- 1 small bottle of white vinegar
- Spoons or sticks plus a Small cup or bowl for mixing
- 12 small cups
- Plastic table cover
- 3 zipper bags
- Empty water bottle
- Ruler & small measuring scoops
- This workbook + a pencil

You will also need a few things from home — paper towels, a marker, and water. Optional: kitchen scale.



ACTIVITY 1
SQUISH IT! – THE CORNSTARCH STRESS BALL

WHAT IS THIS ACTIVITY ABOUT? First, let's train our scientist eyes and hands. You will mix cornstarch and water to make a gooey paste. You will observe its surprising properties. Then you will trap it in a balloon to make a stress ball you can keep! Your job is to figure out one thing. After mixing, do you still have cornstarch? Or did you make something new?

MY LEARNING GOAL

I will use my senses to observe the properties of a material before and after I mix it.

WHAT YOU NEED

- 1 balloon (plus 1 spare)
- Small funnel
- Cornstarch
- Water
- A cup and stick for mixing
- Empty water bottle
- The plastic table cover
- A pencil and this workbook

BOLT SAYS

Cornstarch is safe to touch, but don't eat it! Spread your table cover on the table before you start. This can get a little messy. That's part of the fun

BUILD IT!

BUILD IT: PART 1 – OBSERVE THE CORNSTARCH

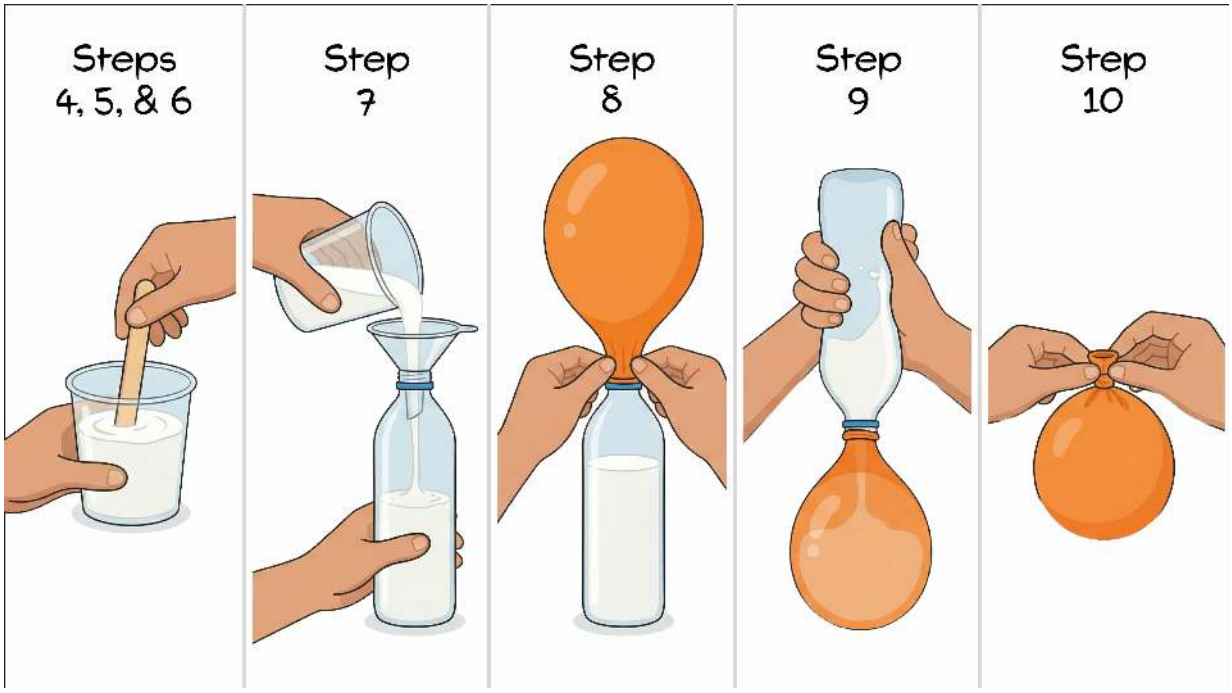
STEP 0. Put down your plastic table cover. It keeps your table

STEP 1. Pour a little dry cornstarch into your cup. Look at it. Touch it. Try to pour it. Then fill in the "Before" column of your data table on the next page.

MM • ACTIVITY 1
shoeboxlab.org/mm1

ACTIVITY 1
SQUISH IT! – THE CORNSTARCH STRESS BALL

BUILD IT! (CONTINUED)



BUILD IT: PART 2 – MIX THE OOBLECK

STEP 2. Add 6 tablespoons of cornstarch to your cup.

STEP 3. Slowly add 3 tablespoons of water.

STEP 4. Mix with a spoon or your fingers. Stop when it is smooth and thick, like toothpaste. * This gooey mixture has a name — Oobleck! * Is it crumbly? Add a few more drops of water and keep stirring.

STEP 5. STOP and explore! Before you fill the balloon, spend time with your mixture. Stir it slowly. What happens? Now stir it fast. What happens? Poke it gently. Then poke it hard. This mixture has a surprise!

STEP 6. Write down what you notice in the "After Mixing" column of your data table.

ACTIVITY 1
SQUISH IT! – THE CORNSTARCH STRESS BALL

BUILD IT! (CONTINUED)

BUILD IT: PART 3 – FILL THE BALLOON

STEP 7. Place the funnel in the top of the empty water bottle. Carefully pour the mixture through the funnel into the bottle. This may take a minute.

STEP 8. Stretch the neck of a balloon over the mouth of the water bottle.

STEP 9. Turn the bottle upside down and gently squeeze the mix into the balloon.

STEP 10. Carefully remove the balloon from the bottle and tie it off.

STEP 11. Cut the neck off a second balloon and stretch it over the first balloon. This gives your stress ball extra strength!

STEP 12. Squeeze and knead your stress ball for 30 seconds.

WORD WATCH

PROPERTY — A property is something you can observe that describes a material. Color, texture, and smell are properties.
TRY IT: Look at the cornstarch. Name three of its properties.

INVESTIGATE!

Run your experiment!

STEP 1. Squeeze your stress ball slowly. What happens? Now squeeze it quickly. What happens?

STEP 2. Drop your stress ball from waist height onto a hard floor. What happens?

STEP 3. Fill in the "Stress Ball" column of your data table.

BOLT SAYS

You just made your first creation. Here's the big question: you mixed two things and it looks different ... but is it really different? We will look at this more next.

Activity 1
Squish It! – The Cornstarch Stress Ball

My Data

Property	Cornstarch Before (Dry)	After Mixing (in Cup)	Stress Ball (in Balloon)
Color			
Texture (feel)			
Does it flow / pour?			
What happens when touched slowly?			
What happens when touched quickly?			

Reflect

1. What happened when you stirred or squeezed the mixture slowly? What happened when you did it fast? Were you surprised?

2. Do you think that the mixture inside the balloon is still cornstarch and water, or did it become something completely new? Why?

3. ✏✨ Challenge: Your stress ball feels different depending on how you squeeze it — soft when you go slow, firm when you go fast. Is there anything else that acts differently depending on how you touch it?

ACTIVITY 2
STRETCH IT! – THE SLIME TEST

WHAT IS THIS ACTIVITY ABOUT? You are about to mix two plain liquids together. Something amazing is going to happen! First, you will observe each liquid. After, you will observe what you made. Here is the question. Is your slime just a mix of what you started with? Or is it something brand new?

MY LEARNING GOAL

I will investigate whether mixing two substances makes a new substance with different properties.

WHAT YOU NEED

- Clear school glue
- Linker solution
- Graduated measuring cups with lid
- Water
- Spoon or craft stick
- 1 zipper bag (for storing your slime)
- Kitchen scale (optional — for the Bonus Extension)
- A pencil and this workbook

SAFETY FIRST — The linker solution is safe to touch, but do NOT drink it. If it gets in your eyes, rinse with clean water right away and tell an adult. Remember: nothing in this kit is food!

INVESTIGATE!

Run your experiment!

INVESTIGATE: PART 1 – OBSERVE YOUR INGREDIENTS

STEP 1. Pour 2 ounces of clear glue into your graduated cup. Look at it carefully. Write its properties in the "Glue" column of your data table.

STEP 2. (NOT SHOWN) Add 1 ounce of water to the glue. Put on the lid. Shake well until it is fully mixed.

MM • ACTIVITY 2
shoeboxlab.org/mm2

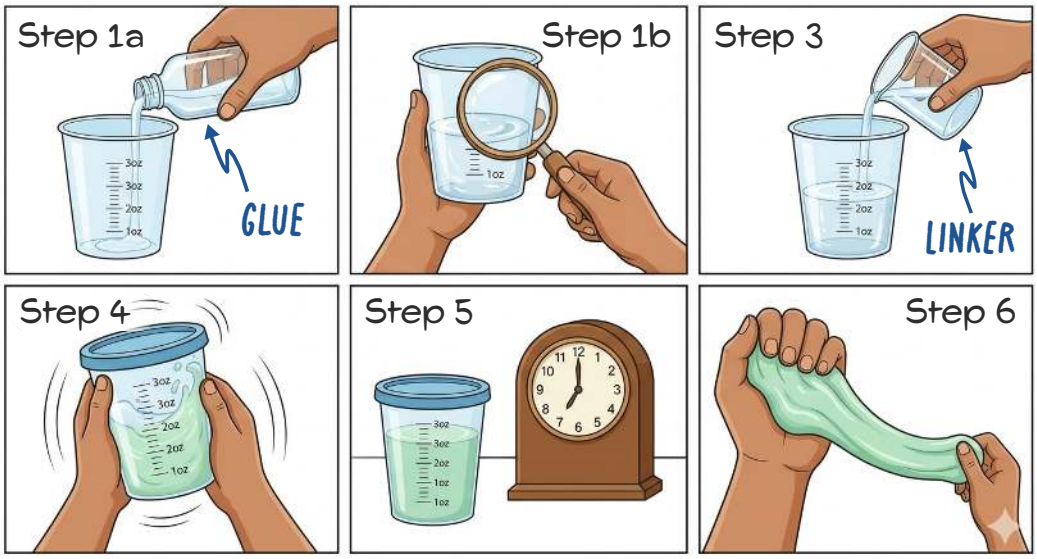
ACTIVITY 2
STRETCH IT! – THE SLIME TEST

INVESTIGATE! (CONTINUED)

Run your experiment!

BOLT SAYS

If you want to try the Bonus Extension at the end of this activity, pause now and put your glue-and-water cup on a kitchen scale. Write down the weight for later.



INVESTIGATE: PART 2 – MIX AND OBSERVE

STEP 3. Pour 1.5 ounces of linker solution into the cup.

STEP 4. Put on the lid. Shake hard for 1 minute. Stop a couple of times to look. You will see the mixture start to change! It gets thicker. It pulls away from the sides. It starts to clump together.

STEP 5. Let the slime mixture rest for 1 to 5 minutes.

STEP 6. After letting the slime mixture rest, take it out and knead it with your hands for 1 minute.

STEP 7. Now observe your finished slime. Stretch it. Squeeze it. Try to pour it. Does it hold its shape? Write everything in the "Slime" column of My Data.

Activity 2
Stretch It! – The Slime Test

Word Watch

Physical change — A physical change happens when a material changes shape, size, or form. You can usually reverse a physical change and get back what you started with.
Try it: Mixing water and cornstarch in Activity 1 led to a physical change. If you let it dry out, you would get the cornstarch back.

My Data

Property	Glue (Before)	Linker (Before)	Slime (After)
Color			
Texture			
Does it flow / pour?			
Does it stretch?			
Does it hold its shape?			

Bolt says

Could you split your slime back into glue and linker? I am afraid not, as something important just happened. A chemical change created a new substance!

Word Watch

Chemical change — A chemical change happens when two or more substances are mixed and create a brand-new substance. The new substance has different properties from the originals — and you usually cannot get the originals back.
Try it: After you make your slime, ask yourself: does it look, feel, and act the same as the glue? Or the linker?

Activity 2
Stretch It! – The Slime Test

BONUS EXTENSION (OPTIONAL)

The Weighing Test

Bolt says

Have a kitchen scale? Try this! Weigh your ingredients before mixing. Then weigh your finished slime. What do you notice about the numbers?

What I weighed	Weight (grams)
Glue + water (before mixing)	
Linker (before mixing)	
Glue + water + linker combined	
Finished slime	

Did the total weight change? Write what you notice.

Key words for this section

These words appear in this section. See the Glossary at the back for full definitions.

Mixture (noun) — A mixture is what you get when two substances are combined but each one keeps its own properties — like mixing sand and salt.

Substance (noun) — A substance is a specific type of matter with its own set of properties. Glue is a substance. Water is a substance. Your slime is a brand-new substance!

Activity 2
Stretch It! – The Slime Test

Reflect

1. Which properties of the slime are different from both the glue AND the linker?

2. Could you separate the slime back into glue and linker? Is your slime a mixture, or is it a new substance? How do you know?

3. ✏✨ Challenge: Your stress ball and your slime were both made by mixing things together. But one was a physical change and one was a chemical change. What is the difference? Use what you observed in your data tables to explain your answer.

Bolt says

Great job! Store your slime in the container you mixed it in (with the lid on) or a zipper bag to keep it fresh. Now wash your hands with soap and water.

A TIMELINE OF AMAZING POLYMERS

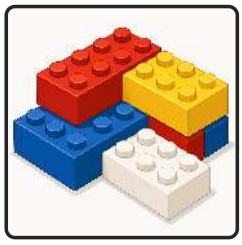
Your slime is a polymer. So is a plastic water bottle. So is the bouncy ball you will make later! A polymer is a material made of long chains of tiny parts, all linked together. People have made things with polymers for thousands of years.

~1600 BCE – MESOAMERICAN RUBBER. Long ago, people in Central America found a stretchy liquid called latex. It comes from rubber trees. They shaped it into balls, sandals, and waterproof coats. Latex is one of nature's own polymers!

1839 – GOODYEAR'S VULCANIZED RUBBER. The story goes: Charles Goodyear dropped rubber mixed with sulfur onto a hot stove — by accident! But it did not melt. It got tough and flexible. Flexible means it can bend without breaking. That new rubber was strong enough to make tires and boots.

1943 – SILLY PUTTY. James Wright was an engineer. He tried to make a new kind of rubber. Instead, he made a toy! It became one of the most famous toys ever — Silly Putty.

1963 – LEGO SWITCHES TO ABS PLASTIC. LEGO made their bricks from a new polymer called ABS plastic. They still use it today.



1968 – SILLY PUTTY GOES TO SPACE. Remember Silly Putty? In 1968, astronauts took it to space! They used it to hold their tools. This polymer went from a failed experiment all the way to space — because someone asked, "What if?"

MM • HISTORY SPOTLIGHT
shoeboxlab.org/mm6

ACTIVITY 3
BOUNCE IT! – THE POLYMER BOUNCY BALL

WHAT IS THIS ACTIVITY ABOUT? You have made a stress ball and slime. Now you will use the same ingredients to make something new. This time, you will change how much linker you add. More linker means more connections between the tiny pieces inside. Will more connections change the properties?

MY LEARNING GOAL

I will explore how changing the amount of linker changes the properties of the material I make.

WHAT YOU NEED

- Clear school glue
- Linker solution (from your kit)
- Cornstarch
- A Graduated measuring cup with lid
- 2 zipper bags
- Ruler
- Measuring spoons
- A hard floor surface

BOLT SAYS

Remember - the linker solution is safe to touch but NOT to drink. Wash your hands when you finish making each ball!

INVESTIGATE!

Run your experiment!

You will make TWO balls. One has less linker. One has more. For each ball, do steps 1 to 6. Then do the drop test with both balls.

INVESTIGATE: PART 1 – MAKE THE BALLS

STEP 1. In the provided container, add 2 tablespoons of clear glue. (See the image on the next page.)

STEP 2. Add ¼ teaspoon of cornstarch to the container.

STEP 3. Add ½ teaspoon of linker to the container.

MM • ACTIVITY 3
shoeboxlab.org/mm3

Activity 3
Bounce It! – The Polymer Bouncy Ball

INVESTIGATE! (CONTINUED)

Run your experiment!

STEP 4. Seal the container and shake hard for 1 minute.

STEP 5. Remove the ball from the container and knead it (squeeze it back and forth) for 1 minute.

STEP 6. Roll the ball between your palms to smooth it into a nice round ball.

INVESTIGATE: PART 2 – DROP TEST

STEP 7. Hold the ball 30 cm (about 12 inches) above a hard floor. Drop it — do NOT throw it.

STEP 8. Watch where the top of the ball reaches when it bounces back up. Measure that height with your ruler.

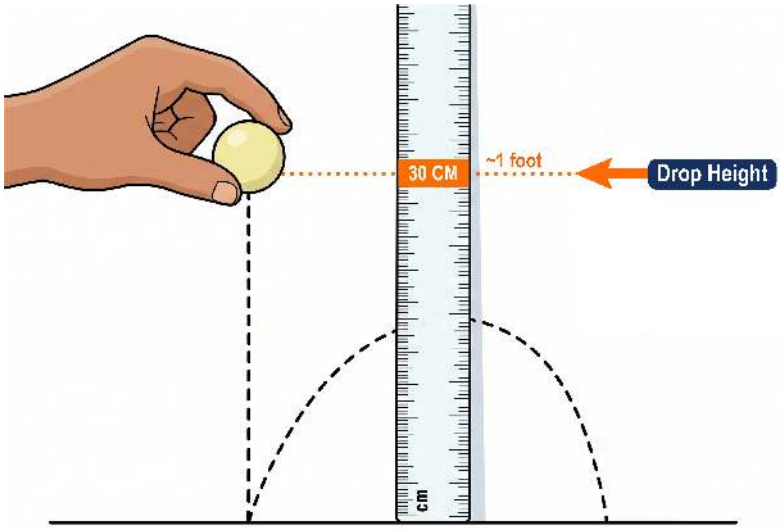
WORD WATCH

VARIABLE — A variable is the one thing you choose to change in an experiment. Everything else stays the same. That way, if your results are different, you know the variable caused the change.
TRY IT: In this activity, the variable is the amount of linker solution.

Activity 3
Bounce It! – The Polymer Bouncy Ball

INVESTIGATE! (CONTINUED)

Run your experiment!



STEP 9. Record your measurement in Trial 1. Repeat for Trials 2 & 3.

STEP 10. Make a second ball with 2 teaspoons of linker and repeat the drop tests. Remember: the only thing that changes between Ball A and Ball B is the amount of linker. Everything else stays the same!

MY DATA

Ball	Linker Amount	Trial 1 (cm)	Trial 2 (cm)	Trial 3 (cm)	Best Run
A (less linker)	½ tsp				
B (more linker)	2 tsp				

Bolt says

You just made a toy you can keep from glue, cornstarch, and linker! Materials engineers do exactly this kind of testing when they invent new plastics, rubbers, and fabrics.

Activity 3
Bounce It! – The Polymer Bouncy Ball

Key Words for This Section

Ratio (noun) — A ratio describes the relationship between two amounts — how much of one thing compared to how much of another. In this activity, you are changing the ratio of linker to glue between the two balls.

Reflect

1. Which ball bounced higher — the one with less linker or the one with more linker?

2. Your slime and your bouncy ball were made from very similar ingredients. What do you think caused them to have such different properties?

3. ✎✨ Challenge: A scientist wants to make a material that is stretchy like slime but also bounces a little. Based on your data, how much linker would you suggest she try? What evidence supports your answer?

Bolt Says

Store your bouncy ball in a zipper bag when you're not playing with it—it can dry out over time. Time to wash your hands!

Word Watch

Polymer — Everything around you is made of tiny pieces far too small to see — scientists call these pieces molecules. A polymer is a material made of really long chains of molecules, all linked together. Your slime and your bouncy ball are both polymers. So are rubber tires and plastic milk bottles.

SCIENCE SPOTLIGHT

WHAT'S REALLY GOING ON? YOU TESTED WHAT HAPPENED – NOW LET'S LEARN WHY.

CONCEPT 1 – PROPERTIES OF MATTER

WORD WATCH

MATTER — Matter is anything that has weight and takes up space. All the stuff around you is made of matter.
TRY IT: Your slime, your bouncy ball, even the air is matter.

Every material has properties — the ways you can describe it. How does it look? How does it feel? How does it behave? The cornstarch was white and powdery. The slime was clear, sticky, and stretchy.

Scientists use properties to name and sort materials. You described how the cornstarch looked, felt, and behaved. That is exactly what a real scientist does! Your eyes, your fingers, and your ruler are science tools.

WORD WATCH

OBSERVATION — An observation is what you notice when you look at something closely and carefully. Scientists observe with all their senses and write down what they notice. *TRY IT:* Every number in your data tables is an observation.

MM • SCIENCE SPOTLIGHT
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SCIENCE SPOTLIGHT

WHAT'S REALLY GOING ON? YOU TESTED WHAT HAPPENED – NOW LET'S LEARN WHY.

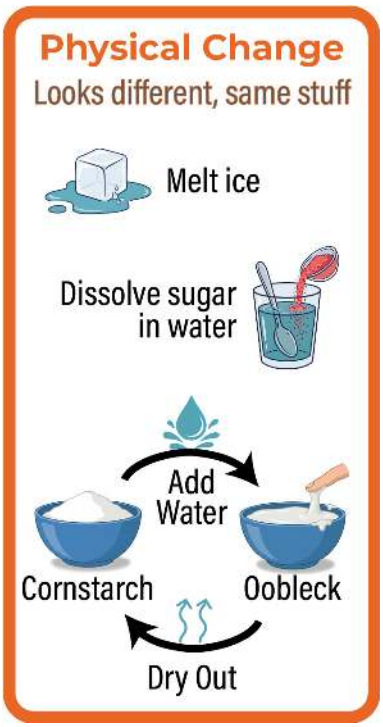
CONCEPT 2 – PHYSICAL CHANGE VS. CHEMICAL CHANGE

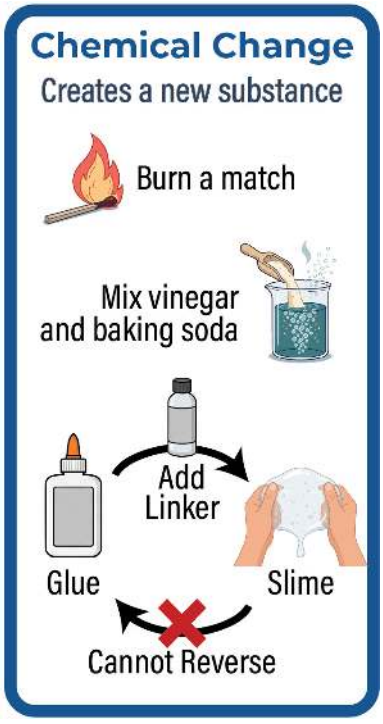
Remember your stress ball? You mixed cornstarch and water into oobleck. It looked different. It felt different. But the cornstarch and water were still there. Let them dry and you get the cornstarch back. That is a physical change. The form changed, but the stuff inside did not.

Now remember your slime. You mixed glue and linker. You got something completely new! It does not act like glue. It does not act like the linker. And it is really hard to split it back apart. That is a chemical change. A brand-new substance was made.

Here's how to tell the difference:

QUESTION	PHYSICAL CHANGE	CHEMICAL CHANGE
What happens?	Shape, size, or form changes	A new substance is created
Same stuff as before?	YES – still the same material	NO – different properties
Can you reverse it?	Usually yes	Usually no
Your example	Cornstarch + water → oobleck	Glue + linker → slime

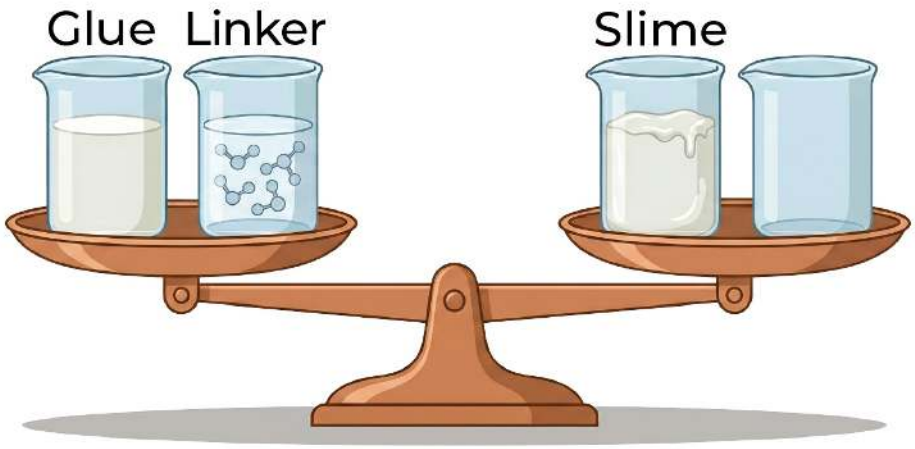




SCIENCE SPOTLIGHT

WHAT'S REALLY GOING ON? YOU TESTED WHAT HAPPENED – NOW LET'S LEARN WHY.

~~Conservation of Matter~~
None of the Matter is Lost



CONCEPT 3 – NO MATTER IS LOST

Here's one of the biggest ideas in all of science:

MATTER IS NEVER MADE OR LOST. IT CAN ONLY BE REARRANGED.

When you made slime, the glue and linker did not disappear. All the matter that went into your cup is still there. It just rearranged into a brand-new substance — slime.

Did you try the Bonus Weighing Test in Activity 2? Then you saw this yourself. The glue and the linker weighed a certain amount. The finished slime weighed about the same! Nothing was lost. Nothing was gained. The matter just changed form.

Scientists have a fancy name for this: the conservation of matter. Conservation means saving something. So all of the matter is saved. None is lost.

SCIENCE SPOTLIGHT

WHAT'S REALLY GOING ON? YOU TESTED WHAT HAPPENED – NOW LET'S LEARN WHY.

WORD WATCH

CONSERVATION — Conservation means saving something. Conservation of matter means matter is never made or lost — it can only be rearranged into new forms or new substances.

CHECK YOUR UNDERSTANDING

1. Your stress ball was made by mixing cornstarch and water. Was that a physical change or a chemical change?
   - ○ A) Physical change — the cornstarch and water are still cornstarch and water
   - ○ B) Chemical change — a new substance was created
2. Your slime was made by mixing glue and linker. Was that a physical change or a chemical change?
   - ○ A) Physical change — you can separate it back into glue and linker
   - ○ B) Chemical change — a new substance with different properties was created
3. ✎✨ In your own words explain what happens when you combine the glue and linker to make slime. (Hint: Look back at Science Spotlight Concept 3)

✎ WRITE YOUR ANSWER HERE!

BOLT SAYS

You just did real materials science! Engineers who design sneakers, phones, and even spacecraft make new polymers — like your slime — every single day.

GRAND CHALLENGE
CRACK THE CASE! MYSTERY INVESTIGATION

WHAT IS THIS ACTIVITY ABOUT? You have done three experiments. You observed properties. You made new substances. You saw how changing one thing changes the result. Now it is time to use all of it to solve a mystery!

Inside your kit are three sealed vials: Powder A, Powder B, and Powder C. They all look the same — three white powders. But they are NOT the same substance! Your job is to figure out which is which. You will use only the evidence you collect. You will do this in two parts:

1) THE DETECTIVE'S LAB: First, you will run tests on three labeled powders. Then you will know exactly how each one behaves.

2) THE MYSTERY INVESTIGATION: Next, you will run the same tests on the mystery vials. Then you will match the results.

WORD WATCH

EVIDENCE — Evidence is information that supports a conclusion — what you decide is true. You gather it by observing — by watching, measuring, and testing. Scientists do not guess. They collect evidence and let it lead them to the answer.

WHAT YOU NEED

- 3 labeled reference vials: Cornstarch, Baking Soda, Salt
- 3 labeled mystery vials: Powder A, Powder B, Powder C
- Small bottle of white vinegar
- Water
- Small measuring spoons
- 12 small cups (two for each powder — 2 detective + 2 mystery)
- Spoon or craft stick
- A marker (for labeling cups)
- Paper towels
- Spoon or sticks for stirring

BOLT SAYS

Real scientists use these same tests to name unknown substances in real labs. You are doing real science right now!

MM • GRAND CHALLENGE
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GRAND CHALLENGE
CRACK THE CASE! MYSTERY INVESTIGATION

PART 1 – THE DETECTIVE'S LAB

Before you solve a mystery, you need to know what the clues look like. In this part, you will run four tests. You will test the three labeled vials: Cornstarch, Baking Soda, and Salt.

Write your results in the table called My Reference Card. In Part 2, you will run the same tests on the mystery vials. Then you will use My Reference Card to figure out which is which.

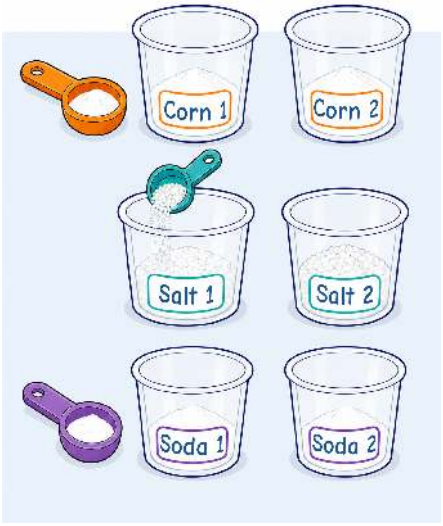
IMPORTANT! — Do NOT taste the mystery powders! Real scientists never identify substances by tasting them. Use only the four tests in your investigation. Wash your hands when you are finished.

PREPARATION

STEP 1. LABEL CUPS. Label six of the sample cups as Corn 1, Corn 2, Salt 1, Salt 2, Soda 1, and Soda 2.

STEP 2. FILL THE CUPS. Using the small scoops provided, put a small amount of salt into each of the salt-labeled cups. Repeat this for cornstarch — a small scoop of cornstarch in the Corn 1 cup, a small scoop of cornstarch in the Corn 2 cup. Repeat, placing a scoop of baking soda into each of the two Soda cups.

Steps 1 & 2



BOLT SAYS

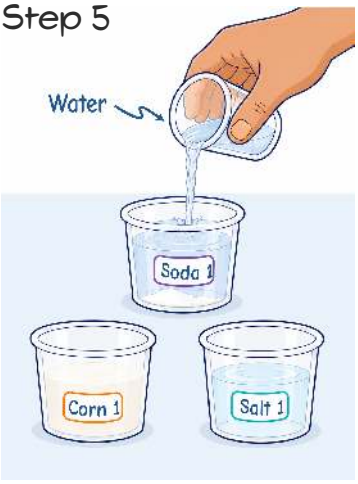
Use a fresh small sample for each test — about a pinch is plenty. And use a different spoon for each powder so you don't mix up your evidence!

GRAND CHALLENGE
CRACK THE CASE! MYSTERY INVESTIGATION

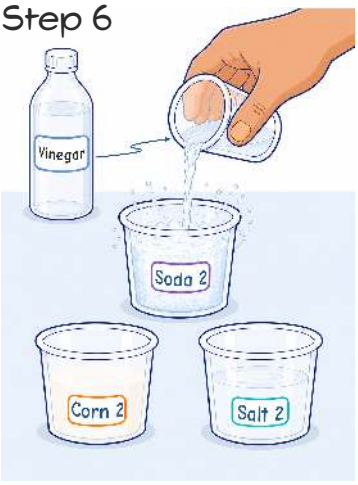
PART 1 - THE DETECTIVE'S LAB (CONTINUED)

Steps 3 & 4

Step 5



Step 6



TESTS

STEP 3. LOOK AT IT. Observe and record the color, texture, and grain size of each powder. Can you see the individual grains (like sand) or not (like flour)?

STEP 4. TOUCH IT. Take a small pinch of each powder between your fingers. How does it feel? Smooth? Gritty? Silky? Record what you notice.

STEP 5. WATER TEST. For the cups Corn 1, Salt 1, and Soda 1, add water to each cup. Fill the cup to about ¼ full with water.

Watch carefully. Does it stay white? Does it become cloudy? Does it dissolve and become clear?

Write down your observations.

STEP 6. VINEGAR TEST. For the cups Corn 2, Salt 2, and Soda 2, add vinegar to the cup. Fill the cup to about ¼ full with vinegar.

Watch carefully! Does anything happen? Fizzing? Bubbles? No reaction? Does it stay white? Does it become cloudy?

Write down exactly what you see.

Grand Challenge
Crack the Case! Mystery Investigation

My Reference Card

Test	Cornstarch	Salt	Baking Soda
Color			
Grain Size			
Texture (feel)			
Water: What happens?			
Vinegar: What happens?			

Part 2 – The Mystery Investigation

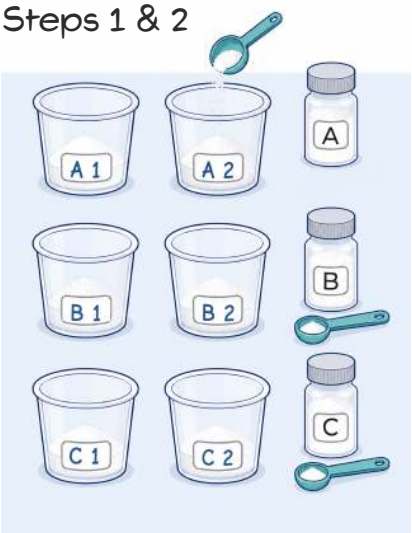
Now run the same four tests on each mystery vial. Write every result in your data table. Then compare it with your green My Reference Card to find the match. Take your time — good evidence comes from careful looking.

Preparation

Step 1. Label cups. Label six of the sample cups as A1, A2, B1, B2, C1, and C2.

Step 2. Fill the cups. Using the small scoops provided, put a small amount of each powder into each of the same-labeled cups. Put one scoop of A into A1 and one scoop of A into A2. Repeat this for powder B and the B cups. Repeat for powder C and the C cups.

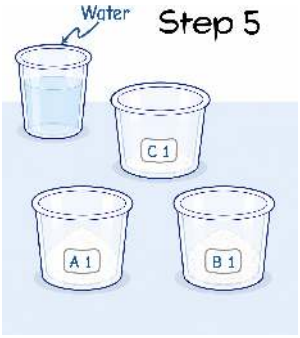
Steps 1 & 2



Grand Challenge
Crack the Case! Mystery Investigation

Part 2 - The Mystery Investigation (continued)

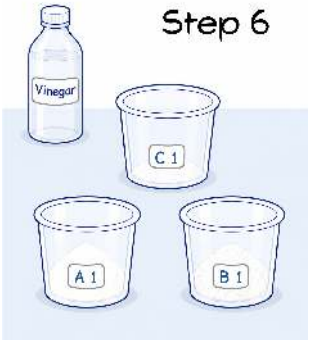
Tests



You already know these four tests — you just ran them on your reference powders. Now do the exact same four tests on each mystery powder.

Step 3. Look at it. Note the color, and grain size - big like sand or fine like flour?

Step 4. Touch it. Pinch a little between your fingers. Smooth, gritty, or silky?



Step 5. Water test. For cups A1, B1, and C1, add water to about ¼ full. Does it stay white, turn cloudy, dissolve clear, or clump together?

Step 6. Vinegar test. For cups A2, B2, and C2, add vinegar to about ¼ full. Does it fizz, bubble, or do nothing?

Take your time — good evidence comes from careful observation.

My Data

Test	Powder A	Powder B	Powder C
Color			
Grain Size			
Texture (feel)			
Water: What happens?			
Vinegar: What happens?			
My Match: This powder is...			

GRAND CHALLENGE
CRACK THE CASE! MYSTERY INVESTIGATION

WHY IT WORKED

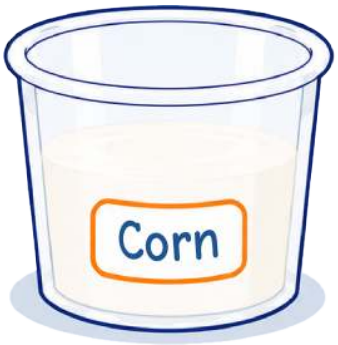
Your data told you which powder is which. But why does each test work? Each result is a clue about the powder's hidden chemistry. You already learned how to read most of these clues in this kit!

WHY BAKING SODA FIZZES
(CHEMICAL CHANGE)

Fizzing is a chemical change — like when glue and linker became slime. The vinegar and baking soda react. They make a brand-new substance: a gas called carbon dioxide. The bubbles are that gas going into the air. Cornstarch and salt do not do this. So only baking soda fizzes.

WHY CORNSTARCH CLOUDS THE WATER
(PHYSICAL CHANGE)

You already know this one! Cornstarch does not dissolve. Its tiny pieces stay solid and float in the water. That makes the water look milky. The cornstarch is still cornstarch — just wet.



WHY SALT DISAPPEARS
(PHYSICAL CHANGE)

Salt dissolves. The water pulls it apart into pieces too small to see. The salt is still there. Let the water dry up and the salt comes back! So cornstarch clouds the water, and salt vanishes. That is how the water test tells them apart.

So: cornstarch clouds the water, salt vanishes. That's how the water test tells them apart.

BOLT SAYS

You just used four tests and your own evidence to crack a real mystery. That is how scientists name unknown substances in real labs — one clue at a time.

GRAND CHALLENGE
CRACK THE CASE! MYSTERY INVESTIGATION

REFLECT

1. Which powder was the easiest to identify? Which was the hardest? Why?

2. Which test gave you the most useful information? Could you have solved the mystery without it?

OUTSTANDING WORK

You observed the properties of materials like a real scientist. You found out the difference between physical changes and chemical changes. You made a stress ball, slime, AND a bouncy ball. You figured out why they act so differently. You solved a mystery using nothing but evidence and your own science skills.

THAT'S REAL SCIENCE – AND YOU DID IT ALL YOURSELF!

"KEEP ASKING QUESTIONS – EVERY GREAT DISCOVERY STARTED WITH CURIOSITY!"

– BOLT THE BEAR

GLOSSARY

HERE ARE ALL THE SCIENCE AND ENGINEERING WORDS YOU USED IN THIS WORKBOOK.
THESE ARE REAL WORDS THAT SCIENTISTS AND ENGINEERS USE EVERY DAY!

WORD	DEFINITION
CHEMICAL CHANGE (noun)	A change that makes a brand-new substance with different properties. You usually cannot reverse it.
CONSERVATION OF MATTER (noun phrase)	The idea that matter is never made or lost — it can only be rearranged. The total amount always stays the same.
CROSS-LINKING (noun)	A connection between two polymer chains, like rungs on a ladder. More cross-links make a material stiffer and bouncier.
EVIDENCE (noun)	Facts you gather by observing, measuring, or testing. Evidence helps you show what is true.
EXPERIMENT (noun)	A fair test. You change just one thing and keep everything else the same. Then you know what caused the result.
HYPOTHESIS (noun)	A smart, careful guess about what will happen in an experiment. You can test it to find out.
MATERIAL (noun)	What something is made of. Wood, plastic, rubber, and slime are all materials.
MATTER (noun)	Anything that has weight and takes up space. Solids, liquids, and gases are all matter.
MIXTURE (noun)	Two or more substances mixed together. Each one keeps its own properties. You can usually separate them again, like sand mixed with salt.
MOLECULE (noun)	A tiny piece of matter, far too small to see, that everything is made of. Long chains of molecules form polymers.
OBSERVATION (noun)	Something you notice using your senses or a measuring tool. Careful observations are how good science starts.
PHYSICAL CHANGE (noun)	A change in the shape, size, or form of a material. It does not make a new substance. You can usually reverse it.
POLYMER (noun)	A material made of very long chains of molecules. The word means "many units." Rubber, slime, and even DNA are polymers.
PROPERTY (noun)	Something you can observe or measure about a material. Color, texture, and whether it flows are all properties.

GLOSSARY

HERE ARE ALL THE SCIENCE AND ENGINEERING WORDS YOU USED IN THIS WORKBOOK.
THESE ARE REAL WORDS THAT SCIENTISTS AND ENGINEERS USE EVERY DAY!

WORD	DEFINITION
RATIO (noun)	How much of one thing compared to how much of another. In Activity 3, you changed the ratio of linker to glue.
SUBSTANCE (noun)	A type of matter with its own set of properties. Glue is a substance. Water is a substance. Slime is a new one.
TRIAL (noun)	One full run of an experiment. Scientists do several trials so they can trust their results.
VARIABLE (noun)	The one thing you change in an experiment. Everything else stays the same, so you can see what the change does.

This STEM kit was designed and tested by Randolph Kirchain, III, as part of earning the Eagle Scout rank at Troop 313 in Arlington, Massachusetts, Spirit of Adventure Council. The kits were assembled and distributed by the Scouts and community members of Troop 313.

Eagle Scout is the highest rank in Scouting America — and one of the most demanding achievements for youth anywhere. Fewer than 4% of Scouts go on to earn Eagle Scout. Those who do must demonstrate sustained leadership and plan and execute a significant community service project of their own design. This kit is the result of one of those projects. It was created for families at The Root Cellar, a refugee and immigrant transition center in Lewiston, Maine, with the hope that kits like these will find their way to similar programs and communities across the country.

For more than a century, Scouting America has prepared young people for lives of impact and purpose — building character, leadership, and personal fitness through hands-on adventure and real-world challenges. What is less widely known is that Scouting also cultivates curiosity about science, technology, engineering, and math. With merit badges spanning topics from astronomy to artificial intelligence and from robotics to environmental science, Scouts explore the world around them in ways far beyond the trailhead. Scouting America is open to all young people, boys and girls, from kindergarten through high school.

To learn more about Scouting or find a troop near you, visit www.scouting.org

THE MOST WORTHWHILE THING IS TO TRY TO PUT HAPPINESS INTO THE LIVES OF OTHERS - ROBERT BADEN POWELL (SCOUTING'S FOUNDER)

the Shoebox Lab

Matter Mayhem!

Mix, Squish, & Discover the Science of Stuff

a the **Shoebox Lab** kit

contact us at hello@shoeboxlab.org