AKA SCIENCE

Cool Chemistry: Fizz, Pop WOW!
Grades 4-6

AKA Science is funded by our generous community partners.

Cool Chemistry: Fizz, pop, WOW! (Grades 4-6)

Class 1: Polymer Power

Supplies	#
Bags (Ziploc, snack)	16
Butcher paper (sheets)	1
Cups (9oz, plastic, punch)	12
Fortune Teller Fish	16
Gumdrops, bag of 26	16
Markers (black, wet erase)	2
Newspaper	
Notebooks	16
Pans (large, oval, aluminum)	1
Paper towels (large rolls)	1
Pencils	16
Pipettes (1mL, plastic)	8
Pitchers with lids	1
Plates (9in, sturdy paper, brown)	8
Salt (packets)	32
Scissors (site provides)	1
Snow Day Packs (16 paper 1oz cups, 4oz Instant Snow, 2oz polymer crystals, 2 calibrated 1oz plastic cups & 1 disposable diaper)	1
Spoons (plastic)	11
Tape (rolls, Scotch)	2
Toothpicks, bundle of 20	16
Water	

Worksheets:

Worksheets: Pre-Survey	16
Worksheets: Survey Answers	1
Worksheets: Take-Home Supplies Advisory (half-sheet)	16
Worksheets: Consent Form for Publicity	16
Worksheets: Make a Molecule!	8

Welcome to AKA Science!

Chemistry is the study of the properties of matter and how matter interacts with energy. Chemistry can explain all sorts of things, such as why soap gets your hands clean, why there are bubbles in soda, how medicine works in your body, and why cutting onions make you cry. There is so much to learn and explore in the great world of Chemistry and chemical reactions! Over the next 8 weeks, you will transform liquids into a bubbling lava lamp, explore solar reactions, get fizzy by creating your own elephant toothpaste, make instant snow, and mix up some fantastic flubber!

BEFORE YOU START:

- **Please be sure the take-home supply advisories are put into the hands of your students' adults.**
- **NOTHING from the AKA Science kit should go in anyone's mouth, nose, eyes, or ears.**
- **Remind students that scientists *never* eat or drink their lab supplies.** Mystery substances can be harmful, and even familiar substances can be contaminated. **If a student ingests a non-food product, call Poison Control: 1-800-222-1222 or 911.** Make sure you consult with your Site Coordinator about any issues.
- **If you have concerns about whether your students can do an activity safely, use your judgment.** You can skip, modify, or change the order of activities.
- **Newspaper is helpful for covering desks.** A small bundle is in your kit. If it gets used up, you may want to grab a free newspaper to replenish your supply.
- **Be thoughtful about your strategy for handing out supplies.** To minimize spills and accidents, don't give students more supplies than they need for each step of an activity, and gather back supplies when they're no longer being used.

- **You don't have to do all of the activities.** You may not have time to do every activity in the curriculum with your class—and that's okay! It's up to you which activities to shorten, lengthen, or skip if needed.

- **Activities with black stars are connected to our pre- and post-survey questions.** These are great vocabulary-building opportunities, so we encourage you to emphasize those words as you teach the class.

- **Engage through Human Connection read-alouds.** These may be read aloud to your class prior to each lesson's *Pair & Share* or at any other time you feel it could tie in with your lesson.

- **Engage through reading**. If you have time, use our "Suggested Readings" during the *Daily Debrief* to encourage students to investigate further. These books are available at local libraries.

- **Make time for- and encourage students to use their Lab Notebooks** to reflect (i.e. think deeply and carefully about) and record their observations as you go.

- **We all make mistakes!** Assure your students that mistakes are learning opportunities and in science, it's how discoveries are made. It might take some time, but you will learn how to do this, you will get better at this, and you will eventually overcome challenges that arise. <u>You can do hard things!</u>

  If an experiment didn't work the way they had hoped, we invite you to ask students:
  - ✓ *What happened today that made me try hard? How did that feel?*
  - ✓ *What can I learn from this?*
  - ✓ *What other strategies can I try? What could I improve for next time?*
  - ✓ *What do I need to get information about or work on before I try this again?*
  - ✓ *Where could I get advice or help from?*
  - ✓ *How could I safely try this experiment in a different way?*
  - ✓ *What did I do today that I am proud of? What are my goals for the next class?*

Helpful "*Cool Chemistry: Fizz, Pop, WOW!*" vocabulary:

- **<u>Acid</u>:** A chemical compound that breaks down things like <u>metals and minerals</u>. Strong acids feel like they burn; the ones that are OK to eat taste sour. Examples of acids include vinegar, citrus fruits, battery acid, etc.

- **Atom**: The smallest unit of matter. Made of positive protons, neutral neutrons, and negative electrons.
- **Base**: A substance that can neutralize the acid by reacting with hydrogen ions. Bases are known for their slippery texture; the ones that are OK to eat taste bitter. Bases make good cleaners because they break down fats and oils. Examples of bases include soap, bleach, ammonia, etc.)
- **Chemistry:** The study of matter—all the "stuff" in the universe—and how it changes and interacts with energy.
- **Density:** A property that describes how much matter something has compared to how much space it takes up. Different things can have more or less matter packed into the same amount of space.
- **Electron:** Negatively charged particles that orbit the nucleus of an atom.
- **Element:** A substance that cannot be separated into simpler substances through chemistry. Made of only one type of atom. Examples are hydrogen, oxygen, and carbon.
- **Emulsion**: A fine mixture of things that you wouldn't normally be able to combine, such as oil and water.
- **Hydrophobic:** Something that repels or doesn't mix with water.
- **Indicator**: Certain types of dyes act as acid-base indicators. Scientists call these dyes "indicators" because they "indicate" whether a chemical is acidic or basic. Example indicators include cabbage juice and litmus paper, which contains a special dye that's sensitive to acids and bases.
- **Matter:** Matter is what makes up everything in the known universe, from trees to clouds to comets to you and me. Matter comes in three main states: solid, liquid and gas. When something is in a solid state, its molecules (tiny particles) are tightly packed together. In a liquid state, the molecules are less tightly packed—and in a gas state, the molecules are much more spread out.
- **Mixture:** A substance in which two or more substances are mixed but not chemically joined together, meaning that a chemical reaction has not taken place. Mixtures can be easily separated and the substances in the mixture keep their original properties.
- **Molecule:** A group of atoms bonded together, representing the smallest unit of a chemical compound that can take part in a chemical reaction.
- **Polymer:** A substance made up of chains of molecules hooked together repeatedly.
- **Properties**: A characteristic or trait that you can use to describe matter by observation, measurement, or combination.
- **Surface Tension**: A force created by the cohesion between the water molecules. The water molecules like each other so much that they stick together and form a hump rather than spread out.

Prep (prior to class):

TIP:	**If you can't access your room before class**, you can prepare various items on a rolling cart or tray. Alternately, you can prepare them as you hand them out or while students are engaged in a warm-up activity early in the class.

- **GENERAL:** Ask your Site Coordinator/Manager about the best way to send home the "Take-Home Supplies Advisory" so it reaches parents/guardians.
- **Act. 2:** Sharpen pencils (or you could have students do this).
- **Act. 4a:** Fill another four 9oz cups half-full of water. After that, fill the pitcher ¾-full of water.
- **Act. 4b:** Use a calibrated cup to put ¼oz of polymer crystals apiece in eight 1oz paper cups.
- **Act. 4c:** Use the second calibrated cup to put ¼oz of Instant Snow apiece in eight 1oz paper cups.

Activity One – Set the Tone   Time: 5 Minutes

Supplies	#	Supplies	#
Butcher paper (sheets)	1	Markers (dark blue, washable)	1
Tape (roll, Scotch)	1		

Goal: To set the tone by establishing class agreements.

Procedure:

1. Gather students in a circle and facilitate an introductory icebreaker (e.g., name + kind of animal they would like to be for a day).
2. Using marker and butcher paper, facilitate a discussion among students to establish a set of class rules that they can all agree on.

Example questions:

- ***We have limited supplies in class. How can we share?***
- ***How do we safely use science supplies?***
- ***What is appropriate/inappropriate behavior in class?***
- ***How do we want to be treated in class?***
- ***How can we be our best selves in class?***
- ***What happens if someone breaks one of our agreements?***
- ***What are the clean-up procedures?***

3. Once rules are established, have students sign their name or something that is unique to them (like a stamp pad and thumb print, or a symbol, etc.) directly onto the paper.

OPTIONAL: Human Connection — Time: 1 Minute

*****THIS IS A READ-ALOUD NARRATIVE. If desired, please read aloud to your class prior to *Pair & Share* or at any other time you feel it could tie in with your lesson.*****

Goal: The goal of the Human Connection narrative is to share important and interesting discoveries made by scientists and communities identifying as Indigenous, Black, Brown, Melanated, Latino/Hispanic, Immigrant, Asian, LGBTQIA+ and female, and to encourage students to see themselves in science. **A**ll **k**ids **a**re scientists!

Read-Aloud Narrative:

Take a look around the room; there is chemistry all around you! Chemistry is **the study of matter**—what it consists of, its properties, and how it changes. No matter how you look at matter, it all boils down to atoms. Your pencil, paper, chairs, and even your classmates, are all made up of atoms! Stacking and building on top of each other like microscopic LEGO bricks to form molecules, atoms are the building block of all matter in the known universe. They are so tiny that a single drop of water contains five sextillion atoms! Atoms have three smaller parts: protons, neutrons, and electrons.

Japanese chemist **Kenichi Fukui** proved the importance of electrons and their position in the atom. Fukui began working as a chemist at the University of Kyoto in the late 1930s. His work cracked open the imaginations of what chemists could do at the time. Despite how groundbreaking his work was, Fukui went unrecognized in the West for many years. Fukui was publishing when America and Europe were at war with Japan; it wasn't until an American scientist replicated his initial study a decade later that chemists across the world acknowledged the innovative nature of his work. In 1965, Fukui received the Nobel Prize in Chemistry. He said after receiving the prize, "Chemistry was my least favorite subject in high school." You really can teach an old dog new tricks!

In AKA Science today, you will learn all about atoms, thanks to Fukui's work nearly 100 years ago!

Activity Two – Pair & Share — Time: 10 Minutes

Supplies	#	Supplies	#
Pencils	16	Worksheets: Survey Answers	1
Worksheets: Pre-Survey	16	Lab notebooks	16

Goal: To engage students' thinking and questioning related to the day's activities.

Procedure:

1. Prepare a quiet space for students to give them a physical area to think. The space can be an area set aside from the activity area, where students sit in a circle to ponder the *Pair & Share* question.

2. Make lab notebooks and pencils available.

3. Ask students a *Pair & Share* question:

   - ***What is science?*** *(There are many possible answers, but a good one might be, "Learning about the world.")*
   - ***What is chemistry?*** *(The study of matter—all the "stuff" in the universe—and how it changes and interacts with energy.)*
   - ***Can you think of some examples of how you might use or observe chemistry every day?***
   - ***What kinds of questions do you have about what things are made of and how they interact with each other? What are you curious about?***
   - ***What do you think Atoms are?***

4. Ask students to discuss their ideas with their neighbor before inviting students to share what they came up with. This is a "challenge by choice" opportunity and no one is required to share with the class if they are not comfortable.
5. After the discussion, **administer the pre-survey** to students.
6. Read each question aloud so all students understand each question.
7. Collect completed surveys.
8. Let students know you'll be discovering the answers with them in the coming weeks.
9. **Submit the completed surveys to Site Manager/Coordinator.** These need to go to your Manager/Coordinator as soon as possible so they don't get lost. At the end of the term, you'll be submitting the students' post-surveys as well.

Activity Three – Meet the Molecules   Time: 10 Minutes

Supplies	#	Supplies	#
Bags (Ziploc, snack)	16	Toothpicks, bundle of 20	16
Gumdrops, bag of 26	16	Worksheets: Make a Molecule!	8
Newspaper			

Goal: To learn about molecule structure by constructing models out of gumdrops and toothpicks.

Source: Madison County Schools (https://bit.ly/3Q3jHnA)

Background:
Atoms are the basic building blocks of matter. An atom is the small unit of an element, containing protons, electrons, and neutrons. Each element is

unique, with a specific number of protons, electrons, and neutrons, and can be found in nature as a solid, liquid, or gas, such as carbon (a solid with 6 protons, electrons, and neutrons) or oxygen (a gas with 8 protons, electrons, and neutrons). These atoms combine to make <u>molecules</u>, which can be as simple as water or as complex as DNA.

Matter comes in three main <u>states</u>: solid, liquid and gas. When something is in a solid state, its molecules (tiny particles) are tightly packed together. In a liquid state, the molecules are less tightly packed—and in a gas state, the molecules are much more spread out. Some things can change their state of matter right in front of you! Water is a good example – you usually see it as a liquid, but if you freeze water, it becomes a solid (ice), and if you boil it, it becomes a gas (steam).

In future experiments, you will see there are two types of changes in chemistry: physical and chemical. A <u>physical change</u> is when something changes its physical form but stays the same at a chemical level. For example, if you tear a piece of paper into pieces, it changes the *form* of the paper (from whole into pieces), but it doesn't change the *fact* that it's paper. The same goes for boiling or freezing water.

A <u>chemical change</u> – also called a <u>chemical reaction</u> – is when something new is created, and the change can't be undone. The materials you end up with are chemically different from what you started out with. For example, when you bake cookies, there are a bunch of chemical changes to your ingredients. Gasses form, sugars caramelize, and proteins change shape. The cookies that come out of the oven are chemically different from the dough that went in. Other examples of chemical reactions include setting off fireworks and burning gasoline as fuel. Both release lots of energy! (https://n.pr/3AzRKhk, https://bit.ly/3e6b4vl)

<u>Survey Connection</u>:

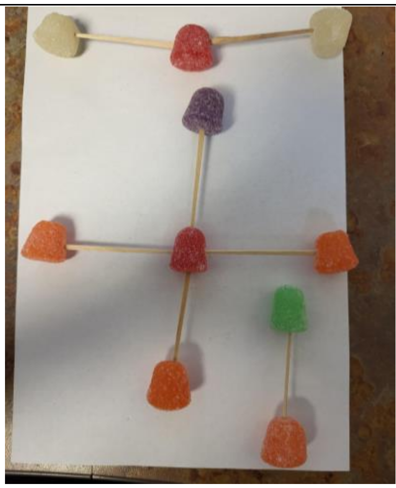
Q. _____________is everything around us in the form of solids, liquids, and gasses.
A. Matter

<u>Procedure</u>:

<u>TIPS</u>:

- **It's great for science activities to be *as hands-on as possible*—but it's also important to <u>modify activity instructions as needed</u>** based on your group of students (and your space) to manage messes & ensure safety.
- **For this activity, if preferred, you could have students work together in pairs or groups of 4**.
- **The worksheet is double-sided, with more complicated models on the back. If the simple structures on the front are too easy, have the students try a more challenging model from the back.**

1. <u>Ask students:</u> ***Have you ever heard of matter? What is it?***



Act. 3, Meet the Molecules.
Examples of gumdrop molecules.

2. Tell students:
    - ***Matter is everything around us and it comes in different states: solids, liquids, and gasses.***
    - ***Matter is all the "stuff" in the universe. Everything that has mass and takes up space is matter, including you!***

3. Ask students:
    - ***We discussed what matter is, but what is matter made of?*** (Atoms or molecules).
    - ***What are atoms?*** *(Small "pieces" of matter, the building blocks of everything in the universe).*
    - ***How are atoms different from molecules?*** *(Molecules are more than one atom joined together. Think of an atom as one LEGO brick and a molecule as a set of LEGO bricks stuck together).*

4. Tell students:
    - ***States of matter depend on how fast molecules can move. For example, the air we breathe is a gas, so the molecules move fast and are very spread out.***
    - ***Liquids like water have slower molecules that slide past each other.***
    - ***A solid like the salt you put on your food has molecules packed tightly together that move very slowly.***

5. Have students form pairs.
6. Hand each group of two a *Make a Molecule!* worksheet.
7. Let students know that these are gumdrops! Each color stands for an atom. Some things are liquid, solid, or gas, some colors of atoms are used more than once.

    Discussion Prompt:
    - ***Which colors (or atoms) are the most common on the worksheet?*** *(purple, hydrogen!)* ***What might that tell us about these atoms?*** *(They are common building blocks of different molecules and matter on Earth!)*

8. Give each student a bag of gumdrops and a bundle of toothpicks.
9. Lay a sheet of newspaper over each workspace to contain the sugar from the gumdrops.
10. Remind students about safety rules with pointy objects (no poking each other) Also tell them to not eat the gumdrops as they are for building the molecules.

    Note: Once the activity is complete the gumdrops are safe to take home and eat.

11. Have students build molecules using their gumdrops and toothpicks. If needed, you can demonstrate this with the water molecule by

sticking two toothpicks into a white gumdrop (oxygen), then placing a purple gumdrop (hydrogen) on the open ends of each of those toothpicks.

- Allow the students to trade gumdrop colors as needed and build as many molecules as they wish.
- If students want a challenge, they can work together to build the larger molecules on the back of the worksheet!

12. After they have finished building for 5-7 minutes, hand out the snack bags for the students to take their creations home (the bags the gumdrops came in will be full of loose sugar).

    Discussion Prompts:
    - ***What molecule(s) would you make with unlimited gumdrops?***

13. You may want to shake the sugar off the newspapers into a trash can before moving to the next activity.
14. Worksheets can either be sent home with students or collected at the end of the activity.

Activity Four – Snow Day! Time: 20 Minutes

Supplies	#	Supplies	#
Cups (9oz, plastic, punch—4 with water are from previous activity)	8	Plates (9in, sturdy paper, brown)	8
Glasses (plastic, safety, with Ziploc bags for storage)	17	Salt (packets)	32
Newspaper		Scissors (site provides)	1
Pans (large, oval, aluminum)	1	Snow Day Packs (16 paper 1oz cups, 4oz Instant Snow, 2oz polymer crystals, 2 calibrated 1oz plastic cups & 1 disposable diaper)	1
Paper towels (large rolls)	1	Spoons (plastic)	8
Pipettes (1mL, plastic)	8	Water	
Pitchers with lids	1	Plates (9in, sturdy paper, brown)	8

Goal: To explore the properties of polymers by adding water to polymer crystals, Instant Snow, and a disposable diaper.

Source: Educational Innovations (www.teachersource.com)

Background:

Instant Snow, polymer crystals and the insides of diapers are made of a polymer that swells up when water is added to it. A polymer is a substance made up of chains of molecules hooked together over and over again. Imagine the polymers you tested as a bunch of tiny sponges that soak up water and expand. The expansion is a physical change: the polymer isn't changing into something different – it's just holding more water. (https://bit.ly/3wCeg88)

Procedure:

TIPS:	• **If preferred, you could have students do this activity in groups of 4 instead of pairs**. Alternately, you could swap some activities between Classes 1 & 2. • **There's extra Instant Snow in your kit.** (We discovered less is more.) You can keep the remainder, discard it in a trash can with a liner, or use it for a demo later in the class or at an end-of-term showcase. • **It's helpful to hold/support the handle of pitcher near the top**, at least when the pitcher is full. (The handle isn't very strong.)

1. Ask students: ***Are physical properties always obvious based on how something looks? Let's see!***

2. Pair students.
3. Ask students: ***How do you think scientists protect their eyes?*** *(By handling supplies carefully*, not touching or rubbing their eyes during experiments, and washing their hands afterwards.)

   Note: Please remind students to handle supplies carefully, do not touch or rub their eyes during experiments, and to wash their hands afterwards.


Act. 4, Snow Day. Examine the dry polymer crystals (left). Then pipette drops of water onto the polymer crystals and watch them expand (right).

4. Give each pair a 1oz paper cup with polymer crystals (from Prep).
5. Have pairs examine the polymer crystals (see photo at left).

   Discussion Prompts:
   - ***What do you think this is?***
   - ***How could you test some of its properties?***
   - ***What do you think will happen if you add water to it? Let's find out!***

6. Give each pair a cup half-full of water (from the previous activity) and a pipette (different from the ones in the previous activity).
7. Have pairs use their pipette to add two drops of water to the polymer crystals.

   Discussion Prompts:
   - ***What happened?*** *(The substance expanded and formed a gel-like substance that looks like crystals – top photo, next page.)*
   - ***What do you think will happen if you add more water?***


Snow Day! When water is added to the polymer crystals, they expand to form gel-like crystals that partly fill the 1oz cup (see above).

8. Have pairs use their pipette to slowly drip more water over the crystals.

Snow Day! 1/4oz of polymer crystals in a 1oz paper cup (left) and 1/4oz of Instant Snow powder in a 1oz paper cup (right).

Act. 4, Snow Day. Provide a brown plate, a 1oz paper cup with Instant Snow, and a plastic spoon.

Act. 4, Snow Day. Use the pipette to slowly drip water over the Instant Snow.

<u>Discussion Prompts:</u>

- ***How much did the crystals grow?***
- ***Was it more than you guessed?***
- ***Why do you think that happened?*** *(The crystals are made out of a substance called a polymer. Some polymers can absorb more than 100 times their weight in water!)* ***Let's test another polymer!***

9. Give each pair a 1oz paper cup with Instant Snow (from Prep), a brown paper plate, and a plastic spoon.
10. Have each pair pour their Instant Snow powder into the center of their plate.
11. <u>Ask students:</u> ***How much do you think this polymer will expand if you add water to it? Let's make a hypothesis! A <u>hypothesis</u> is a "testable guess" about the answer to a question. You make your best guess, then do an experiment and compare your guess with what you observe.***

12. Have students predict how much the polymer will expand if they add water to it.
13. <u>Have pairs</u>:
    - Use their pipette to slowly drip water over the Instant Snow.
    - Observe and explore the Instant Snow. (Pairs can use their spoon to gently move the snow around without removing it from the plate.)

<u>**TIPS**</u>:
- **Make sure students don't let the Instant Snow overflow their plate**.
- **Pairs should use their spoon to interact with the snow, rather than touching the snow directly.** (It's good practice to avoid touching it, but in this case, it's OK if they do. Just make sure they wash their hands.)

<u>Discussion Prompts:</u>

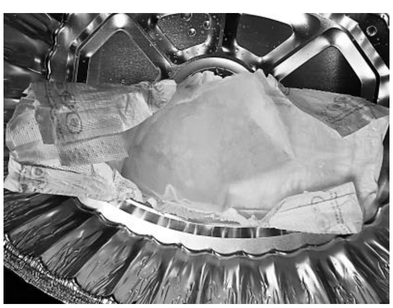
1. ***How did your hypothesis compare to what actually happened?*** *(The Instant Snow may have expanded more than expected. It's OK for a hypothesis to be disproven – that's how scientists learn new things!)*
2. ***What does this polymer look like?*** *(Snow.)*
3. ***Can you think of a way we could get the polymer to release (let go of) the water?***

14. Give each pair four packets of salt.
15. <u>Have pairs</u>:
    - Pour the salt onto <u>half</u> of the snow on their plate.
    - Watch for a minute or two.
    - If desired, use the spoon to stir the half of the snow that has salt on it.

<u>Discussion Prompts:</u>

Snow Day! When Instant Snow powder is poured onto the center of a plate and water is slowly added, the "snow" expands to cover the plate.

Act. 4, Snow Day. Pour the salt packets onto <u>half</u> of the snow (top). Watch for a minute of two. Notice how the salt "melts" the snow. If desired use the spoon to stir the half of the snow that has salt on it (bottom).



Act. 4, Snow Day. Cut the disposable diaper and place it in the large, oval pan. Gradually pour 9oz cups of water into the diaper.

- ***What happened?*** *(The salted snow started to look like it was melting.)* ***Why did that happen?*** *(Salt causes the hydrated polymers to release the water they were holding.)*
- ***What could be some useful purposes of a substance like Instant Snow Polymer?*** *(Instant Snow can absorb up to 500 times its mass in pure water in a matter of seconds. That makes it a great substance to use for absorbing industrial spills)*.
- ***Can you think of any household objects that might contain a super-absorbent polymer?*** *(Baby diapers!)*

16. Show students a disposable diaper.
17. <u>Ask students:</u> ***What material do you think is inside this diaper? Let's find out!***

18. Use the scissors to cut a long slit through the top layer of the diaper lining and open the lining. (One method is to start cutting along the side, cut or rip it the rest of the way, then peel back the top layer of the diaper to reveal the inside.)
19. <u>Ask students:</u> ***How much water do you think the diaper can absorb?***

20. Have students predict how many 9oz cups of water the diaper can hold.
21. Place the diaper in the large oval pan.
22. Using a 9oz cup from one of the student pairs, fill it nearly full of water from the other 9oz cups and/or the pitcher, and gradually pour water into the diaper.
23. Refill the 9oz cup with water and repeat as needed (see bottom photo).

<u>Discussion Prompts:</u>

- ***What happened?*** *(The diaper absorbed a lot of water!)*
- ***Why?*** *(The inside of the diaper contains a super-absorbent polymer, similar to polymer crystals and Instant Snow.)*

OPTIONAL EXTENSION – Instant Snow Stress Ball

<u>Procedure</u>:

1. Empty four 8oz water bottles and cut the top of the bottle off with scissors. Keep the neck of the bottle, discard the rest.
2. Hand out one 9" balloon to each student.
3. Students can take turns inserting the opening of the balloon through the bottom of the bottle neck, then wrapping the opening around the top of the bottle neck (see picture at left).
4. Using a plastic spoon, scoop the instant snow into the balloon. Students can also add more water to the instant snow inside the balloon with their pipettes.
5. Remove the balloon from the funnel and tie it closed.

Act. 4, Snow Day. Optional Extension. Wrap the balloon around the cut bottle neck to create a funnel.

Act. 4, Snow Day. Fill the balloon with instant snow to make a squishy stress ball. More water can be added with a pipette to expand the instant snow.

6. Discard the following items in a trash can with a liner: the plates with remaining Instant Snow on them, the 1oz paper cups (including the ones with polymer crystals in them), the empty salt packets, the plastic spoons, and the soggy diaper.

TIP:
- **Instant Snow and polymer crystals should not go near a sink because they clog drains.** If they end up in the sink, pour salt down the drain.

7. Save the 9oz cups, the pipettes, and the oval pan.
8. Have students wash their hands.

OPTIONAL: Activity Five – Flexible Fish — Time: 5 Minutes

Supplies	#	Supplies	#
Bags (Ziploc, snack - from previous activity)	16	Pitchers with lids	1
Fortune Teller Fish	16	Water	
Paper towels (large rolls)	1		

Goal: To learn about polymers by observing how cellophane interacts with moisture.

Source: www.terrificscience.org & www.polymerambassadors.org/FortuneFish.pdf

Background:
The fish are made of cellophane, which is a naturally occurring polymer that comes from wood. Cellophane absorbs water very easily. The palms of your hands have lots of sweat glands that produce moisture. When you place the fish on your palm, it absorbs the water from your sweat. As the cellophane absorbs the water, its molecules change shape and swell up, making the fish twist and turn (the main direction it curls depends on the "grain" of the cellophane). Cellophane is also thin enough that when you put it on the table, the water evaporates quickly, making it flatten back out. (https://bit.ly/3TAOk70)

Procedure:
1. Ask students: ***Have you ever seen a fortune teller fish? It can't really tell your fortune, but there's some fun science behind it!***

2. Give each student a Fortune Teller Fish.
3. Have students remove the fish from its wrapper (without handling it too much) and set it flat on the table. Keep the wrapper nearby.

   Discussion Prompts:
   - ***What properties does the fish have?*** *(It's red, transparent, thin, etc.)*

- ***What type of matter is it?*** *(Solid.)* ***Let's see how it acts if you put it on your hand instead of the table.***

4. Have students put the fish flat in the palm of their hand.

   Discussion Prompt:
   - ***What happened?*** *(The fish started to wiggle and curl – see top photo.)*

5. Have students put the fish on a dry part of their desk (it will stop moving).

   Discussion Prompts:
   - ***What do you think caused the fish to move?*** *(It could be heat or moisture from your hand.)*
   - ***How could you figure out whether heat vs. moisture is causing the effect?***

6. Have students lay the wrapper flat on their palm, then put the fish on top of it.

   Discussion Prompts:
   - ***What happened?*** *(The fish didn't move.)*
   - ***What effect do you think the plastic wrapper had?*** *(It blocked moisture from reaching the fish.)*
   - ***Do you think it blocked heat?*** *(No.)*
   - ***What can we rule out as a possible explanation for what makes the fish move?*** *(Heat.)*

7. Tell students: ***Our hypothesis is that moisture is what makes the fish move. How could we test that?***

TIP:	• **Here's another way to rule out heat: put the fish near a warm, sunny window. It won't move.** (Don't put the fish near a lamp, heater, etc.)

8. Give each student a piece of paper towel.
9. Walk around with a pitcher of water (or place the pitcher in a central location).
10. Have students take turns dipping their paper towel in the water and wringing it out over the pitcher. (The paper towel should be damp but not dripping.)

    Discussion Prompts:
    - ***Do you think this paper towel has more or less moisture than your hand?*** *(More.)*
    - ***What do you think will happen if you put the fish on top of it?***

11. Have students lay the paper towel flat on the table, then put the fish on top of it.

Flexible Fish. Have students put the fish flat in the palm of their hand. It will start to wiggle and curl.

Flexible Fish. Have students lay the wrapper flat on their palm, then put the fish on top of it. The fish won't move.

Flexible Fish. Have students lay the paper towel flat on the table, then put the fish on top of it. The fish will curl even more than before.

<u>Discussion Prompts:</u>
- ***What happened?*** *(The fish curled up even more than before!)*
- ***How is your fortune teller fish like the Instant Snow?*** *(They both have the property of absorbing water and responding in interesting ways. In fact, they're both highly absorbent polymers!)*

12. If time allows, have students try doing jumping jacks or jogging in place to see whether working up a sweat increases the moisture on their palms.
13. Have students put their fish back in its wrapper and put the wrapped fish in the Ziploc bag with the gumdrops to take home.

Activity Six – Daily Debrief — Time: 5 Minutes

Supplies	#
Worksheets: Take-Home Supplies Advisory (half-sheet)	any left
Lab Notebooks	16
Pencils	16

<u>Suggested Reading</u>: *Science Ninjas: Valence Chemistry Trilogy Book 1* by Nathan Schreiber

<u>Goal</u>: To draw today's activities together through a thoughtful question and give students an opportunity to ask their own questions.

<u>Procedure</u>:
1. Encourage students to reflect on what they learned in today's class and what new questions they might have.
2. Allow students a few seconds to think. Have them discuss their thoughts and questions with a partner, then share with the rest of the class and/or write down in their lab notebook.
3. <u>If needed, feel free to offer prompts like:</u>
   - ***What do you think would happen if we changed one thing about today's activities (for example: materials, speed, temperature, etc.)?***
   - ***If you could investigate (explore) one more thing about today's activities, what would you like to find out?***
4. <u>If time allows, ask the following question:</u>
   - ***How could you use polymers to help during a flood or hurricane?*** *(Instead of sandbags, to stop soil erosion, etc.)*

Clean up: Make sure students help clean the room before they leave.

> **TIP**:
> - **To make sure all students are involved in cleaning up, you may want to have students put away supplies and pick up trash before moving on to the "Daily Debrief" section.**

NOTES ABOUT SENDING SUPPLIES HOME FROM AKA SCIENCE:

1. Remember to save all the items in the "SAVE" column of the "WHAT TO SAVE" table (see below).
2. Let students know that they'll get to take home various AKA Science supplies over the course of the term—however, they won't take home *all* the supplies, and they won't necessarily take supplies home after *every* day of class.
3. **Instruct students that they should never put AKA Science supplies in their mouths, eyes, ears, or noses, or use them in a way that could hurt anyone.** *(There are very rare exceptions when students can put supplies in their mouths, and you'll tell them clearly when it's allowed.)*
4. Please use your judgment about sending supplies home with students. If the "WHAT GOES HOME" section includes a supply item that you don't think your students can handle safely while unsupervised, **don't send it home.**

What to save:

Materials used	#	SAVE	Materials used	#	SAVE
Bags (Ziploc, snack)	16	0	Plates (9in, sturdy paper, brown)	8	0
Butcher paper (sheets)	1	1	Salt (packets)	32	0
Cups (9oz, plastic, punch)	12	12	Scissors (site provides)	1	1
Gumdrops, bag of 26	16	0	Snow Day Packs (16 paper 1oz cups, 4oz Instant Snow, 2oz polymer crystals, 2 calibrated 1oz plastic cups & 1 disposable diaper)	1	2 calibrated cups + option to save unused snow
Fortune Teller Fish (optional)	16	0	Spoons (plastic)	11	3
Markers (black, wet erase)	2	2	Tape (rolls, Scotch)	2	2
Newspaper			Toothpicks, bundle of 20	16	0
Pans (large, oval, aluminum)	1	1	Water		
Paper towels (large rolls)	1	1	Worksheets: Pre-Survey	16	16
Pencils	16	16	Worksheets: Survey Answers	1	1

Pipettes (1mL, plastic)	8	8	Worksheets: Take-Home Supplies Advisory (half-sheet)	16	any left
Pitchers with lids	1	1	Worksheets: Make a Molecule!	8	0

What goes home: Cellophane fish in wrapper (optional), stress ball (optional), & gumdrop molecules.

(Review safety guidelines with students: small items should always be kept away from children ages 3 and younger to avoid the risk of choking; supplies from AKA Science should not go in students' mouths, eyes, ears, or noses.)

Reminders:

- **Please give completed Pre-Surveys to your Site Coordinator/ Manager.**

Cool Chemistry: Fizz, pop, WOW! (Grades 4-6)

Class 2: Mix it Up!

Supplies	#
Balloons (7in - 1 is extra)	9
Coffee filters (paper, round)	41
Coffee filters prepped with black ink circles (Chromatography paper)	16
Color fizzers (small tablets, labeled "Mix & Separate" and "Fun Filtration")	8
Cone cups (6oz, paper, with tips cut off)	8
Cornstarch (oz)	6
Cups (10oz, plastic)	8
Cups (1oz, plastic, calibrated)	2
Cups (4oz, plastic, clear)	16
Cups (9oz, plastic, punch)	22
Dish soap (20oz bottles, liquid)	1
Iodine tincture (1oz bottles)	1
Magic Sand (oz, blue)	2.5
Markers (black, wet-erase)	2
Mix & Separate Packs (16 pipe cleaners, 8 pepper packets, 8 pieces of paper (eighth-sheets, solid color), 2oz puffed rice, 1oz neon fuse beads)	1
Newspaper	
Paper towels (large rolls)	1
Pencils	16
Pipettes (1 mL, plastic)	16
Pitchers with lids	1
Plates (9in, brown kraft)	20
Plates (10in, paper, high sides)	8
Salt (packets)	4
Spoons (plastic)	20
Stir sticks (small straws)	8
Tape (rolls, Scotch)	2
Toothpicks (flat)	16
Water	

Worksheets:

See next page.

Prep (prior to class):

TIPS:
- **For many activities, the supply list includes a pitcher, newspaper & paper towels:**
  - The pitcher is helpful for filling and transporting water.
  - Newspaper is helpful for covering desks. (A bundle is in your kit; if it gets used up, you may want to grab a free newspaper to replenish your supply.)
  - Paper towels are helpful for drying spills. (A roll is in your kit; if it gets used up, you may want to supplement with paper towels from the site.)
- **Your kit also contains the following items to use if/when you'd find them helpful:**
  - 1 disposable plastic tablecloth
  - 1 garbage bag

- **Act. 2a**: Inflate and tie off 8 balloons. *Please inflate the balloons yourself, since balloons can be a suffocation/choking hazard for kids ages 8 & under.*
- **Act. 2b**: Use a calibrated cup to put 1oz of cornstarch apiece in four 9oz cups. Keep the calibrated cup handy to use during Act. 4, which also involves measuring cornstarch.
- **Act. 3 (Optional)***: Put water in sixteen 9oz cups just up to the indent at the base of each cup.
- **Act. 4 (Optional)***: Fill four 10oz cups half-full of water.
- **Act. 5a**: Use the second calibrated cup to put 1oz of powdered milk apiece in eight bowls. Wash the calibrated cup afterwards so you have a clean one to use later.
- **Act. 5b (Optional)***: Fill sixteen 9oz cups half-full of water. This will need to be done after Act. 3.
- **For Act. 2 & 5**: Make sure the pitcher is at least half-full of water.

**If preferred, you can make sure the pitcher is full of water and do these steps during the activity.*

OPTIONAL: Human Connection — Time: 2 Minutes

Goal: To share important and interesting discoveries made by scientists and communities identifying as Indigenous, Black, Brown, Melanated, Latino/Hispanic, Immigrant, Asian, LGBTQIA+ and female, and to encourage students to see themselves in science. **A**ll **k**ids **a**re scientists!

Read-Aloud Narrative:

In the last 100 years, many of the most important chemical discoveries have come from polymer science, which include developing materials like Styrofoam, nylon, and maybe even the shirt you're wearing. There are many naturally occurring polymers, too. Silk, wool, and DNA are all polymers! Let's look at one of the most influential polymer chemists of the last decade, whose discovery you probably see every day.

Walter Lincoln Hawkins was born in 1912. From a young age, Hawkins knew he was born to be a scientist and showed immense interest and intelligence in multiple scientific fields. After graduating from the prestigious all-Black Dunbar High School, Hawkins received a chemistry degree from Columbia University and became the first Black scientist at Bell Labs. Over his 34-year

Worksheets: Pre-Survey (for any students who haven't done it)	any left
Worksheets: Take-Home Supplies Advisory (half-sheet)	any left

career at Bell Labs, Hawkins became known for his work in polymer chemistry. By taking advantage of oxygen's reactive nature, Hawkins developed a method for removing oxygen from polymers, creating longer-lasting polymers. Plastics at the time degraded quickly, while Hawkins' plastics lasted for years--and were cheaper to make too!

During this time, Hawkins made his most infamous invention- the fiber optic sheath. Hawkins developed the sheath to make telephone wires more durable. As a result, the fiber-optic sheath phone cable was easier to produce, maintain, and repair. The cable expanded across rural America and eventually enabled global telecommunications. Thanks to Hawkins, we can now call and connect with our family and friends across the globe.

Activity One – Pair & Share — Time: 10 Minutes

Supplies	#	Supplies	#
Pencils	16	Worksheets: Survey Answers	1
Worksheets: Pre-Survey	16	Lab notebooks	16

Goal: To engage students' thinking and questioning related to the day's activities.

Procedure:

1. Prepare a quiet space for students to give them a physical area to think. The space can be an area set aside from the activity area, where students sit in a circle to ponder the *Pair & Share* question.
2. Make lab notebooks and pencils available.
3. Ask students a *Pair & Share* question:
    - ***Have you ever had to separate things that were all mixed together?*** *(Laundry, puzzle pieces, etc.)* ***How did you do it?***
4. Ask students to discuss their ideas with their neighbor before inviting students to share what they came up with. This is a "challenge by choice" opportunity and no one is required to share with the class if they are not comfortable.
5. After the discussion, administer the pre-survey to any students who haven't already completed their pre-survey (e.g., students who were absent on the first day.)
6. Collect completed surveys.
7. **Submit the completed surveys to Site Manager/Coordinator.** These need to go to your Manager/Coordinator as soon as possible so they don't get lost. At the end of the term, you'll be submitting the students' post-surveys as well.

Survey Connection: ***All* of the following activities are linked to the following survey question (plus some are linked to others):**

Q. ____________is everything around us in the form of solids, liquids, and gasses.
A. Matter

Activity Two – Mix & Separate Time: 15 Minutes

*****Do this activity if your class could use additional support with the concepts of "mixtures" and "separation," or if you have extra time.*****

Supplies		#	Supplies	#
Balloons (7in - 1 is extra)		9	Paper towels (large rolls)	1
Color fizzers (small tablets, labeled "Mix & Separate")		4	Pitchers with lids	1
Cornstarch (oz)		4	Plates (9in, brown kraft)	8
Cups (1oz, plastic, calibrated)		2	Plates (10in, paper, high sides)	8
Cups (9oz, plastic, punch)		4	Spoons (plastic)	4
Mix & Separate Packs (16 pipe cleaners, 8 pepper packets, 8 pieces of paper (eighth-sheets, solid color), 2oz puffed rice, 1oz neon fuse beads)		1	Tape (rolls, Scotch)	2
Newspaper			Water	

Goal: To explore the separation of mixtures by observing how a cornstarch/water mixture settles out and using a static-charged balloon to pull puffed rice away from beads.

Source: *Chemistry Experiments* by Louise V. Loeschnig, The Mad Scientist Handbook & Chemistry for Every Kid

Background:

Did you know that static electricity and the electricity that turns on lights are the same thing? They're both created by electrons. Everything in the world has electrons. These electrons can move back and forth between things. When you rubbed the balloon against the plate, you bumped electrons off the plate and onto the balloon. When you had enough electrons on the balloon, it was able to pick up the paper/puffed rice because the paper/rice were attracted to the electrons.

Chemical bonds work through something like static electricity—but instead of a balloon attracting paper/rice, atoms attract other atoms. Chemical attraction takes many forms. One type of strong chemical bond is called an ionic bond. An ionic bond happens when a positively charged atom is attracted to a negatively charged atom. When two atoms join, they have very different properties than before. For example, sodium is a metal that burns when it touches water, and chlorine is a poisonous gas. But when sodium ions and chlorine ions meet, they form ionic bonds & make table salt! (https://bit.ly/3KkJs1k)

Act. 2, Mix and Separate. Provide a 9oz cup with 1oz of corn starch inside, two pepper packets, and a plastic spoon (top left). Fill the cup halfway with water and add the pepper and a color fizzer, then mix (top right, bottom left). Set aside and check back to see that it separates out (bottom right).

Procedure:

TIP:	• **On humid days, it can be difficult to charge up balloons with static electricity.** If it's a humid day, you may want to just do the first part of this activity and save the part with balloons for a drier day. (You can also test the activity before class to assess whether it's a good day for static.)

1. Ask students: ***Have you ever made a mixture before? Let's explore some mixtures!***

2. Put students in 4 groups. (Students will take turns doing the following steps.)
3. Give each group a 9oz cup with cornstarch (from Prep), two pepper packets, and a plastic spoon.
4. Have the first student in each group empty both pepper packets into the cup.
5. Have the next student use the spoon to stir the pepper into the cornstarch.

   Discussion Prompts:
   - ***What makes something a mixture?*** *(A mixture is made when you combine 2 or more things that don't have a chemical reaction to each other, which means they can be separated back out.)*
   - ***Have you made a mixture in the cup?*** *(Yes! The flour is speckled with pepper, but the pepper could still be separated back out.)*
   - ***What if you add water?***

6. Walk around with the pitcher and fill each group's cup half-full of water.
7. Have the next student stir the contents of the cup.

   Discussion Prompts:
   - ***Is it still a mixture?*** *(Yes. The water could be evaporated out as steam, which would leave the cornstarch and pepper behind.)*
   - ***Will it still be a mixture if you add color to it?***

8. Give each group a color fizzer.
9. Have the next student add the color fizzer to the mixture, stir, and observe. (Feel free to leave the spoon in the cup.)
10. Ask students: ***What do you think will happen after a few minutes? Let's wait and see!***

11. Have groups set their cup aside in a location where it won't spill or get jostled.
12. Tell students: ***One of the most important properties of a mixture is that you can separate out its parts. Sometimes it can be difficult or time-***

Act. 2, Mix and Separate. Provide an inflated balloon, a Styrofoam plate (taped down), and a 1/8 piece of paper that will be ripped up as shown above. Charge the balloon by rubbing it vigorously on the plate.

Act. 2, Mix and Separate. Hold the charged balloon above the paper. Move the balloon back and forth slightly to get as much as possible.

consuming to separate the materials after they've been combined. Let's try a cool method for separating materials!

13. Pair students.

> **TIP:**
> - **For activities that use tape, you may find it helpful to walk around and pass out pieces as needed.** Alternately, if your students are more mature, you can pass the rolls of tape around for students to share.

14. Give each pair a Brown kraft plate. Make tape available.
15. Have pairs put 1-2 rolls of tape on the bottom of their Brown kraft plate, then set the plate flat on a desk so it sticks to the desk.
16. Give each pair a 1/8-sheet of paper.
17. Have pairs rip their paper so both students have a half-piece, then rip those halves into tiny pieces next to their plate.
18. Ask students: ***When you ripped your paper, was that a physical or chemical change?*** *(Physical change. The chemical composition of the paper didn't change—the pieces just got smaller.)*

19. Give each pair an inflated balloon (from Prep).
20. In each pair, have students take turns doing the following:
    a. Gently hold the edge of the Brown kraft plate.
    b. Rub the balloon vigorously on top of the plate to build up a static charge.

> **TIPS:**
> - **It may take a full minute of activity to build up a charge.**
> - **If rubbing the balloon back and forth on the surface of the plate isn't working, it may help to rub the balloon firmly in one direction** on the plate, lift it up, then move it back to the starting point and repeat.
> - **As an alternative, students could try rubbing the balloon on their shirt.**
> - **It may be helpful to palm the tied-off end of the balloon** and focus on charging the top of the balloon.
> - **Although it can take time to build up a charge, once the balloon is charged, it tends to be easier to recharge it.**

21. In each pair, have students take turns doing the following:
    a. Hold the charged part of the balloon just above the paper.
    b. Move the balloon back and forth slightly while hovering just above the paper. (It's OK to skim the tops of the pieces of paper.)
    c. Count how many pieces of paper stuck to the balloon (see photo).
    d. Brush the pieces of paper off the balloon and back onto the table.
    e. Recharge the balloon and repeat.

Discussion Prompts:
- ***What happened?*** *(The paper was attracted to the balloon! Some pieces stuck to the surface.)*

Act. 2, Mix and Separate. Repeat the activity this time skimming the tops of the puffed rice and bead mixture. The balloon will attract the rice.

- ***Why do you think that happened?*** *(When you rub a balloon on Styrofoam or clothes, some tiny, negatively charged particles called electrons rub off onto the balloon. That gives the balloon an overall negative charge that can attract other things.)*

22. Have pairs tear a few pieces of paper into even tinier pieces. Repeat the activity.

    Discussion Prompts:
    - ***Did you pick up more or fewer pieces when the pieces were smaller?*** *(More!)*
    - ***Do you think static attraction only works with paper? Let's try using different materials!***

23. Give each pair a 10in paper plate with high sides.
24. Use a clean 1oz calibrated cup to walk around and put the following in the middle of each pair's plate: 1/4oz of puffed rice and enough fuse beads to just cover the bottom of the calibrated cup. (It's also OK to just divvy up the puffed rice and beads among the pairs without measuring.)

    Discussion Prompts:
    - ***Is this a mixture?*** *(Yes.)*
    - ***How could you separate the puffed rice from the beads?*** *(Pick the pieces out one by one.)*
    - ***Is there another way?***
    - ***How could you use the balloon to separate out the puffed rice?***

25. Have pairs repeat the activity, this time skimming the tops of the puffed rice with the charged part of the balloon.

    Discussion Prompts:
    - ***What happened?*** *(Some pieces of puffed rice stuck to the balloon. A few pieces may even have formed short chains that briefly clung to the balloon.)*
    - ***Why didn't the beads stick?*** *(They're too heavy to be moved by the balloon's static electricity.)*

26. Have pairs brush the puffed rice off the balloon and onto the plate, then repeat.
27. Tell students: ***Let's go back and look at our first concoction.***
28. Have groups observe their 9oz cups from earlier in the activity.

    Discussion Prompts:
    - ***What has happened to the mixture?*** *(There's a clump of cornstarch and pepper at the bottom. Above that, there's a layer of colored water.)*
    - ***Why did the mixture separate?*** *(Cornstarch doesn't dissolve in water. When you stirred the cornstarch and water together,*

particles of cornstarch got temporarily suspended in the water, but they eventually sank to the bottom of the cup.)

- ***Why is the water still colored?*** *(The pigment in the color fizzer dissolved in the water. It mixed fully and evenly to form a solution.)*
- ***Could you still separate all of the items back out of this mixture—including the color—if you wanted to?*** *(It would be challenging and might require some special equipment, but yes!)*

29. If time allows, have students un-tape their Brown kraft plate from the table, then hover the bottom of the Brown kraft plate just above the plate with the puffed rice.
30. Keep the Brown kraft plates handy for the next activity. Keep the spoons handy for Activity Four: Fun Filtration. (Optional: it may be helpful to keep the cups of cornstarch and water handy to look at in Activity Four.)
31. If desired, students can string some fuse beads onto a pipe cleaner to take home.

Activity Three – Cool Chromatography Time: 10 Minutes

Supplies	#	Supplies	#
Coffee filters prepped with black ink circles (Chromatography paper)	16	Paper towels (large rolls)	1
Coffee filters (paper, round)	16	Pencils	16
Cups (9oz, plastic, punch)	16	Pitchers with lids	1
Markers (black, wet-erase)	2	Plates (9in, brown kraft - 8 are from earlier activity)	16
Newspaper		Water	

Goal: To perform chromatography with coffee filters and water to separate black marker ink into multiple colors of dye.

Source: https://bit.ly/3RdbOwG

Background:

Chromatography is a method scientists use to separate out the different dyes in ink. When you put the coffee filter in the water, the water immediately spreads out through the paper via a process called capillary action. The ink gets dissolved in the water and moves along with it.

Ink is actually made of a mixture of different dyes. As the different dyes move with the water, some of them are more attracted to the paper, so they move slowly and stop soon. Some of the dyes are more attracted to the water, so they move quickly and travel farther away from the center of the paper. After a little while, the dyes separate so you can see each individual color. Different brands of black markers use different combinations of dyes. Even if the markers look the same when you write with them, the inks separate out differently.

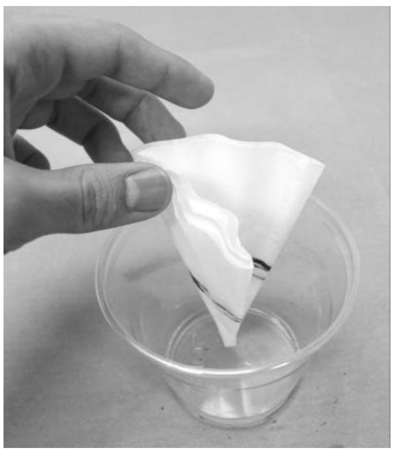
Chromatography can be used in real life to figure out what things are used to make up ink and other liquids. You can use chromatography to separate out all the ingredients, then you can use different tests to find out what those ingredients are. Chromatography was used to figure out what makes leaves change colors. Scientists used chromatography to separate out the pigments in green leaves, proving that the leaves also have reds and oranges in them. (https://bit.ly/3CAQI7x)

Procedure:

Discuss the definition of a mixture if you've skipped the *Mix & Separate* activity. See *Mix* & Separate talking points if needed

1. Ask students: ***What is the color black? Is it just one color or a mixture of different colors? Let's explore!***
2. Give each student a pencil, a coffee filter with a black circle on it, a brown kraft plate, and a 9oz cup that has water in it just up to the indent near the base of the cup. (If the cups weren't filled as Prep, you can fill each cup as you go around).

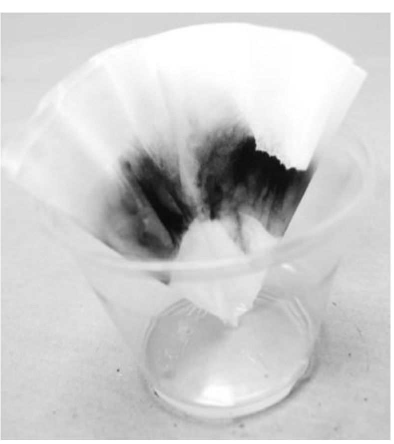
TIP:	• **If desired for a more dramatic effect, you could have students use a wet-erase marker to trace an *additional* black circle on their filter (over the existing one).** Err on the side of making the 2nd circle slightly larger.



Act. 3, Cool Chromatography. Place the folded coffee filter wedge in the cup, point down. The tip of the wedge will be submerged in the small amount of water in the cup.

3. Have students:
   a. Use the pencil to label their filter somewhere near the outer rim.
   b. Fold their filter in half 3 times to form a wedge ("like a pizza slice").
   c. Gently place the wedge in their cup point-down—so the tip of the filter is in the water—then let go (see top photo).

TIP:	• **Make sure the black marker line stays above the level of the water.** (Otherwise, the black ink will seep into the water in the cup, and the activity won't work very well.)

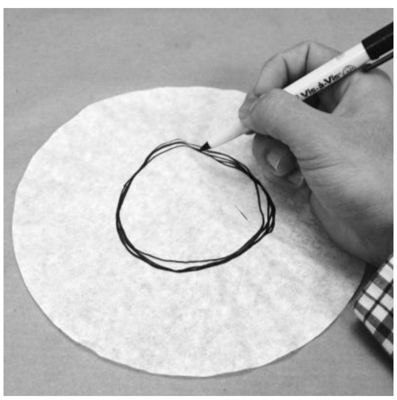


Act. 3, Cool Chromatography. Water spreads up the filter and separates the ink into different colors.

4. Have students watch as the water travels up the filter (see bottom photo).

   Discussion Prompts:
   - ***What do you notice?*** *(As the filter absorbs the water, the ink gets carried along with it. As the ink travels upward, it starts to spread out into different bands of color. This is called chromatography. It's a method scientists use to separate out different dyes and pigments.)*
   - ***What colors can you see separating out from the marker?*** *(Red, yellow, and blue.)*

Act. 3, Cool Chromatography. See the colors of a completed, dried filter.



Act.3, Cool Chromatography. Draw 5-7 circles on the coffee filter, around the part where the flat part starts to become wavy. (Do this on top of a Brown kraft plate so the marker won't bleed onto the table.)

5. After a few minutes, have students gently lift their filter out of the water (holding it by the edges) and spread it out over the top of the cup to dry.

TIPS:
- **It works best to remove the filter while the edges are still dry.** The marker ink will continue to travel a little further, even after the filter has been removed from the water.
- **Tell students not to touch the wet ink on the filter**, since the ink will come off on their hands. (However, the ink can be washed off.)
- **The filter will look best once the white part dries**, since it creates visual contrast with the separated colors.

6. If time allows, give each student (or each pair of students) a blank coffee filter and a Brown kraft plate. Make the two black wet-erase markers available to share.
7. Have students (or pairs):
   a. Put the new filter on the plate (so marker ink won't bleed onto the table).
   b. Draw 5-7 large circles around the part of the filter where the flat part starts to become wavy (see photo).
   c. Remove their first filter from on top of the cup and lay it on the Brown kraft plate, ideally upside-down (the gap between the center of the filter and the plate will help the filter dry).
   d. Repeat the activity.

TIP:
- It may not be obvious where the flat part of the coffee filter ends, and the wavy part begins. **The important thing is that the marker circles should be big enough that the water won't touch the black ink when the tip of the filter goes in the water.**

8. Students can take their dried filter(s) home at the end of class.
9. Keep the 9oz cups handy for Act. 5: Magic Sandbox.

Activity Four – Fun Filtration Time: 15 Minutes

Supplies	#	Supplies	#
Coffee filters (paper, round)	25	Iodine tincture (1oz bottles)	1
Color fizzers (small tablets, labeled "Fun Filtration")	4	Newspaper	
Cone cups (6oz, paper, with tips cut off)	8	Paper towels (large rolls)	1
Cornstarch (oz)	2	Pipettes	4
Cups (9oz, plastic, punch)	2	Plates (9in, Brown kraft)	4
Cups (10oz, plastic)	8	Spoons (plastic- from earlier Mix & Separate activity)	4
Cups (1oz, plastic, calibrated)	1	Stir sticks (small straws)	8
		Water	

Goal: To filter out water from a water/cornstarch mixture, then use iodine to demonstrate that the cornstarch was left behind.

Source: Van Cleave, Janice. (1995). *The Human Body for Every Kid*. USA: John Wiley & Sons, Inc.

Survey Connection:

★ **Q.** Fill in the blank: When you combine two or more things and they change into something new, that's called a chemical ____________.

A. Reaction.

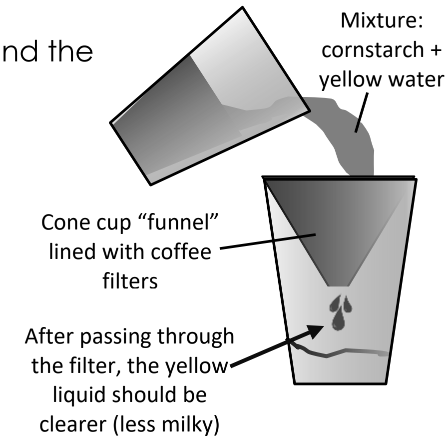
Background:

Compared to water molecules or the fizzer molecules, starch molecules are huge! The filter acts like a fishnet, catching the big starch molecules and letting the water and color get through. Your intestines also work as a filter. When food enters your digestive system, the nutrients your body needs to live can pass through into your bloodstream—which delivers them all around the rest of your body—while wastes get filtered out. What other filtration systems do you know of? (https://bit.ly/3PJTHgU)

Procedure:

1. Ask students:
   - ***Remember how the mixture of cornstarch and yellow water settled into layers when you let it sit?*** *(Note: if the cups from the Mix & Separate activity are still available, students can look at them directly.)*
   - ***What if you wanted to just work with the yellow water – would it have been easy or hard to get it out of the cup without disturbing the cornstarch?*** *(It would have been pretty hard. Maybe you could have spooned the water off the top, but that might also have mixed some of the cornstarch back in.)*
   - ***Is there a way to separate a mixture of cornstarch and water so you can work with each part separately? Let's see!***
2. Put students in 4 groups. (Students will take turns doing the following steps.)
3. Give each group five coffee filters, two cone cups with the tips cut off, an empty 10oz cup, and a spoon from the Mix & Separate activity.
4. Have the first student in each group:
   a. Fit the two cone cups together to make a double strength "funnel."
   b. Stack the 5 coffee filters, then turn the stack upside-down.

c. Hold the edge of the upside-down stack in one hand, then put the pointer finger of the other hand under the center of the stack.
d. Squeeze the stacked filters around the index finger so The filters form a cone shape.
e. Carefully push the stack of coffee filters into the "funnel." (Have another student hold the funnel steady.)
f. Put the filter-lined "funnel" tip-down in the empty 10oz cup, so it rests on the rim of the cup (see diagram above).



5. <u>Ask students:</u> ***What have we made?*** *(A filtration system.)* ***Let's see how it works!***

6. Give each group a color fizzer and a new 10oz cup that's half-full of water. (If the cups weren't filled as Prep, you can fill each cup as you go around).
7. Have the second student in each group put the color fizzer in the water.
8. Allow the group to observe as the fizzer bubbles and dissolves.
9. Walk around and put half an ounce of cornstarch in each group's cup of water.
10. Have the next student use the spoon to stir the mixture until the cornstarch particles are no longer visible. The liquid will be milky yellow.

<u>Discussion Prompts:</u>

- ***If you had a mixture of sand and water, and you poured it into your filtration system, what do you think would happen?*** *(The filter would strain out the sand, and the water would end up in the bottom of the cup.)*
- ***Why?*** *(Because the small holes in the coffee filters would trap the sand, but water could still flow through.)*
- ***What do you think will happen if you pour this cornstarch/water mixture into your filtration system? Let's find out!***

11. Have the next student carefully pour about <u>half</u> of the liquid into the "funnel." (Don't let the liquid slosh out of the funnel – see top photo.)
12. Have groups compare the cornstarch/water mixture left in the cup to the liquid that comes out of the filtration system.

<u>Discussion Prompts:</u>

- ***What happened to the liquid that passed through the filter?*** *(The liquid that passed through the filter became much clearer than it was when it went in – see bottom photo.)*


Act. 4, Fun Filtration. Create a cone shape out of the filters by placing them on the pointer finger and squeezing the stack with the other hand.


Fun Filtration. Pour about half the liquid into the filter-lined "funnel." (The coffee filters are difficult to see in this photo, but they're on the inside of the cone cup "funnel.")


Fun Filtration. The liquid that passed through the filter became much clearer than it was when it went in.

- ***Why do you think that is?*** *(The cornstarch molecules were too large to pass through the coffee filters, so they got left behind during the filtering process. However, the water molecules were small enough to pass through.)*
- ***Why is the water still colorful?*** *(The fizzer molecules were small enough to pass through the filters, leaving the water clearer but still yellow.)*
- ***The filtered liquid looks different—but is there a way to actually test whether cornstarch got left behind?***

13. Set up a station in the room where you can cover a flat surface with newspaper.
14. Open the bottle of iodine and place the bottle and applicator in a 9oz cup at the station. Have four empty Brown kraft plates, four pipettes, one fresh stack of 5 coffee filters spread out on a fifth plate, eight stir sticks, and an empty 9oz cup ready.

CAUTION: Iodine is poisonous if ingested, may irritate eyes, and will stain.
- ***ONLY YOU*** **as the Class Leader should handle the bottle of iodine.**
- **NOTE: there's a stick applicator attached to the cap of the iodine bottle, so after you unscrew the cap, lift it straight up.**
- **If any is swallowed,** call 911 or Poison Control: 1-800-222-1222.
- **If any gets in a student's eyes,** immediately flush with running water and call Poison Control.
- **If any gets on a student's skin,** immediately wash it off. If irritation occurs, call Poison Control.
- **If you don't think your students can safely handle a stir stick with the tip dipped in iodine without flicking the iodine off in an uncontrolled way, then you'll want to do the iodine portion of the activity as a demo.** (You may want to wear gloves.)

15. One at a time, have groups bring their filtration system to the station and spread their stack of filters on one of the empty Brown kraft plates.
16. Help groups remove their stack of coffee filters and spread it out on a Brown kraft plate, face-up.

    Discussion Prompts:
    - ***What do you notice about the top surface of your used filter?*** *(There's some white goop in the center.)*
    - ***What do you think it is?*** *(Probably the cornstarch.)*
    - ***Do you know what iodine is?*** *(It's a mineral. Sometimes it's used as an antiseptic. Sometimes it reacts in interesting ways with other substances.)*
    - ***What do you think will happen if we put iodine on the part of the filter that has white goop on it versus the part that doesn't?***
    - ***What do you think will happen if we iodine test our filtered liquid? Let's find out!***

17. Hold the 9oz cup with the bottle of iodine over the plate.
18. One at a time, help each student in the group:

Fun Filtration. Let a drop of iodine fall onto the filter near the edge, then re-dip the stir stick and let a drop of iodine fall onto the filter near the center. The iodine near the center of the filter turns <u>black</u>, while the iodine near the edge stays brown.

a. Dip the end of a stir stick in the bottle of iodine.
b. Hold the stir stick about an inch above the filter and let a drop of iodine fall onto the filter <u>near the edge</u>.
c. Re-dip the stir stick and hold it about an inch above the filter.
d. Let a drop of iodine fall onto the filter <u>near the center</u> (see photo).
e. Finally, have one member of each group drop iodine onto the area of the new filter stack where their filtered liquid had been pipetted.

<u>TIPS</u>:
- **Hold the stir stick near the top, but don't cover the top opening.**
- **If needed, give the stir stick a <u>very small</u> downward shake so that a drop of iodine falls onto the filter.**
- **The same stir stick can be reused for 2-4 students.** After 2-4 uses, put the stir stick in the empty 9oz cup. The discarded sticks can be dumped into a trash can with a liner and the cup can be washed.

<u>Discussion Prompts:</u>
- ***What happened?*** *(The iodine turned black where it touched the white goop but stayed brown where it touched the outer edge of the filter, and where it touched the filtered liquid.)*
- ***Why do you think that happened?*** *(Iodine has the chemical <u>property</u> of turning black in the presence of starch. When you add iodine to something and it turns black, that's a <u>chemical reaction</u> that indicates starch is present.)*
- ***Since the iodine turned black where it touched the white goop, and stayed brown where it touched the filtered liquid, what does that tell you more about where the cornstarch is?*** *(In the filter, not the liquid!)*

19. When a group finishes at the station, have them leave their plate with coffee filters at the station, then start cleaning up their group's workspace. (At the end of the activity/class, you as the Class Leader should put the filters with iodine in a trash can with a liner and wash the Brown kraft plates.)
20. Rinse out the 4 pipettes, and 9oz cups for use in the next activity.

Activity Five – Milk Motion　　　Time: 10 Minutes

Supplies	#	Supplies	#
Bowls (20oz, sturdy paper)	8	<u>Milk Motion Packs</u> (8oz of powdered milk & 2 small bottles of food coloring (different colors))	1
Cotton swabs (6in, wood handle)	16	Newspaper	
Cups (1oz, plastic, calibrated)	1	Paper towels (large rolls)	1
Cups (9oz, plastic, punch - from Cool Chromatography activity)	8	Pitchers with lids	1

Dish soap (20oz bottles, liquid)	1	Spoons (plastic)	8
		Water (oz)	

<u>Goal</u>: To explore the action of soap by observing how touching the surface of powdered milk with soap causes food coloring to mix and swirl.

<u>Source</u>: https://bit.ly/3cm7sEM & thanks to Katie Bryars Wenner

<u>Background:</u>

Let's think about the three players in this experiment: milk, food coloring, and soap. Milk is mostly water, but it's not clear like water because it has fat, proteins, and other nutrients suspended in it. Food coloring is mostly dyed water. Soap is a very special molecule! Soap is a molecule with two different ends. One end loves water, and the other end loves fat.

When you put soap in a mixture of fat and water, one end of the soap attaches to water molecules, and the other end attaches to fat molecules. In this experiment, there were a lot of water molecules, but the fat was suspended in the milk. When you touched the surface of the milk with your soapy Q-tip, the soap raced out to find fat molecules and attach them to water molecules in a continuous process that caused the surface of the liquid to move. The food dye particles went along for the crazy ride, and helped you see how the milk, soap, and water moved!

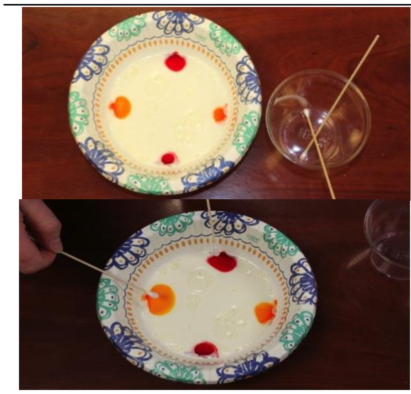
Soap's special property is what makes it so good for washing your hands! The soap clumps around the oil and dirt on your hands, then washes away under running water. (https://bit.ly/3cm7sEM)

<u>Procedure</u>:

1. <u>Tell students:</u> ***We just saw that different liquids can have completely different properties, and that some liquids won't mix together. Now let's explore these properties up close!***

2. Pair students.
3. Give each pair a bowl with powdered milk (from Prep), a 9oz cup (from the Cool Chromatography activity), and a plastic spoon.
4. Have pairs use a paper towel to dry out their 9oz cup.
5. Walk around with the pitcher of water and a 1oz calibrated cup (or you could set up a station and have students bring their bowl to the station).
6. Have the first student in each pair dip the cup in the pitcher and add 1oz of water to their bowl.
7. Have the second student in each pair use spoon to stir the water/powdered milk mixture until it's thoroughly blended. (When finished, let the mixture sit undisturbed so the milk stops swirling.)
8. Walk around and give each pair a small squeeze of soap in their 9oz cup and collect back their spoon.

   <u>Discussion Prompt:</u>
   - ***How do you think soap works?***



Act. 5, Milk Motion. Provide two cotton swabs for the 9oz cup with soap and add two drops of one color across from each other and two drops of the other color perpendicular to the first (top). Note the colors will spread before the activity begins (bottom).

Act. 5, Milk Motion. Simultaneously place two soaped cotton swabs in the middle of two different dots of food coloring (top). Repeat multiple times and watch as the colors continue to spread (bottom).

9. <u>Explain to students</u> *that soap molecules have a polar, <u>hydrophilic</u> (water-loving) head and a non-polar, <u>hydrophobic</u> (water-repelling) tail. A soap molecule attaches to water molecules with its polar head and to oil and grime with its non-polar tail. This helps suspend fats and dirt in the water so they can be more easily washed away.)* ***Let's use this property of soap to make the milk move without touching it!***

10. Walk around and add four drops of food coloring to each pair's bowl: two drops of the first color (across from each other, near opposite sides of the bowl) and two drops of the other color (perpendicular to the first set, also across from each other near opposite sides of the bowl).

<u>CAUTION</u>: <u>Food coloring will stain hands and clothes</u>.
- **Add the drops of food coloring close to the surface of the milk to minimize splashing.**
- **Tell students they can only touch the liquid with their cotton swab, and only when instructed.**

<u>Discussion Prompts:</u>
- ***What do you notice about the food coloring?*** *(The color spread out a little bit on the surface of the milk, but otherwise, not much is happening.)* ***Knowing that soap grabs onto water and fat molecules at the same time, what do you think will happen if you dip a cotton swab in the soap, then place the soap on each dot of food coloring? Let's find out!***

4. <u>Tell students:</u> ***You and your partner will both get a little bit of soap on the end of a cotton swab. When I say, "Go" your mission is to put the soapy swab in the milk at the exact same time—right in the middle of two different colors.***

5. Give each pair two cotton swabs.
6. Have students dip their cotton swab in the soap and get ready (hold the swabs off to the side of the bowl, and don't jostle the bowl).
7. When you say, "Go," in each pair, have both students place the soaped end of their cotton swab in the milk at the same time (one student will aim for the middle of one color, and the other student will aim for the other).
8. Have pairs observe what happens, then put their cotton swabs back in the 9oz cup. (It helps to keep the swabs in the 9oz cup when not in use to avoid a mess.)
9. After a moment, have one student re-dip their cotton swab in the soap, then press and hold it in the milk, near where one of the other drops of food coloring was (even if they can't see it clearly).
10. Have them put their cotton swab back in the cup while both students observe.
11. Have the other student repeat the process with the fourth drop of food coloring.

12. Have students take turns repeating the process in different areas of the bowl until the soap no longer causes a visible change.

    Discussion Prompts:
    - ***What happened?*** *(The food coloring moved away from the soap, which caused the different colors to move around and swirl together.)*
    - ***Why do you think that happened?*** *(The soap molecules get busy attaching to the fat and water molecules in the milk. The food coloring went along for the ride and made the motion within the liquid easy to see. As a result of this motion, the colors blended. Once the soap molecules attached to all the fat molecules in the milk, the reaction stopped.)*

Activity Six – Daily Debrief — Time: 5 Minutes

Supplies	#
Worksheets: Take-Home Supplies Advisory (half-sheet)	any left
Lab Notebooks	16
Pencils	16

Suggested Reading: *Basher Science: Chemistry: Getting a Big Reaction* by Simon Basher and Dan Green.

Goal: To draw today's activities together through a thoughtful question and give students an opportunity to ask their own questions.

Procedure:
1. Encourage students to reflect on what they learned in today's class and what new questions they might have.
2. Allow students a few seconds to think. Have them discuss their thoughts and questions with a partner, then share with the rest of the class and/or write down in their lab notebook.
3. If needed, feel free to offer prompts like:
   - ***What do you think would happen if we changed one thing about today's activities (for example: materials, speed, temperature, etc.)?***
   - ***If you could investigate (explore) one more thing about today's activities, what would you like to find out?***
4. If time allows, ask the following question:
   - ***If you could invent a machine to mix things together or separate mixtures into their different parts, what would you invent? How would it work?***

Clean up: Make sure students help up clean the room before they leave.

Cool Chemistry: Fizz, pop, WOW! (Grades 4-6)

Class 2: Mix it Up!

What to save:

Materials used	#	SAVE	Materials used	#	SAVE
Balloons (7in - 1 is extra)	9	0	Milk Motion Packs (8oz of powdered milk & 2 small bottles of food coloring (different colors))	1	any food coloring
Bowls (20oz, sturdy paper)	8	0	Mix & Separate Packs (16 pipe cleaners, 8 pepper packets, 8 pieces of paper (eighth-sheets, solid color), 2oz puffed rice, 1oz neon fuse beads)	1	0
Coffee filters (paper, round)	41	0	Newspaper		
Coffee filters prepped with black ink circles (Chromatography paper)	16	0	Paper towels (large rolls)	1	1
Color fizzers (small tablets, labeled "Mix & Separate)	4	0	Pencils	16	16
Color fizzers (labeled "Fun Filtration")	4	0	Pipettes	16	16
Cone cups (6oz, paper, with tips cut off)	8	0	Pitchers with lids	1	1
Cornstarch (oz)	6	0	Plates (9in, Brown kraft)	20	20
Cotton swabs (6in, wood handle)	16	0	Plates (10in, paper, high sides)	8	8
Cups (10oz, plastic)	8	8	Salt (packets)	4	0
Cups (4oz, plastic)	16	0	Spoons (plastic)	20	20
Cups (1oz, plastic, calibrated)	2	2	Stir sticks (small straws)	8	0
Cups (9oz, plastic, punch)	22	6	Tape (rolls, Scotch)	2	2
Dish soap (20oz bottles, liquid)	1	1	Toothpicks (flat)	16	0
Iodine tincture (1oz bottles)	1	1	Water		
Markers (black, wet erase)	2	2	Worksheets: Pre-Survey (for students who haven't done it)	any left	any new
			Worksheets: Take-Home Supplies Advisory (half-sheet)	any left	any left

NOTE: Pipe cleaners are common objects, but they do have sharp ends. For this and future classes, if you don't think your students can handle them safely while unsupervised, please don't send them home.

What goes home: Chromatography filter(s) & fuse beads on a pipe cleaner (optional). You can wrap the beaded pipe cleaner around a scrunched chromatography filter to create a butterfly.

(Review safety guidelines with students: small items should always be kept away from children ages 3 and younger to avoid the risk of choking; supplies from AKA Science should not go in students' mouths, eyes, ears, or noses.)

Cool Chemistry: Fizz, pop, WOW! (Grades 4-6)

Class 3: Liquid Tricks

Supplies	#
Alka-Seltzer (tablets)	16
Bags (Ziploc, sandwich)	16
Bottles (8oz water bottles)	16
Color fizzers (small tablets, labeled "Lava Lamp")	16
Color fizzers (small tablets, labeled "Liquid Layers")	1
Corn syrup (oz, light)	16
Cups (20oz, plastic)	5
Cups (4oz, plastic, clear)	16
Cups (9oz, plastic, punch)	16
Dish soap (20oz bottles, liquid)	1
Funnels (2oz, plastic)	1
Liquid Layers Packs (4 rubber bouncy balls (translucent), 4 quarter-pieces of chalk (A+ Homework brand), 4 mini clothespins (natural wood), 4 corks (small), 4 paper clips (assorted colors), 4 rubber bands (thin/small), 4 clamrose shells (small) & 4 spiral shells (very small))	1
Magic Sand (oz, blue)	2.5
Newspaper	
Oil (oz, vegetable)	64
Paper towels (large rolls)	1
Pencils	16
Pipettes (1mL, plastic)	16
Pitchers with lids	1
Salt (packets)	4
Spoons (plastic)	20
Toothpicks (flat)	16
Water	

Worksheets:

Worksheets: Pre-Survey (for any students who haven't done it)	any left
Worksheets: Take-Home Supplies Advisory (half-sheet)	any left

Prep (prior to class):

TIP: • **When a prep step says to prepare 16 items (15 students + 1 teacher)**, if there are fewer than 15 students in your class, just prepare one item for each student.

- **Act. 2 (Optional)*:** Fill a 20oz cup ¾-full of water.
- **Act. 2a:** Use a calibrated cup to put 1/8 oz of Magic Sand apiece in sixteen 4oz cups.
- **Act. 4a**: Remove the labels from sixteen water bottles.
- **Act. 4b:** Empty sixteen water bottles (feel free to empty them into the pitcher to use the water).
- **Act. 4c:** Use the 48oz bottle of oil and a funnel to add oil to each water bottle up to the 2nd indented line from the top of the bottle. (Tip: if you have fewer than 16 kids in your class, prep one per student and just divvy up the 48oz of oil among the bottles—though don't fill past the top indented line.)
- **Act. 4d:** Make sure the pitcher is full of water.
- **Act. 4e (Optional):** Break sixteen Alka-Seltzer tablets in half.

**If preferred—and if you have access to a sink—you can do these steps during the activity.*

OPTIONAL: Human Connection Time: 1 Minute

Goal: To share important and interesting discoveries made by scientists and communities identifying as Indigenous, Black, Brown, Melanated, Latino/Hispanic, Immigrant, Asian, LGBTQIA+ and female, and to encourage students to see themselves in science. **A**ll **k**ids **a**re scientists!

Read-Aloud Narrative:

Whether you're baking a cake or making soap, oil and water interact in a unique way. Oil, and other fats, are hydrophobic. This means the chemical structure of fats and oil prevents them from bonding and forming a mixture with water (hence, hydro-phobic!). **Alice Ball**, a Black scientist born in 1892, manipulated the hydrophobic properties of water to treat a once rampant skin disease – leprosy.

Ball showed an aptitude for chemistry at a young age. She received a full scholarship to the University of Hawaii, becoming the first Black woman to do so. After graduating, Ball studied the interactions between leprosy and its only known treatment–chaulmoogra oil. Applying the oil as a lotion slowed the progression of the disease. However, because the oil is hydrophobic, it cannot be absorbed by the blood. This means that chaulmoogra oil in its natural state cannot fully cure leprosy. Luckily, Alice Ball developed "the Ball Method." The Ball Method is a way to make hydrophobic oils water soluble by isolating specific fats. The method she developed turned chaulmoogra oil from a temporary solution for leprosy into a permanent solution! The Ball Method was the primary treatment for leprosy for over 50 years. Unfortunately, Ball passed away before her work was published and her lab-mates took credit for developing the treatment. Only a century later were Ball's contributions discovered.

Activity One – Pair & Share — Time: 10 Minutes

Supplies	#	Supplies	#
Pencils	16	Worksheets: Survey Answers	1
Worksheets: Pre-Survey	16	Lab notebooks	16

Goal: To engage students' thinking and questioning related to the day's activities.

Procedure:

1. Prepare a quiet space for students to give them a physical area to think. The space can be an area set aside from the activity area, where students sit in a circle to ponder the *Pair & Share* question.
2. Make lab notebooks and pencils available.
3. Ask students a *Pair & Share* question:

    - ***What are the properties of your favorite shirt? How about your favorite toy or game?***

4. Ask students to discuss their ideas with their neighbor before inviting students to share what they came up with. This is a "challenge by choice" opportunity and no one is required to share with the class if they are not comfortable.
5. Have any students who were absent on the first or second days of class complete their pre-survey while you prep the next activity.

Survey Connection Note: ***All* activities are linked to this survey question (plus some are linked to others):**

Q. ____________is everything around us in the form of solids, liquids, and gasses.
A. Matter

Activity Two – Magic Sandbox — Time: 20 Minutes

Supplies	#	Supplies	#
Cups (4oz, plastic, clear)	16	Pipettes (1mL, plastic)- 4 from earlier activity	16
Cups (9oz, plastic, punch)- from earlier chromatography activity	16	Pitchers with lids	1
Dish soap (20oz bottles, liquid)	1	Salt (packets)	4

Magic Sand (oz, blue)	2.5	Spoons (plastic)- including ones from earlier activities	20
Newspaper		Toothpicks (flat)	16
Paper towels (large rolls)	1	Water	

<u>Goal</u>: To explore the unique properties of hydrophobic (water-repellent) sand.

<u>Source</u>: https://bit.ly/3CztrmE

<u>Background:</u>

Magic sand is very different from regular sand. While regular sand is hydrophilic (likes and can bind to water), magic sand is hydrophobic (repels water.) Magic sand stays dry underwater because each grain of sand is covered in a water-repellent coating. It's as if each grain of sand is wearing a raincoat.

Have you ever noticed how water beads up on the outside of a clean car? The coating on the outside of a car doesn't like water, either. Imagine that coating on each individual grain of magic sand. The magic sand refuses to interact with water. When the magic sand is in a cup of water, it sticks to itself because it would rather clump together with other magic sand than touch water.

The word <u>hydrophobic</u> means "water-fearing," from the Greek words "hydro" (water) and "phobia" (fear). The word <u>hydrophilic</u> means "water-liking," from the Greek "philia" (friend). Hydro*phobic* materials – such as oil and wax – repel water, while hydro*philic* materials – like salt and regular beach sand – love water and easily dissolve or get wet. (https://bit.ly/3wuTTd9)

Act. 2, Magic Sandbox. Empty the salt packet into one cup of water, stir, and observe how it dissolves (left). Sprinkle a half-spoonful of Magic Sand on top of the other cup of water (right), stir, and observe how it does not mix.

<u>Procedure</u>:

1. <u>Tell students:</u> ***In this class, we've experimented with mixing and separating things. But did you know some substances have properties that <u>prevent</u> them from mixing with each other? Let's investigate some examples!***

2. Put students in 4 groups.
3. Give each group a 9oz cup half-full of water, a packet of salt, and a plastic spoon. (If the cups weren't filled as Prep, you can fill each cup as you go around).
4. <u>Have groups</u>:
    a. Empty the packet of salt into the water.
    b. Use the spoon to stir thoroughly and observe what happens to the salt.

    <u>Discussion Prompt:</u>
    - ***What happened to the salt?*** *(It dissolved fully and evenly in the water. This is a special type of mixture called a solution.)* ***Let's try something different!***

Act. 2, Magic Sandbox. Provide a 9oz cup half-full of water, a 4oz cup with Magic Sand, a pipette, and a toothpick. Push the sand to one side of the cup.

Act. 2, Magic Sandbox. Use the pipette to add water to the cup, starting with the side that does not have sand. Keep pipetting water in until the sand is covered

Act. 2, Magic Sandbox. Experiment moving and shaping the sand underwater using the toothpick or spoon as tools.

5. Give each group another 9oz cup half-full of water.
6. Use a dry spoon to sprinkle a half-spoonful of Magic Sand on top of each group's cup of water. Leave a spoon with each group.
7. Have groups use the new spoon to stir the Magic Sand and observe.

   Discussion Prompts:
   - ***What happened to the sand?*** *(It didn't mix with the water. It either sank to the bottom of the cup or floated on top of the water.)*
   - ***Why do you think the sand and water won't mix?***

8. Tell students: ***Magic Sand is coated in a special oil-like polymer that repels—or pushes away—water. The coating is similar to Rain-X, which goes on car windows to make rain bead up, and Scotchgard, which goes on fabric and upholstery to resist stains.***

9. Ask students: ***What do you think will happen if you take the sand out of the water?***

10. Have groups use the spoon in the cup with Magic Sand to lift some sand above the surface of the water (though keep the spoon over the cup).

    Discussion Prompt:
    - ***What do you notice?*** *(The sand looks dry! If desired, students can touch the sand with a fingertip to confirm that it's dry to the touch.)* ***Let's keep exploring!***

11. Give each student a 4oz cup with Magic Sand (from Prep), a pipette, and a toothpick.
12. Have four students use the spoons from the cups of Magic Sand and give spoons to the remaining students.
13. Give each pair of students a 9oz cup half-full of water (or, if preferred, students can share cups of water in groups).
14. Have students:
    a. Use their spoon to push the Magic Sand up against one side of their cup.
    b. Use the pipette to add water to their cup, starting in the area of the cup where the sand isn't covering the bottom.
    c. Keep adding water until the sand is underwater.
    d. Experiment with moving and shaping the sand underwater using the spoon and toothpick as tools.

    Discussion Prompts:
    - ***Do you know what we call things that have the property of repelling water?*** *(Hydrophobic. It means "water-fearing.")*

15. Remind students:
    - ***Remember when you used soap to mix the food coloring in milk? We talked about how soap molecules have one end that's hydrophobic, or water-repelling, and one end that's***

hydrophilic, or water-attracting. The soap was able to grab molecules of fat/oil and suspend them in water. What do you think will happen if you add soap to Magic Sand?

16. Have students return to their groups and retrieve the 9oz cup with Magic Sand.
17. Walk around and put a small squeeze of soap in each group's cup.
18. Have groups stir with a spoon and observe.

    Discussion Prompts:
    - ***What happened?*** *(The Magic Sand de-clumped and fell to the bottom of the cup.)*
    - ***Why do you think that happened?*** *(The soap broke down the oil-like coating on the Magic Sand.)*

19. Discard all 4oz cups of Magic Sand—as well as the 9oz cups of Magic Sand—in a trash can with a liner. Discard toothpicks. Wipe off any Magic Sand clinging to spoons over a trash can, then keep them four of them handy for the next activity.

TIP: • **Magic Sand should not go near a sink because its water-repellent properties make it problematic for drains.**

20. Have students wash their hands.

Activity Three – Liquid Layers — Time: 15 Minutes

Supplies	#	Supplies	#
Color fizzers (small tablets, labeled "Liquid Layers")	1	Oil (oz, vegetable)	16
Corn syrup (oz, light)	16	Paper towels (large rolls)	1
Cups (20oz, plastic)	5	Pitchers with lids	1
Dish soap (20oz bottles, liquid)	1	Spoons (plastic – from previous activity)	4
Liquid Layers Packs (4 rubber bouncy balls (translucent), 4 quarter-pieces of chalk (A+ Homework brand), 4 mini clothespins (natural wood), 4 corks (small), 4 paper clips (assorted colors), 4 rubber bands (thin/small), 4 clamrose shells (small) & 4 spiral shells (very small))	1	Water	
Newspaper			

Goal: To investigate the property of density by creating a cup of layered liquids and adding different solid items to observe where they float.

Source: Chemistry Experiments *by Louise V. Loeschnig*

Background: What causes some things to sink and other things to float? As students will discover, heavier objects tend to sink and lighter objects tend to float. But it's not just about the weight! A pound of pine wood would float in water, but a pound of bricks would sink. Why? Pine is less "dense" than brick—and it's also less dense than water. Any object that's less dense than water will float in water—and any object that's denser than water will sink in water (https://bit.ly/3QTlVqM).

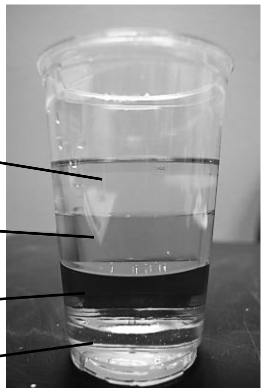
Solid objects aren't the only things that have different densities! Liquids can also have different densities, as you will see in this activity. In addition, there are things you can do—like adding or removing heat—to change the density of a liquid.

Dissolving something in a liquid can also change its density. For instance, when salt is added to water, the water becomes denser. In some caves, less dense freshwater seeps in from rivers and floats on top of denser saltwater that enters from the ocean. The place where the two types of water meet is called a halocline, and it looks like an underwater river! Objects like leaves and litter get trapped in one layer or the other based on their densities. Since leaves are denser than the freshwater, they sink in that layer. However, they are less dense than saltwater, so they float on top of that layer. The result is that leaves get trapped between the freshwater and saltwater, just like the objects you tested got trapped between different liquid layers! (https://bit.ly/3wwk7vJ)

Procedure:

TIP:
- **If preferred, you could do this activity as a whole class.** If you do that, make 2 Liquid Layers cups instead of 4, and have students take turns adding items to the cups (there are 8 different items per cup).

1. Ask students:
   - ***Have you ever floated in water?***
   - ***Is it easier to float in saltwater (like the ocean) or regular water?*** *(Saltwater.)*
   - ***Why do you think that is?*** *(Salt increases the density of the water.)*
   - ***What is density?*** *(Density is a property that describes how much matter something has compared to how much space it takes up. Different things can have more or less matter packed into the same amount of space.)*
   - ***Which weighs more: a pound of bricks, or a pound of feathers?*** *(It's a sneaky question: they both weigh one pound! But imagine how much space a pound of feathers would take up—it would be a lot more space than a brick! That's because a brick is denser than a feather—it has more matter packed into the same amount of space.)* ***Let's investigate some liquids that have different densities!***
2. Show students the 24oz bottle of oil, the bottle of dish soap, the corn syrup, and a 20oz cup ¾-full of water. (If the cup wasn't filled as Prep, you can fill it now.)
3.
4. Tell students***: Let's add some color to the water to make it easier to see.***



Act. 3 Liquid Layers. The liquids stack up inside the cup.

5. Put a "Liquid Layers" color fizzer in the cup of water and let it dissolve as you continue.
6. Line up four <u>empty</u> 20oz cups and have students watch or gather around.
7. <u>Ask students:</u>
   - ***If I pour <u>all four of these liquids into an empty cup</u>, do you think they'll mix together?***
   - ***What if I add them one by one?***

8. Have students make a hypothesis about what will happen with the liquids.

   <u>Discussion Prompt:</u>
   - ***Which liquid do you think is the densest, to pour in the cup first?*** *(The corn syrup)*

9. Divide the corn syrup evenly among the four empty cups.

<u>TIPS</u>:
- **Pour each layer of liquid slowly and carefully.**
- **If desired—and if your students can pour liquids carefully—you can have students help add the liquid to each cup.** If you make all 4 Liquid Layers cups, there will be 16 opportunities to add a liquid to a cup.

<u>Discussion Prompts:</u>
- ***Do you think it will stay there as I add more liquids?***
- ***What should go next?***
- ***Which liquid is the densest after the corn syrup?***

10. Have students predict what the next layer should be.
11. **<u>Add the following items in order on top of the corn syrup</u>**, having students make a hypothesis in between each item: dish soap, then colored water, then oil.

<u>TIPS</u>:
- **You'll put about 4oz of each liquid in each cup (16oz per liquid total across four cups), though you don't need to measure precisely.**
- **Each liquid should be about 1 inch deep** (1/5 the height of the cup) as viewed from the side—though the layers should get slightly shorter toward the top since the top of the cup is wider than the bottom.

<u>Discussion Prompts:</u>
- ***What happened?*** *(The liquids formed layers in the cup – see photo.)*
- ***Why?*** *(The liquids have different densities. Less dense liquids float on top of denser ones!)*

12. Show students the Liquid Layers Pack.

<u>Discussion Prompts:</u>

Here's a sample of how different items may settle out in the layers of liquid, from top to bottom (results vary):

Floats on top of oil:
- Cork

Floats on water:
- Bouncy ball

Straddles soap & corn syrup:
- Mini clothespin

Floats on corn syrup (but gets there gradually and makes bubbles on the way down):
- Chalk

Floats on corn syrup:
- Rubber band & spiral shell

Sinks to bottom:
- Paper clip & clamrose shell

Act. 3, Liquid Layers. Use a plastic spoon to blend the layers, then discard the spoon. Set the stirred cup aside and examine later. Notice there are now only 3 layers as the water and soap stay blended.

- ***Which of these objects do you think are the densest?***
- ***Which do you think are the least dense?***
- ***How do you think their densities compare to the liquids in the cup? Let's find out!***

13. Put students in 4 groups.
14. Give each group a Liquid Layers cup and one of each of the following: a quarter-piece of chalk, a mini clothespin, a cork, a paper clip, a rubber band, a clamrose shell, and a spiral shell. (You can also give each group a bouncy ball, or you can wait and hand those out toward the end of the activity to minimize distraction.)

Discussion Prompt:
- ***If you put these items in the cup one at a time, what layers do think they'll stop at?***

15. Have the students in each group:
    a. Pass the various objects around to examine them.
    b. Take turns gently adding each item to the cup, making a prediction before each item.

Discussion Prompts:
- ***What happened?*** *(The items settled out in different layers, based on their densities relative to the liquids – see sample list at left.)*
- ***Does anything surprise you?*** *(The ball may be less dense than expected, and the rubber band may be denser.)*
- ***Why do you think the clothespin straddles 2 layers?*** *(Because the wood part and the metal part of the clothespin have different densities.)*
- ***What do you think will happen if you stir the layered concoction?***

16. Give each group a plastic spoon.
17. Have groups stir their concoction to blend the layers, then discard the spoon.

TIPS:
- **If preferred, you could just stir one cup as a demo for the class.**
- **Stir gently.** The spoon doesn't need to touch the bottom of the cup.

18. Set the stirred cup(s) aside where they won't spill or get jostled, then come back to examine them after the next activity. (Some layers will have separated back out—though the soap and water will have stayed blended, so there will be three layers instead of 4. Also, some objects may have shifted to different layers.)

19. Discard each whole Liquid Layer cup (including the cup) in a trash can with a liner.

TIPS:	• **Liquid Layers should not go down the sink because oil can clog drains**. • **If desired, you could take the bouncy balls out** to wash and save before discarding everything else.

20. Have students wash their hands if their hands got messy.

Activity Four – Lava Lamp — Time: 15 Minutes

Supplies	#	Supplies	#
Alka-Seltzer (tablets)	16	Newspaper	
Bags (Ziploc, sandwich)	16	Oil (oz, vegetable)	48
Bottles (8oz water bottles)	16	Paper towels (large rolls)	1
Color fizzers (small tablets, labeled "Lava Lamps")	16	Pitchers with lids	1
Funnels (2oz, plastic)	1	Water	

Goal: To create physical and chemical reactions by making a homemade "lava lamp" using Alka-Seltzer, oil, and water.

Source: Inspired by Cool Concoctions

Background:

There are 3 things going on in this activity. (1) Alka-Seltzer's reaction with water is a chemical reaction because it produces something new: bubbles of carbon dioxide gas. (2) The color fizzer also creates a brief chemical reaction because it contains the same ingredient as Alka-Seltzer. (3) However, once the color fizzer stops fizzing, the remaining effect is a physical change: mixing the pigment with the water. Adding pigment or dye to something is different than creating a color change due to a chemical reaction.

Real lava lamps work using density to get things moving, but instead of Alka-Seltzer, they use heat. By mixing just the right combination of chemicals, wax, and water, you can make a blob that moves up when it's warm and falls back down when it cools. (https://bit.ly/3QSH30y)

Survey Connection:

★

Q. Fill in the blank: When you combine two or more things and they change into something new, that's called a chemical ____________.

A. Reaction.

Procedure:

TIP:	•	**If you don't think your students can handle taking a bottle of oil & water home, you could have students make lava lamps in pairs.**

1. Ask students:
   - ***Have you ever seen a lava lamp before?***
   - ***Do you know how it works?*** *(A lava lamp contains two liquids inside a glass jar. The liquids have similar densities. When you turn the light bulb on, it heats up the liquids. Some of the liquid on the bottom expands and becomes slightly less dense, which causes it to float to the top. Once it rises to the top, away from the heat source, it cools down and sinks again.)*
   - ***How can we build a lava lamp that doesn't require a light bulb?***

2. Give each student an 8oz water bottle with oil in it (from Prep). Keep the bottle caps handy for later in the activity.

   Discussion Prompts:
   - ***In the last activity, was the oil more or less dense than the water?*** *(The oil was less dense. The layer of oil floated on top of the layer of water.)*
   - ***When we made the layers in the cup, we added the oil on top of the water. What do you think will happen if we add water on top of the oil in this bottle? Let's find out!***

Act. 4, Lava Lamp. Add water to each bottle so the total liquid is an adult finger width above the top indented line of the bottle.

3. Walk around with the pitcher and add water to each student's bottle. (Fill until the total liquid is an adult finger width above the top indented line of the bottle.)

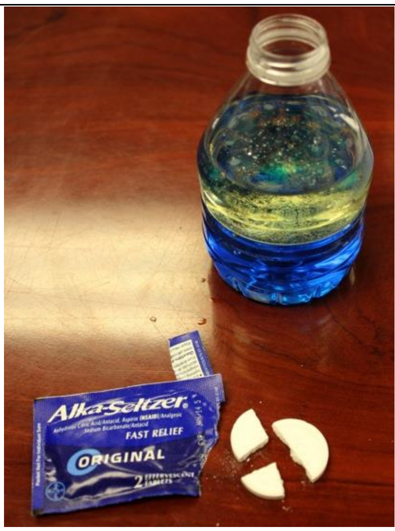
TIP:	•	**If your room has a sink, it may be easier to add water to each bottle from the faucet, rather than from the pitcher.** Alternately, you could use the funnel to make it easier to pour water into each bottle.

   Discussion Prompt:
   - ***What happened?*** *(The water and oil changed places! The oil still ended up on top.)* ***Let's see what happens if we add some color.***

4. Give each student a color fizzer from the bag labeled "Lava Lamp".
5. Have students drop the color fizzer into their bottle.

Act. 4, Lava Lamp. Add a blue color fizzer to each bottle.

   Discussion Prompt:
   - ***What did you observe?*** *(The color fizzer sank down through the oil because it was denser than the oil. When the color fizzer reached the layer of water, there was a burst of color and fizz as the tablet started dissolving in the water. Although some*



Act. 4, Lava Lamp. Break the Alka-Seltzer in half, then one piece in half again.

Act. 4, Lava Lamp. Drop a quarter piece of Alka-Seltzer into the bottle and observe your lava lamp. Repeat with the additional pieces of Alka-Seltzer.

bubbles floated up into the layer of oil, the color fizzer only changed the water's color—not the oil.)

6. Give each student an Alka-Seltzer tablet (or 2 half-pieces if you did optional Prep.)
7. <u>Have students</u>:
   a. Break the whole tablet in half (if not already done).
   b. Break one of the halves in half again (to make 2 quarter-pieces).
   c. Drop a quarter-piece of Alka-Seltzer into the bottle and observe.

<u>Discussion Prompts:</u>

- ***What happened?*** *(The Alka-Seltzer tablet reacted with the water to form bubbles of carbon dioxide.)*
- ***What type of matter is carbon dioxide—solid, liquid, or gas?*** *(Gas.)* ***Do you think carbon dioxide gas is more or less dense than water?*** *(Carbon dioxide is <u>less</u> dense than water. That's why the bubbles rise to the top of the liquid. When the gas rises, it carries some of the colored water up with it through the layer of oil. When the bubbles get to the top, they burst, and the water sinks back down. This continues until the Alka-Seltzer tablet is all used up and no more carbon dioxide gas is being produced.)*
- ***Where else have you seen fizzy bubbles like the ones in the lava lamp?*** *(In Class 1, when you added vinegar to baking soda, baking powder, and chalk. Also, in carbonated drinks.)*
- ***Do you think you could make the lava lamp react again if you add more Alka-Seltzer?***

8. Once the initial reaction slows down, have students put their second quarter-piece of Alka-Seltzer in the bottle and observe.

<u>Discussion Prompts:</u>

- ***Did it work?*** *(Yes.)*
- ***What do you think will happen with a larger piece of Alka-Seltzer?***

9. Have students put their <u>half-piece</u> of Alka-Seltzer in the bottle and observe.

<u>Discussion Prompt:</u>

- ***What happened?*** *(There were even more bubbles that time, and they moved faster!)*

10. Have students wait until their lava lamp stops reacting.

TIP:
- **DON'T let students put the cap on their Lava Lamp bottle until you no longer see bubbles forming.** If they put the cap on too soon, pressure can build up inside the bottle from gas that can't escape, which could cause the bottle to burst and/or leak and make an oily mess.

11. Give each student a Ziploc sandwich bag.
12. Have students screw the cap on their bottle, then put the bottle in the Ziploc bag.

TIP:
- **The lava lamps should be carried outside of students' backpacks** (this will protect the bottles from getting accidentally crushed and leaking).
- **Don't send leftover Alka-Seltzer home with students.**
  - However, you can have students shake their sealed-and-bagged bottle to see how the oil and water temporarily combine, then separate back out (i.e., the bottle is still interesting).
  - If students' parents help them obtain Alka-Seltzer, they can also reactivate the lamp; alternately, there are DIY lava lamp options online that use baking powder or baking soda.

Activity Five – Daily Debrief — Time: 5 Minutes

Supplies	#
Worksheets: Take-Home Supplies Advisory (half-sheet)	any left
Lab Notebooks	16
Pencils	16

Suggested Reading: *A Drop of Water* by Walter Wick

Goal: To draw today's activities together through a thoughtful question and give students an opportunity to ask their own questions.

Procedure:
1. Encourage students to reflect on what they learned in today's class and what new questions they might have.
2. Allow students a few seconds to think. Have them discuss their thoughts and questions with a partner, then share with the rest of the class and/or write down in their lab notebook.
3. If needed, feel free to offer prompts like:
   - ***What do you think would happen if we changed one thing about today's activities (for example: materials, speed, temperature, etc.)?***
   - ***If you could investigate (explore) one more thing about today's activities, what would you like to find out?***

4. If time allows, ask the following question:

- ***How do you think submarines move up and down in the water? Do you think it has something to do with density?*** *(When submarine operators need to dive, they open the submarine's "ballast tanks" so the submarine takes on water and becomes denser. When it's time for the submarine to rise, they use compressed air to push the water out of the ballast tanks. Without the water, the submarine is less dense and floats to the surface.)*

Clean up: Make sure students help clean up the room before they leave.

- **Remember: Magic Sand & Liquid Layers items don't go home or down the drain.**

What to save:

Materials used	#	SAVE	Materials used	#	SAVE
Alka-Seltzer (tablets)	16	0	Magic Sand (oz, blue)	2.5	0
Bags (Ziploc, sandwich)	16	0	Newspaper		
Bottles (8oz water bottles)	16	0	Oil (oz, vegetable)	64	0
Color fizzers (small tablets, labeled "Lava Lamps")	16	0	Paper towels (large rolls)	1	1
Color fizzers (small tablets, labeled "Liquid Layers")	1	0	Pencils	16	16
Corn syrup (oz, light)	16	0	Pipettes (1mL, plastic)	16	16
Cups (20oz, plastic)	5	1	Pitchers with lids	1	1
Cups (4oz, plastic, clear)	16	0	Salt (packets)	4	0
Cups (9oz, plastic, punch)	16	12	Spoons (plastic)	20	20
Dish soap (20oz bottles, liquid)	1	1	Toothpicks (flat)	16	0
Funnels (2oz, plastic)	1	1	Water		
Liquid Layers Packs (4 rubber bouncy balls (translucent), 4 quarter-pieces of chalk (A+ Homework brand), 4 mini clothespins (natural wood), 4 corks (small), 4 paper clips (assorted colors), 4 rubber bands (thin/small), 4 clamrose shells (small) & 4 spiral shells (very small))	1	0	Worksheets: Pre-Survey (for students who haven't done it)	any left	any new
			Worksheets: Take-Home Supplies Advisory (half-sheet)	any left	any left

What goes home: Lava lamp in Ziploc sandwich bag (carry outside of backpack)

(Review safety guidelines with students: small items should always be kept away from children ages 3 and younger to avoid the risk of choking; supplies from AKA Science should never go in students' mouths, eyes, ears, or noses; remind students not to drink the lava lamp, even though it's in a bottle; when students no longer want to keep the lava lamp, it should go in the trash—the oil shouldn't go down the drain)

Cool Chemistry: Fizz, pop, WOW! (Grades 4-6)

Class 4: Get a Reaction!

Supplies	#
Bottles (8oz water bottles)	4
Cold packs (instant)	1
Cups (1oz, plastic)	16
Cups (1oz, plastic, calibrated)	2
Cups (6-12oz, paper)	4
Cups (9oz, plastic, punch)	32
Dish soap (20oz bottles, liquid)	1
Epsom salt (oz)	16
Gloves (pairs - vinyl, disposable, small)	32
Glow sticks (thick, safety style)	1
Hand warmers (instant)	1
Hydrogen peroxide (oz, 3%)	14
Markers (black, wet-erase)	1
Newspaper	
Pans (9in, round, aluminum)	4
Paper towels (large rolls)	1
Pencils	16
Pennies (not shiny)	48
Pitchers with lids	1
Plates (9in, brown kraft)	8
Salt (packets)	16
Spoons (plastic)	16
Vinegar (oz)	16
Water (including some warm)	
Yeast packets (8.75g, active dry)	6

Worksheets:

Worksheets: Pre-Survey (for any students who haven't done it)	any left
Worksheets: Take-Home Supplies Advisory (half-sheet)	any left

Prep (prior to class):

- **Act. 2a:** Use the wet-erase marker to label eight 9oz cups: four "Vinegar" & four "Vinegar + Salt."
- **Act. 2b:** Fill each of the labeled 9oz cups *less* than a quarter-full of vinegar.
- **Act. 4a:** Fill sixteen 9oz cups half-full of water. (The water should be room temp for the activity.)
- **Act. 4b:** Fill eight 1oz cups with Epsom salt.
- **Act. 4c (Optional):** Fill an *additional* eight 1oz cups with Epsom salt, to make sixteen total. *(As a default, the eight cups in the previous step can just be refilled during the activity.)*
- **Act. 4d:** Put .5tsp of yeast apiece in eight 9oz cups. (Tear open the top of a yeast packet, pinch the sides together to make a pour spout, pour the yeast into the 1oz calibrated cup up to the .5tsp mark, then transfer the yeast to a 9oz cup. Repeat for each of the eight cups. You'll use two yeast packets total.)
- **Act. 5a:** Remove the labels from four water bottles. Empty the water bottles.
- **Act. 5b:** Use the funnel to put hydrogen peroxide in each water bottle up to the 2nd indented line from the top of the bottle (this equals approximately 3oz). Put the caps on the bottles.
- **Act. 5c:** The best plan is to use very warm water for this activity. It's ideal to get the water just before you're ready to do the activity. If you won't have a way to do that, though, fill the pitcher with hot water as prep (and put the lid on) so the water will still be warm by the time you're ready to use it.

OPTIONAL: Human Connection — Time: 1 Minute

Goal: To share important and interesting discoveries made by scientists and communities identifying as Indigenous, Black, Brown, Melanated, Latino/Hispanic, Immigrant, Asian, LGBTQIA+ and female, and to encourage students to see themselves in science. **A**ll **k**ids **a**re scientists!

Read-Aloud Narrative:

Scientists and chefs alike once thought there were four flavors: sweet, salty, bitter, and sour. One day, while eating dashi broth in his native Japan, **Kikunae Ikeda** tasted a flavor he couldn't place. The broth wasn't sweet, salty, bitter, or sour. What was it? Why did this dashi taste so different from the other dashi broth he had eaten? Ikeda decided that this dashi's unique and delicious flavor was from adding Kombu seaweed.

Kombu is a seaweed made from macroalgae and fish flakes–creating a deep nutty flavor. Ikeda used his years of chemistry training to uncover the chemical basis for this unidentified fifth flavor he called "umami." In 1908, Ikeda discovered tiny brown crystals that conveyed the umami flavor: monosodium glutamate. If you're a fan of seafood, mushrooms, or kimchi, you might have tasted umami! Ikeda developed a methodology to produce tiny brown glutamic acid crystals cheaply and efficiently. He called this invention Ajinomoto. You might know it as MSG. Ikeda's discovery and mass production of MSG revolutionized the culinary world. People across the globe can now savor the fantastic taste of umami.

Activity One – Pair & Share   Time: 10 Minutes

Supplies	#	Supplies	#
Pencils	16	Lab notebooks	16

Goal: To engage students' thinking and questioning related to the day's activities.

Procedure:

1. Prepare a quiet space for students to give them a physical area to think. The space can be an area set aside from the activity area, where students sit in a circle to ponder the *Pair & Share* question.
2. Make lab notebooks and pencils available.
3. Ask students a *Pair & Share* question:
    - ***Other than soap, what are some chemicals that help remove stuck-on layers of things?*** *(Nail polish remover, paint thinner, etc.)*
4. Ask students to discuss their ideas with their neighbor before inviting students to share what they came up with. This is a "challenge by choice" opportunity and no one is required to share with the class if they are not comfortable.

Survey Connection Note: ***All* activities are linked to this survey question (plus some are linked to others):**

★ **Q.** _____________is everything around us in the form of solids, liquids, and gasses.
A. Matter

Activity Two – Lucky Penny   Time: 15 Minutes

Supplies	#	Supplies	#
Cups (9oz, plastic, punch)	8	Pennies (not shiny)	48
Gloves (pairs - vinyl, disposable, small)	16	Plates (9in, brown kraft)	8
Markers (black, wet-erase)	1	Salt (packets)	16
Newspaper		Spoons (plastic)	8
Paper towels (large rolls)	1	Vinegar (oz)	16

Goal: To make dull pennies shinier using a chemical reaction with vinegar and salt.

Source: *Science Fun With a Homemade Chemistry Set* by Rose Wyler

Background:

Previously, we talked about how mixtures are made up of two or more different parts that can be separated. A solution is a special type of mixture. In a solution, the parts are mixed together so evenly that you can't tell the difference between them. In the vinegar/salt solution you made, the grains of salt split into very tiny pieces (ions) that mixed evenly with the vinegar so that you couldn't tell one substance apart from the other. (https://bit.ly/3KjQvaP)

Pennies are coated with a metal called copper, which forms copper oxide over time when it's exposed to the air. Metal oxides aren't shiny the way metals are, so the copper oxide that forms on the surface of pennies gives them a gritty, dirty look. In your vinegar/salt solution, the dissolved salt broke down into sodium and chloride ions. The chloride ions reacted with the copper in the penny to break down the copper oxide, which revealed the shiny copper metal underneath!

Did you know that the Statue of Liberty is coated in a thin layer of copper? The statue actually started out brown, and it turned green over time due to the oxidation of the copper! (https://bit.ly/3CBjzsm)

Survey Connection:

★

Q. What type of chemical is vinegar?
A. Acid.

★

Q. Fill in the blank: When you combine two or more things and they change into something new, that's called a chemical ____________.
A. Reaction.

Procedure:

1. Ask students: ***Have you ever thought about how cleaning products work? There are lots of chemicals we use every day to clean things. Could we use chemistry to clean a penny? Let's try!***

2. Put students in 4 groups.
3. Give each group 12 pennies.
4. Have groups examine their pennies.

   Discussion Prompts:
   - ***Are your pennies dirty?*** *(Yes.)*
   - ***How do pennies get dirty?*** *(In addition to regular dirt and grime, the copper in pennies undergoes a long, slow chemical reaction with oxygen over time. This reaction – called oxidation – causes a dull film called copper oxide to form on the pennies.)*
   - ***How could you clean the pennies to shine like new?***

Act. 2, Lucky Penny. Provide a9oz cup labeled "Vinegar," a 9oz cup labeled "Vinegar + Salt", a Styrofoam plate, a paper towel, two spoons, four packets of salt and 12 pennies.

Act. 2, Lucky Penny. Add four pennies to the "Vinegar" cup, four pennies to the "Vinegar + Salt" cup and leave four as a control. Stir the pennies in the cups using the spoon and gloves.

5. Give each group a paper towel to divide up and share.
6. <u>Ask students:</u> ***Can you rub your pennies clean with the paper towel? Let's try!***

7. Have groups try to rub their pennies clean with the paper towel. (Allow students to wet their paper towel or use soap and running water if they think it may help.)

8. <u>Ask students:</u>
    - ***Did your pennies get clean?*** *(No.)*
    - ***Can you think of a different way to clean them?***

9. Give each student a pair of gloves. Have students put them on.
10. Give each group a 9oz cup with vinegar labeled "Vinegar" and a 9oz cup with vinegar labeled "Vinegar + Salt" (from Prep). In addition, give each group a brown kraft plate, a paper towel, two spoons, and four packets of salt.
11. <u>In each group, have students take turns doing the following</u>:
    a. Empty a packet of salt into the "Vinegar + Salt" cup.
    b. Stir the mixture until the salt dissolves.
    c. Repeat until all four packets of salt have been added

    <u>Discussion Prompts:</u>
    - ***Now you have two different liquids: a cup with just vinegar, and a cup with the vinegar/salt solution you just made. What do you think will happen if you put some pennies in each liquid?***
    - ***Do you think the results will be the same or different?***

12. Have students make a hypothesis about which liquid will cause a bigger change.
13. Have groups put the two cups side-by-side on the brown kraft plate, with a spoon in each cup.
14. <u>Have groups</u>:
    a. Put 4 pennies in the "Vinegar" cup.
    b. Put 4 pennies in the "Vinegar + Salt" cup.
    c. Leave 4 pennies on the desk.

    <u>Discussion Prompts:</u>
    - ***Why is it important to leave some pennies out on the desk?*** *(For comparison purposes. The liquids in the cups are "independent variables." The goal of the experiment is to figure out if putting pennies in Vinegar (or Vinegar + Salt) causes a change that wouldn't have happened otherwise. The pennies left out of the liquids are the "control." They're the same as the other pennies, except that they're not exposed to the independent variables.)*

Act. 2, Lucky Penny. Keep track of which pennies came from which cup. Compare the pennies. Note how the "Vinegar and Salt" cup pennies are the cleanest.

- ***Why is it important to put more than one penny in each cup?*** *(To gather as much data as possible. If a change happens for one penny, it might be a coincidence or an error—but if the same change happens for several pennies, it's more likely to be part of a pattern.)*

15. In each group, have students work together to do the following:
    a. Gently stir and/or swirl the liquid in each cup.
    b. After 1-4 minutes, use the spoon in each cup to remove the pennies and place them on a paper towel.
    c. Keep track of which pennies came from which cup.
    d. Compare the pennies from each liquid to the pennies that stayed out.

    Discussion Prompts:
    - ***Do you notice any difference between the pennies that were in the liquids vs. the pennies that stayed out****? (Yes! The pennies that were in the liquid are generally shinier than those that stayed out.)*
    - ***Is there any difference between the pennies that were in the cup with just vinegar vs. the pennies that were in the vinegar/salt solution?*** *(Yes! The pennies from the vinegar/salt solution look shinier.)*
    - ***Why do you think that is?*** *(Salt and vinegar react to form a weak solution of hydrochloric acid. Even though it's a weak solution, hydrochloric acid is still stronger than acetic acid, a.k.a., vinegar.)*

16. At the end of class, each student will be able to take home one shiny penny, one partially-shiny penny, and one not-shiny penny.*
    a. ***Alternative #1:*** If time allows, students can clean their not-shiny and partially-shiny pennies by putting them in the same Vinegar + Salt solution as before. In that case, each student can take home 2-3 shiny pennies.
    b. ***Alternative #2:*** If you're interested, you can put the remaining not-shiny pennies in the vinegar/salt solution, remove them after 1-4 minutes, then let them sit (unrinsed) on a plate until the next class. Greenish malachite will form on the surface of the unrinsed pennies…check out this link for an explanation + an extension activity that uses the vinegar/salt solution: *https://bit.ly/3PLuse1*

17. Have students take turns rinsing their pennies under running water.

18. Have students remove their gloves, discard them, and wash their hands.

> **TIPS**:
> - **It's important to rinse the pennies**—partly so they stay shiny, and partly so the residue from the vinegar/salt solution won't irritate students' skin.
> - **You may want to show students how to remove their gloves without directly touching the parts of the glove that had liquid on them.**
> - **Always wash hands after activities for which gloves are required.**

Activity Three – Hot Cold Glow — Time: 5 Minutes

Supplies	#	Supplies	#
Cold packs (instant)	1	Hand warmers (instant)	1
Glow sticks (thick, safety style)	1		

Goal: To explore practical applications of chemical reactions by examining an instant cold pack, an instant hand warmer, and a glow stick.

Source: *Jr. Boom Academy* by Wild Good Co. & *Chemistry for Every Kid* by Janice Van Cleave

Background:

Chemistry is very important in our lives! Soap uses chemistry to help you wash your hair, hands, and clothes. There are also lots of chemical reactions used to produce things, such as dyes for clothes, plastics for toys and containers, etc. (https://bit.ly/3ct3k5U)

Speaking of toys: Did you know that low temperatures slow the rate of the chemical reaction in glow sticks? That means you can put an activated glow stick in the freezer to make it last longer! (https://bit.ly/3pJAIZ8)

Survey Connection:

★ **Q.** Fill in the blank: When you combine two or more things and they change into something new, that's called a chemical ____________.

A. Reaction.

Procedure:

1. Ask students:
   - ***What are some chemical reactions that help us in everyday life?*** *(Batteries convert chemical energy into electrical energy to operate things like flashlights and radios; car engines convert gasoline into mechanical power for motion; we cook various foods to make the food tastier and easier to digest, etc.)*
   - ***What else can chemical reactions do for us? Let's find out!***

2. Show students the instant cold pack.
3. <u>Ask students:</u>
   - ***What is this used for?*** *(It's a cold pack. It helps reduce swelling when someone gets hurt.)*
   - ***What causes it to get cold?*** *(Inside the pouch, there are two chemicals separated by a barrier. When you squeeze the pouch and break the barrier, the chemicals react. This reaction makes the bag feel cold.)*

4. Pass around the cold pack so students can feel that the bag isn't cold. (Tell students to handle the bag gently, without squeezing it.)
5. Activate the cold pack by following the directions on the package (see top photo).
6. Pass the cold pack around again for students to touch.

   <u>Discussion Prompts:</u>
   - ***What do you notice?*** *(The bag feels cold.)*
   - ***Are there chemical reactions that make things feel warm?*** *(Yes. An instant hand warmer works almost the same way as a cold pack, but there are different chemicals inside. When the chemicals in a hand warmer are exposed to the air, they react and produce heat.)*

7. Pass around the hand warmer inside its package so students can feel that the package isn't warm.
8. Activate the warmer by following the directions on the package (middle photo).
9. Pass the hand warmer around for students to touch.

Hot Cold Glow. Squeeze the cold pack pouch firmly where indicated to activate the cold pack.

Hot Cold Glow. Tear open the hand warmer package, remove the hand warmer, and shake it to activate it.


Hot Cold Glow. Bend the glow stick to activate it. (The glow stick in your kit is thicker than the one in the photo.)

<u>**TIP**</u>:	• **Be cautious with the hand warmer** (it can get very warm, though it usually takes some time to fully heat up). If needed (i.e., if the hand warmer heats up very quickly), you can set it on the table and have students hover their hands over it to feel the heat, instead of touching it directly.

<u>Discussion Prompts:</u>
- ***What do you notice?*** *(The hand warmer feels warm.)*
- ***Are there any chemical reactions we use just for fun?*** *(Fireworks, etc.)*
- ***What about reactions that are fun <u>and</u> useful?***

10. Remove the glow stick from its package and show it to students (bottom photo).

    <u>Discussion Prompt:</u>
    - ***How to you think glow sticks work?*** *(A glow stick contains two different chemicals that react to produce a glow when they're mixed. Because the glow only lasts for as long as the*

chemical reaction, the glow stick makers have to keep those chemicals separate until the person who buys the stick wants it to glow. To keep the chemicals separate, they put one of the chemicals in a thin glass tube. When you bend the glow stick, the glass tube cracks. The chemical released from the tube mixes with the surrounding chemical, causing a chemical reaction. This reaction glows as long as there are chemicals left to react.)

11. Have the class be as quiet as possible to try to hear the "crack" of the tube.
12. Bend the glow stick just enough to activate it, then put it somewhere at the front of the room where everyone can see it.

TIP:	• **Although the liquid inside a glow stick is non-toxic, it can be an irritant.** It's very unlikely that the liquid will escape the glow stick. However, if a student gets the liquid on their skin, they should wash it off with plenty of soap and water; if it somehow gets in their eye, they should flush it with water.

13. At the end of class, discard the cold pack, hand warmer, and glow stick in the trash (please don't send the items home with students).

Activity Four – Feel the Heat — Time: 15 Minutes

Supplies	#	Supplies	#
Cups (1oz, plastic, calibrated)	1	Paper towels (large rolls)	1
Cups (1oz, plastic)	16	Pitchers with lids	1
Cups (9oz, plastic, punch)	24	Plates (9in, brown kraft - from earlier activity)	8
Epsom salt (oz)	16	Spoons (plastic)	8
Hydrogen peroxide (oz, 3%)	2	Water (including some warm)	
Newspaper		Yeast packets (8.75g, active dry)	2

Goal: To explore physical and chemical reactions that produce temperature changes by combining Epsom salt with water and yeast with hydrogen peroxide.

Source: www.acs.org, https://bit.ly/3CA3PWt

Background:

A reaction that absorbs heat is called an endothermic reaction. A reaction that releases heat is called an exothermic reaction. (https://bit.ly/3R8OznA)

Survey Connection:

Q. Fill in the blank: When you combine two or more things and they change into something new, that's called a chemical ___________.

A. **Reaction.**

Procedure:

TIPS:	• **If preferred, you could have students do the yeast/hydrogen peroxide portion of this activity in 4 groups or together as a whole class.**

1. Ask students: ***What are some ways to tell that a chemical reaction is happening?*** *(The reaction might produce light, gas, or a change in temperature.)* ***Let's explore some other reactions that involve a temperature change!***

2. Pair students.
3. Give each pair two 9oz cups half-full of room temperature water (from Prep).
4. Ask students: ***What do you think will happen if we add Epsom salt to the water in one cup? Let's see!***

5. In each pair, have the first student feel each cup, comparing them and focusing on the temperature of the cups' bases, and then hold one cup in both hands.
6. In each pair, give the second student a 1oz cup of Epsom salt.

TIP:	• **The student holding the cup of water should be touching the bottom of the cup with their palm or thumbs.** (The activity is subtle, but that helps.)

7. Have the second student pour the Epsom salt all at once into the cup being held by their partner and stir the solution with a spoon. The student holding the bottom of the cup should pay attention to any changes.
8. Refill each pair's 1oz cup of Epsom salt (or give each pair a new cup of Epsom salt if you prepped sixteen cups).
9. In each pair, have students switch roles and repeat the activity with the other water cup.

Discussion Prompts:

- ***What happened?*** *(When the salt was poured into the cup, that solution briefly got colder than the water in the other cup.)*
- ***Why do you think that happened?*** *(Energy is needed for Epsom salt to dissolve in water. The Epsom salt takes the energy for the process from the warmth of the water, which lowers the temperature of the solution.)* ***This reaction was a physical change, since the Epsom salt/water solution is still a mixture that can be separated by evaporating the water. Let's make a chemical reaction that produces heat!***

Act. 4, Feel the Heat. Grip the bottoms of both cups in palms and pour 1oz of Epsom salt into one of the cups and notice any changes. The water should get subtly colder. Switch roles and repeat.

Act. 4, Feel the Heat. Use a calibrated cup to add .5oz of hydrogen peroxide to each yeast cup. The mixture will bubble and foam, but will stay in the cup. Feel the cup periodically to feel the cup heat up with the reaction.

10. Give each pair a brown kraft plate, a plastic spoon, and a 9oz cup with .5tsp of yeast (from Prep).
11. Have pairs put their 9oz cup containing yeast on top of their plate flat on the table.
12. Walk around and use a clean calibrated cup to add .5oz of hydrogen peroxide to each pair's cup. (NOTE: the mixture will bubble and foam, but will stay in the cup.)

CAUTION: Hydrogen peroxide is toxic if ingested and may irritate eyes & skin.

- ***ONLY YOU* as the Class Leader should handle the bottle of hydrogen peroxide.**
- **If any is swallowed,** provide a drink of water and call 911 or Poison Control: 1-800-222-1222.
- **If any gets in a student's eyes,** immediately flush with running water for 15-20 minutes and call Poison Control.
- **If any gets on a student's skin,** immediately rinse with cool water. If irritation occurs, call Poison Control.
- **Note that hydrogen peroxide may temporarily bleach skin, hair, or clothing.**

13. Have students in each pair take turns doing the following:
    a. Use the spoon to stir the contents of the cup (see photo).
    b. Periodically put their hand around the cup to feel the temperature. (This reaction is slower than Epsom salt; keep checking back for a few minutes.)

    Discussion Prompts:
    - ***What happened?*** *(When the yeast and hydrogen peroxide were combined, the liquid started to bubble rapidly and the liquid got warmer.)*
    - ***Why do you think that happened?*** *(The yeast caused the hydrogen peroxide to break apart to form oxygen gas and water. This reaction gave off heat.)*
    - ***Was this a physical or chemical change?*** *(Chemical change. Besides the temperature change, the bubbles of gas were another sign that the ingredients had changed into something new.)*

14. Save four 1oz cups and four spoons for the next activity.
15. The eight 9oz cups of yeast/hydrogen peroxide can be discarded in a trash can with a liner but keep the remaining 9oz cups.

Activity Five – Elephant Toothpaste Time: 15 Minutes

Supplies	#	Supplies	#
Bottles (8oz water bottles)	4	Hydrogen peroxide (oz, 3%)	12
Cups (1oz, plastic - from previous activity)	4	Newspaper	
Cups (1oz, plastic, calibrated)	1	Pans (9in, round, aluminum)	4

Cool Chemistry: Fizz, pop, WOW! (Grades 4-6)

Class 4: Get a Reaction!

Cups (6-12oz, paper)	4	Paper towels (large rolls)	1
Dish soap (20oz bottles, liquid)	1	Pitchers with lids	1
Food Coloring (small bottles)	2	Spoons (from previous activity)	4
Gloves (pairs - vinyl, disposable, small)	16	Water (very warm)	
		Yeast packets (8.75g, active dry)	4

Act. 5, Elephant Toothpaste. Provide a 9in pan, a packet of yeast, a 1oz cup, a paper cup, and a plastic spoon. Mix the yeast and 1oz of warm water in the paper cup using the spoon. Let the yeast proof.

Act. 5, Elephant Toothpaste. Provide a small plastic water bottle with hydrogen peroxide inside. Add a large squeeze of soap into the bottle.

Goal: To extend the yeast/hydrogen peroxide reaction from the previous activity by having the reaction bubble over the top of a water bottle.

Source: https://bit.ly/3wCc7td

Background:
When you mix hydrogen peroxide with yeast, the yeast causes the hydrogen peroxide molecule to break down into water and oxygen. The reaction happens so quickly that it generates foam as the air moves through the soapy water. (The name "elephant toothpaste" is just a fun way to describe the foam—there's enough for an elephant!) (https://bit.ly/3AnND8d)

Survey Connection:

Q. Fill in the blank: When you combine two or more things and they change into something new, that's called a chemical ___________.

A. Reaction.

Procedure:

TIPS:
- **Review the cautions about hydrogen peroxide from the previous activity.**
- **If preferred, you could do this activity together as a whole class.**
- **For the best/fastest reaction, use very warm (but not hot) water.**

1. Ask students: ***What do you think will happen if we mix a larger amount of yeast and hydrogen peroxide in the same size container as the previous activity? Let's find out!***

2. Put students in 4 groups.
3. Give each student a pair of gloves. Have students put them on.
4. Give each group a 9oz pan, a packet of yeast, a 1oz cup, a 6-12oz paper cup, and a plastic spoon. Fill the pitcher partway with very warm (but not hot) water.
5. Have students in each group take turns doing the following:
   a. Dip their 1oz cup in the pitcher of very warm water.
   b. Transfer the water to their paper cup.
   c. Open the packet of yeast and dump it into the cup with water.
   d. Use the spoon to thoroughly mix the water and yeast. (It will be lumpy.)

Act. 5, Elephant Toothpaste. Squeeze the sides of the paper cup together to form a pour spout. Pour the proofed yeast mixture into the bottle with the hydrogen peroxide and soap.

Act. 5, Elephant Toothpaste. The mixture will bubble over the top of the bottle and fill the pan with foam.

6. While the mixture proofs (sits at least 30 seconds), walk around to each group and put a bottle with hydrogen peroxide (from Prep) in the center of their 9oz pan. Remove the cap from the bottle and add a large squeeze of soap and a drop of each of the two food coloring colors to the bottle.
7. When you say "Go," have groups:
   a. Squeeze the rim of their paper cup together to make a spout.
   b. Pour the yeast/water mixture into the bottle all at once and stand back.

   Discussion Prompt:
   - ***What happened?*** *(After a few seconds, the foam overflowed from the bottle into the pan!)*

8. Students can touch the foam with gloved hands (but it needs to stay in the pan).
9. Discard the bottles and paper cups in a trash can with a liner (but save the pans).
10. Have students remove their gloves, discard them, and wash their hands.

Activity Five – Daily Debrief Time: 5 Minutes

Supplies	#
Lab Notebooks	16
Pencils	16

Suggested Reading: *Chemical Change: From Fireworks to Rust* by Darlene R Stille.

Goal: To draw today's activities together through a thoughtful question and give students an opportunity to ask their own questions.

Procedure:
1. Encourage students to reflect on what they learned in today's class and what new questions they might have.
2. Allow students a few seconds to think. Have them discuss their thoughts and questions with a partner, then share with the rest of the class and/or write down in their lab notebook.
3. If needed, feel free to offer prompts like:
   - ***What do you think would happen if we changed one thing about today's activities (for example: materials, speed, temperature, etc.)?***
   - ***If you could investigate (explore) one more thing about today's activities, what would you like to find out?***

4. If time allows, ask the following question:

- ***If you were a superhero, which chemical superpower would you like to have? Would you want to make things glow, get very hot or cold, overflow with foam, etc.?***

Clean up: Make sure students help clean the room before they leave.

What to save:

Materials used	#	SAVE	Materials used	#	SAVE
Bottles (8oz water bottles)	4	0	Newspaper		
Cold packs (instant)	1	0	Pans (9in, round, aluminum)	4	4
Cups (1oz, plastic)	16	16	Paper towels (large rolls)	1	1
Cups (1oz, plastic, calibrated)	2	2	Pencils	16	16
Cups (6-12oz, paper)	4	0	Pennies (not shiny)	48	0
Cups (9oz, plastic, punch)	32	32	Pitchers with lids	1	1
Dish soap (20oz bottles, liquid)	1	1	Plates (9in, brown kraft)	8	8
Epsom salt (oz)	16	0	Salt (packets)	16	0
Food Coloring (small bottles)	2	Any left	Spoons (plastic)	16	16
Gloves (pairs - vinyl, disposable, small)	32	0	Vinegar (oz)	16	0
Glow sticks (thick, safety style)	1	0	Water (including some warm)		
Hand warmers (instant)	1	0	Worksheets: Pre-Survey (for students who haven't done it)	any left	any new
Hydrogen peroxide (oz, 3%)	14	0	Worksheets: Take-Home Supplies Advisory (half-sheet)	any left	any left
Markers (black, wet-erase)	1	1	Yeast packets (8.75g, active dry)	6	0

What goes home: 1-3 pennies per student (see the end of Activity 2 for options)

(Review safety guidelines with students: small items should always be kept away from children ages 3 and younger to avoid the risk of choking; supplies from AKA Science should never go in students' mouths, eyes, ears, or noses)

Cool Chemistry: Fizz, pop, WOW! (Grades 4-6)

Class 5: Color Surprise

Supplies	#
Bags (Ziploc, sandwich)	17
Bags (Ziploc, snack)	16
Beads (UV, color-changing - 4 sets of 4 colors divided between 2 small bags)	16
Cardstock rectangles (2.5inx3in, heavyweight - 1 is extra)	10
Cotton swabs (6in, wood handle)	8
Cups (1oz, plastic)	8
Cups (1oz, plastic, calibrated)	1
Cups (9oz, plastic, punch)	4
Gloves (pairs - vinyl, disposable, small)	16
Hydrogen peroxide (oz, 3%)	1
Index cards (4inx6in)	16
Index cards (half-size, 2.5inx3in - 1 is extra)	30
Iodine tincture (1oz bottles)	1
Newspaper	
Pans (9in, round, aluminum)	4
Pans (large, oval, aluminum)	2
Paper towels (large rolls)	1
Pitchers with lids	1
Plates (10in, paper, high sides)	8
Plates (9in, brown kraft)	18
Salt (oz, iodized)	1
Scissors (site provides)	16
Solargraphics paper (3.5inx4in pieces - 3 are extra); **KEEP IN PACKAGE UNTIL READY TO USE**	20
Spoons (plastic)	4
Sunscreen (3.5-gram packets)	1
Tape (rolls, Scotch)	2
Transparencies (3.67inx4.25in pieces)	16
Water	

Prep (prior to class):

- **Act. 2a:** Put hydrogen peroxide in four 9oz cups just up to the indent at the base of each cup.
- **Act. 2b:** Use a calibrated cup to put 1/2oz of iodized salt apiece in eight 1oz cups.
- **Act. 2c (Optional):** Prep sixteen 2in pieces of tape ~or~ tape index cards and cardstock rectangles to plates (see activity for details; this step can be done by students during the activity).
- **Act. 3a:** Fill the pitcher with water and put the lid on.
- **Act. 3b (Optional): Prep** up to 48 pieces of tape (3 pieces per student, approx. 2in each).
- **Act. 3c (Optional):** Cut out simple shapes from half-size index cards (1 per student; see activity).
- **Act. 4a (Optional):** Remove a bead from each of the bags of UV color-changing beads. Set those 2 beads aside. Put the two (sealed) bags of 7 beads on a brown kraft plate. Spread a thick layer of sunscreen on top of one of the bags. Cover the plate with an upside-down plate.
- **Act. 4b (Optional):** Put a piece of Solargraphics paper in a Ziploc sandwich bag. Spread sunscreen on top of half the bag. Keep the bag covered (e.g., on the same plate as the UV beads).

OPTIONAL: Human Connection — Time: 1 Minute

Goal: To share important and interesting discoveries made by scientists and communities identifying as Indigenous, Black, Brown, Melanated, Latino/Hispanic, Immigrant, Asian, LGBTQIA+ and female, and to encourage students to see themselves in science. **A**ll **k**ids **a**re scientists!

Read-Aloud Narrative:

Cooking– from growing the ingredients to serving the final dish– is nothing but a series of chemical reactions. Baking bread, for instance, uses three chemical reactions: photosynthesis in the wheat, fermentation of the yeast, and the Maillard reaction to form the crust! The chemical study of food is called nutrition science. African American scientist **Marie Daly** was one of the first to investigate cooking and digestion through chemical reactions. Today, she is known as the mother of nutrition science!

In 1947, Daly became the first Black woman to receive a Ph.D. in chemistry. Over the next 40 years, Daly studied how cholesterols, sugars, and proteins in our diets affect our health. Almost everything we eat, from butter to broccoli and from chicken to cake, contains these compounds. Daly's work helped draw a connection between our diet and our health. Daly was also an advocate and champion for other Black, Brown, and Indigenous scientists. In 1988, she started a scholarship for scientists of color at Queens College, where she received her degree 40 years earlier. Her scholarship and her impact on the field of nutrition science continue to help inspire young scientists today.

Activity One – Pair & Share

Time: 10 Minutes

Supplies	#	Supplies	#
Pencils	16	Lab notebooks	16

Goal: To engage students' thinking and questioning related to the day's activities.

Procedure:

1. Prepare a quiet space for students to give them a physical area to think. The space can be an area set aside from the activity area, where students sit in a circle to ponder the *Pair & Share* question.
2. Make lab notebooks and pencils available.
3. Ask students a *Pair & Share* question:

   - ***What are some things that are see-through or hard to see, even though we know they're there?*** *(Air, water, windows, contact lenses, etc.)*

4. Ask students to discuss their ideas with their neighbor before inviting students to share what they came up with. This is a "challenge by choice" opportunity and no one is required to share with the class if they are not comfortable.

Survey Connection Note: *All* activities are linked to this survey question (plus some are linked to others):

★

Q. ______________is everything around us in the form of solids, liquids, and gasses.

A. Matter

Activity Two – Invisible Ink

Time: 15 Minutes

Supplies	#	Supplies	#
Bags (Ziploc, snack)	16	Index cards (half-size, 2.5inx3in - 1 is extra)	10
Cardstock rectangles (2.5inx3in, heavyweight - 1 is extra)	10	Iodine tincture (1oz bottles)	1
Cotton swabs (6in, wood handle)	8	Newspaper	
Cups (1oz, plastic)	8	Pans (9in, round, aluminum)	4
Cups (1oz, plastic, calibrated)	1	Paper towels (large rolls)	1
Cups (9oz, plastic, punch)	4	Plates (10in, paper, high sides)	8
Gloves (pairs - vinyl, disposable, small)	16	Salt (oz, iodized)	4
Hydrogen peroxide (oz, 3%)	1	Spoons (plastic)	4
		Tape (rolls, Scotch)	2

Cool Chemistry: Fizz, pop, WOW! (Grades 4-6)

Class 5: Color Surprise

Goal: To reveal hydrogen peroxide "secret messages" via a reaction with iodized salt.

Source: Brianna McCoy, AKA Science

Background:
The salt you used has a special name: "iodized" salt. Iodized salt is regular salt that has been mixed with small amounts of iodine. The iodine in the salt reacted with the hydrogen peroxide on the cards and turned dark bluish-purple. We already learned that iodine is an "indicator" of the presence of starch—so this reaction also helps demonstrate that paper contains starch! (https://bit.ly/3APzx0I)

Survey Connection:

★

Q. When you combine two or more things and they change into something new, that's called a chemical ____________.
A. Reaction.

Procedure:

TIPS:
- **If preferred, students could do the activity in groups instead of pairs.**
- **If preferred, pairs (or groups) could rotate through a liquid station.**
- **If preferred, students could just test the cardstock** (skip the index card).
- **If preferred, you could scrape salt off each pair's (or group's) plate.**

1. Ask students: ***Have you ever heard of invisible ink? How does it work?*** *(Someone writes or draws something that can't easily be seen. When it's time to reveal the message/drawing, there's a chemical reaction to make the ink visible.)* ***Let's experiment!***

2. Pair students and put pairs in groups to share cups of liquid.
3. Give each pair a half-size index card and a small cardstock rectangle.

   Discussion Prompts:
   - ***What properties are similar between these two pieces of paper?*** *(They're both white, about the same size, etc.)*
   - ***What properties are different?*** *(The cardstock is stiffer, the index card has lines on it, etc.)* ***Let's see how those properties affect the way the cards react with invisible ink!***

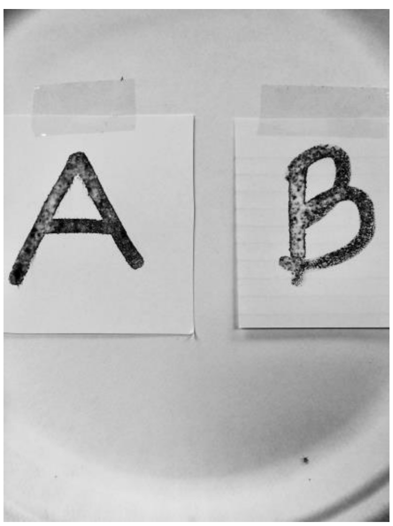
4. Give each pair a 10in paper plate with high sides and two 2in pieces of tape.
5. Have pairs:
   a. Put their index card and cardstock rectangle next to each other on the plate. (Put the index card on the right side of the plate, blank side up.)

Act 2. Invisible Ink. Sprinkle salt evenly across the markings on both cards, then observe. The salt starts to turn yellow, and the clear markings start to darken.

   b. Tape the top edge of each card, with the tape parallel to the top edge.
   c. Decide who will write/draw on the cards and who will sprinkle salt.

6. Give each pair a 1oz cup with 1/2oz of iodized salt (from Prep) and a cotton swab.
7. Give each group a 9oz cup with hydrogen peroxide just up to the indent at the base of the cup (from Prep).

CAUTION: Hydrogen peroxide is toxic if ingested and may irritate eyes & skin.
- ***ONLY YOU*** **as the Class Leader should handle the bottle of hydrogen peroxide.**
- **If any is swallowed,** provide a drink of water and call 911 or Poison Control: 1-800-222-1222.
- **If any gets in a student's eyes,** immediately flush with running water for 15-20 minutes and call Poison Control.
- **If any gets on a student's skin,** immediately rinse with cool water. If irritation occurs, call Poison Control.
- **Note that hydrogen peroxide may temporarily bleach skin/hair and clothing.**



Act. 2 Invisible Ink. Scrape the salt off the cards. The markings that started out clear are now a dark bluish-purple color, and you can see some impressions made by the grains of salt.

8. In each pair, have the first student:
   a. Dip the swab in the hydrogen peroxide.
   b. Make a simple mark (drawn or written) on the card on the left.
   c. Re-dip the swab and make a mark on the card on the right. (It can be the same as the first card or a slight variation, e.g., "A" & "A" or "A" & "B.")

9. ***Immediately*** after the first student is finished, have the second student sprinkle the salt liberally and evenly across the markings on both cards.

TIP:
- **Don't touch or disturb the salt on the cards, or the activity won't work.**

10. Have pairs observe for a minute or so and notice if anything changes (see photo).

    Discussion Prompts:
    - ***What's happening?*** *(The salt has started to turn yellow, and the clear markings underneath have started to darken.)* ***Let's set these aside until they finish reacting!***

11. Have pairs set their plate somewhere out of the way where it won't get jostled or have something spilled on it.

12. Go on to the next activity (or activities), then come back to the plates afterwards.

<u>TIP</u>:	• **It works best to wait at least 15 minutes before scraping the salt off the plates.** (Longer is fine; shorter can work, though the marks may smear.)

13. After 15 minutes, set up a station with four 9in pans and a spoon at each pan. (If preferred, you could set up a station with the two large oval pans if they're dry.)
14. Have pairs line up at each pan.
15. Give each pair in front of pan a pair of gloves. Have students put them on.
16. <u>Have pairs</u>:
    a. Hold the plate upright (vertically) over a pan. The tape should be on the top edge of the cards as the plate is held upright.
    b. Use a spoon to scrape the salt off the cards and into the pan (see photo).

17. Reset the station with fresh gloves. Have the next set of pairs repeat the process.

<u>Discussion Prompts:</u>

- ***What happened?*** *(The markings that started out clear are now a dark bluish-purple color. In some places, you can see the impressions made by individual grains of salt.)*
- ***Why do you think the hydrogen peroxide "invisible ink" was revealed by iodized salt?*** *(Remember when you did the filtration activity with the cornstarch/water mixture? The iodine reacted with cornstarch to turn black. In this case, the iodized salt has a lower concentration of iodine—but it still changes color in the presence of starch! As the iodized salt reacts with the hydrogen peroxide, it turns bluish-purple on the paper because the paper contains starch.)*
- ***Do you notice any difference between the mark you made on the cardstock vs. the index card? If so, why do you think they look different?*** *(Different types of paper contain different ingredients—and different amounts of starch—that affect the reaction.)*

18. If desired, there's an extra piece of cardstock and an extra index card in the kit. You could put the cards on a plate and use the iodine applicator to make a small mark on each card. (The iodine will turn black because the cards contain starch.)

CAUTION: Iodine is poisonous if ingested, may irritate eyes, and will stain.
- ***ONLY YOU*** **as the Class Leader should handle the bottle of iodine.**
- **NOTE: there's a stick applicator attached to the cap of the iodine bottle, so after you unscrew the cap, lift it straight up.**
- **If any is swallowed,** call 911 or Poison Control: 1-800-222-1222.
- **If any gets in a student's eyes,** immediately flush with running water and call Poison Control.
- **If any gets on a student's skin,** immediately wash it off. If irritation occurs, call Poison Control.

19. If desired, each student can keep one "invisible ink" card. (Make sure students won't be tempted to lick the cards; if they might be, don't send cards home.)
20. Have students remove their gloves, discard them, and wash their hands.

Activity Three – Solar Art — Time: 25 Minutes

Supplies	#	Supplies	#
Bags (Ziploc, sandwich)	16	Plates (9in, brown kraft)	16
Index cards (4inx6in)	16	Scissors (site provides)	16
Index cards (half-size, 2.5inx3in - 4 are extra)	20	Solargraphics paper (3.5inx4in pieces - 3 are extra)	19
Newspaper		Tape (rolls, Scotch)	2
Pans (large, oval, aluminum)	2	Transparencies (3.67inx4.25in pieces)	16
Paper towels (large rolls)	1	Water	
Pitchers with lids	1		

Goal: To explore a chemical reaction by developing an image on sun-sensitive paper.

Source: *GeoSafari Solar Graphics Kit*

Background:

Solargraphics paper is coated with chemicals that react to sunlight. When the paper is exposed to sunlight, a chemical reaction occurs. However, if something blocks the sunlight from reaching part of the paper, the blocked part of the paper doesn't react. Soaking the paper in water triggers a second reaction. This reaction turns the parts of the paper that were exposed to sunlight blue and leaves the rest white. This is a chemical reaction because you can't undo it: once you've soaked the paper in water, the pale parts can't turn blue again. (https://bit.ly/3wwWvHi)

Survey Connection:

★

Q. When you combine two or more things and they change into something new, that's called a chemical ____________.
A. Reaction.

Procedure:

TIPS:
- **It's best to do this activity on a day when you can take students outside for the second half, so you may need to adjust accordingly**. The activity will work when it's cloudy, though it works *faster* when it's sunny. If you can't go outside, it works with strong sunlight through a window.
- **Don't remove the Solargraphics paper from its package until you're ready to work with it.** (Also, don't let the paper get exposed to sunlight—including near a window—until you reach that part of the activity.)

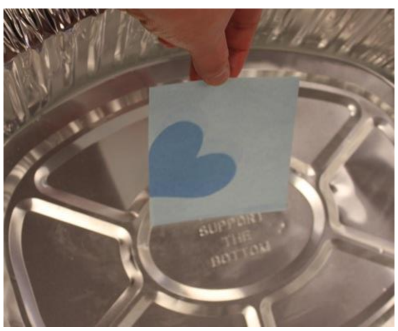
1. Ask students:
   - ***Do you know how plants make food to stay alive and grow?*** *(Plants have special structures in their cells that capture energy from sunlight and transform it into sugars. This process occurs through a series of chemical reactions called photosynthesis.)*
   - ***Are there other ways sunlight can trigger chemical reactions? Let's find out!***
2. Give each student a half-size index card and a pair of scissors.
3. Have students cut out a simple shape from their index card.
4. Give each student a brown kraft plate and a piece of transparency.
5. Make sure all students are in a shaded area of the room where there's as little sunlight as possible coming in from windows or skylights.

TIP:
- **It may be helpful to have students prepare their Solargraphics papers in a hallway (if the hallway has fewer sources of sunlight than your room).**

6. Have students place their brown kraft plate upside-down in front of them.
7. Tell students: ***I'm going to hand you a special type of paper that has a blue coating on one side. The blue side of the paper is the "active" side. It reacts with sunlight, so your mission is to keep it away from sunlight until it's time to do our experiment.***
8. Give each student a piece of Solargraphics paper.
9. Have students:
   a. Put their piece of Solargraphics paper on top of the upside-down plate, with the blue side of the paper facing up.
   b. Put their cut-out shape on top of the Solargraphics paper.
   c. Use their piece of transparency to cover both items like a clear shield.

Act. 3, Solar Art. Cut out a simple shape from an index card. Flip a Styrofoam plate upside down. With as little sunlight as possible, hand out solar graphics paper. Put the solar graphics paper on the bottom of the plate, then the cut out shape, then the transparency. Tape the transparency down on both sides. Tape one side of a 4x6in index card on top of the transparency.

Act. 3, Solar Art. Go stand in a sunny area and flip the 4x6in notecard back to expose the solar graphics paper. Leave the paper uncovered until it becomes a pale blue, then recover and bring to water pan to develop.



Act. 3 Solar Art. Remove the transparency and cut out shape. Take the solar graphics paper and submerge it in the water for one minute.

10. Give each student two pieces of tape or make rolls of tape available to share.
11. Have students tape two sides of their transparency to their plate. (Only the transparency gets directly taped to the plate; the paper and shape are under it.)
12. Give each student a 4inx6in index card and another piece of tape.
13. <u>Have students</u>:
    a. Use the index card to fully cover the transparency and block out light.
    b. Tape one of the long edges of the index card to the plate. (Run the tape parallel to the edge of the card to attach the card securely.)

14. <u>Tell students:</u> ***We're going to carry our plates outside for this reaction! Your mission is to make sure your index card stays in place until you're in position and ready. Put one hand underneath your plate. Put your other hand on top of your index card to hold it flat and steady in case it's windy outside.***

15. <u>Gather all the items to go outside</u>. Students will carry their plate (holding the index card flat), and you'll carry one of these sets of items:
    a. **<u>Option #1</u>:** If you want students to stay outside to develop their images, bring two large pans, paper towels, and a full pitcher of water outside.
    b. **<u>Option #2</u>:** If you want to have students to come back indoors to "develop" their images, you don't need to bring anything else outside with you for this activity. The instructions below are based on Option #1, but the later steps can be done when you come back inside.

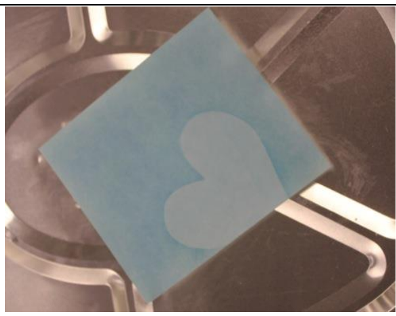
<u>TIPS</u>: **<u>Regardless of whether you choose Option #1 or Option #2</u>:**

- **You may want to bring any extra pieces of Solargraphics paper with you** (in the original package with the top folded over).
- **If you don't want to make a separate trip outside for the <u>next</u> activity, you may want to do steps 4a (and possibly 4b) from the optional Prep for this class.** You'll want to bring all the items from those steps outside.

<u>Discussion Prompt:</u>

- ***Has anyone ever heard of ultraviolet (UV) light? Where does it come from?*** *(UV light is a form of energy that radiates from the sun)*. ***We're going to use UV light from the sun for our experiment today. Let's head out!***

16. Take students outside to an area that's fully in the shade, but close to an area with strong sunlight. Students should hold their index card



Act. 3, Solar Art. Watch the colors of the paper invert as the shape becomes lighter and lighter. After one minute set the paper on a paper towel to dry. It will continue to darken, leaving the exposed areas a dark blue, and the shape white.

flat against their plate until it's time to reveal the Solargraphics paper.

17. Put the pans in the shade and divide the water between them.

TIPS:
- **If it's windy outside, you may want to take a few minutes to gather small rocks, etc., to help weigh down the plate and/or the transparency.** (Alternately, students can hold everything in place if needed.)
- **Don't put anything directly over the Solargraphics paper, or it will become part of the final design.** (Also avoid accidental shadows.)

18. Have students:
    a. Stand in the sunny area and put their upside-down plate on the ground.
    b. Flip back their index card on its tape "hinge" to reveal the transparency-covered Solargraphics paper.
    c. Leave the paper uncovered in the sun until the paper turns pale blue.
    d. Once the paper is pale blue, flip the index card back into place to cover it.
    e. Bring the plate back to the shade.

TIP:
- **Watch for the Solargraphics paper to turn light-colored in the sun.** Pay attention to the lightness of the paper. (The reaction can take anywhere from 2-7 minutes, depending how bright vs. cloudy it is.)

Discussion Prompt:
- ***What happened to your blue paper?*** *(It got lighter in the sun.)* ***We're going to take turns "developing" the papers to see what happened with everyone's designs!***

19. Have students gather around the pans of water.

TIP:
- **Students who *aren't* using the water immediately should keep their index card covering their paper.**

20. At each pan, have 1-4 students at a time:
    a. Flip back their index card on its tape "hinge" to reveal the transparency-covered Solargraphics paper.
    b. Gently remove the transparency from the underside of the plate.
    c. Set aside their cut-out shape.

Discussion Prompts:
- ***What happened underneath your cut-out shape?*** *(The paper under the shape didn't change color, even though the rest of the paper got lighter in the sun.)*
- ***Why do you think that happened?*** *(Solargraphics paper has a white paper base coated with a chemical compound that's*

sensitive to sunlight. When the blue coating is struck by rays of UV light, it undergoes a chemical reaction that creates new molecules. The new molecules are colorless, so the white paper base starts to show through, and the paper looks pale. However, the marker blocks the sunlight, so those parts of the paper don't change.)

- ***What do you think will happen when we put the paper in water? Let's try!***

21. Give each student a piece of paper towel.
22. Have the students at each pan:
    a. Submerge their Solargraphics paper in the water.
    b. Keep the paper submerged for about 1 minute, or until the paper around the design has returned to a significantly darker shade of blue.
    c. Lift the paper up by a corner and let the water drip off over the pan.
    d. Put the piece of paper towel on top of the brown kraft plate.
    e. Put the Solargraphics paper on top of the paper towel to dry in the shade.

TIPS:
- **The Solargraphics images won't be "set" on the paper until they're developed in the water.** (The process is like developing film photos.)
- **The water will turn blue as multiple students develop their paper.** The blue dye is non-toxic, but students should avoid splashing it on their clothes or other students.
- **If you happen to develop the paper indoors, rinsing the paper under running water for 1 minute is an alternate option.**

Discussion Prompts:
- ***What happened?*** *(The light and dark areas of the paper switched places in the water!)*
- ***Why do you think that happened?***

23. Explain to students that when the Solargraphics paper was placed in the water, two important things happened. The parts of the paper that were blocked by the cut-out shape still had the original blue coating on them. However, that coating is water soluble, so it dissolved in the water and washed away, leaving a pale-looking design. On the other hand, the parts of the paper that reacted with the sunlight had a new, different set of molecules on them. Those molecules, which started out colorless, gradually reacted with the water and turned darker blue.

24. If desired, have students gather small items with interesting shapes (like leaves, flowers, etc.) and place them on extra pieces of Solargraphics paper. Alternately, if you have a permanent marker,

you could use thick lines to draw a design directly on a transparency. Arrange the materials in the shade before repeating the activity. (Save one piece of Solargraphics paper for the next activity.)

25. Dump out the water from the pans and bring the class back inside.
26. Have students wash their hands.
27. At the end of class, give each student a Ziploc sandwich bag to take their slightly-damp Solargraphics paper home.

Activity Four – Sunscreen Beads Time: 10 Minutes

Supplies	#	Supplies	#
Bags (Ziploc, sandwich - 16 are from previous activity)	17	Plates (9in, brown kraft)	2
Beads (UV, color-changing - 4 sets of 4 colors divided between 2 small bags)	16	Solargraphics paper (3.5inx4in pieces)	1
Pans (large, oval, aluminum)	1	Sunscreen (3.5-gram packets)	1
Paper towels (large rolls)	1	Water	
Pitchers with lids	1		

Goal: To test how sunscreen blocks ultraviolet rays using UV color-changing beads.

Source: https://stanford.io/3wAzkw1

Background:

From www.stevespangler.com: "There are many forms of light energy and UV is one of them along with incandescent light, fluorescent light, halogen lights, LEDs, sunlight, neon, and others. They're different based on the wavelengths they produce and how the light is produced. Some of these wavelengths create the visible spectrum and allow us to see colors. None of the energy present in the UV part of the spectrum is visible to the human eye. However, when the beads are struck by UV light, a chemical reaction occurs that causes a specific wavelength to be released so you can see a color on the bead."

Survey Connection:

★

Q. When you combine two or more things and they change into something new, that's called a chemical ____________.

A. Reaction.

Act. 4, Sunscreen Beads. Show what a UV bead looks like before exposing it to sunlight.

Act. 4, Sunscreen Beads. Place a bead by the window to show what happens when UV beads are exposed to natural light.

Act. 4 Sunscreen Beads. Put the two small bags of beads on a plate. Seal the bags & spread a thick layer of sunscreen on the top of one of the bags. Optional —place a piece of solar graphics paper into another bag & coat half with sunscreen. Cover this all with a second Styrofoam plate, to block the light.

Procedure:

TIPS:	
	• **It's best to do this activity on a day when you can take students outside, so you may need to adjust accordingly**. The activity will work when it's cloudy, though it works *faster* when it's sunny. If you can't go outside, it may work with strong sunlight through a window—though only if the window doesn't have a UV-blocking film or tint. • **Each small bag starts with 8 assorted color beads.**

1. Remind students: ***In today's class, we've explored some chemical reactions that involved color changes.***

2. Show students two UV beads (one from each small bag).
3. Pass the beads around so each half of the class can examine one of the beads.
4. Ask students: ***What color is this bead?*** *(Off-white/clear.)* ***This bead does something special when it's exposed to sunlight. Let's put it in the sun while we're talking and see what happens!***

5. Put the bead near a window (or outside) so that it's exposed to sunlight.

   Discussion Prompts:
   - ***Have you ever gotten a sunburn or a suntan? What caused it?*** *(Ultraviolet, or UV, rays from the sun. We can't see UV radiation, but it's a powerful form of energy.)*
   - ***Why do people use sunscreen?*** *(To avoid getting an overdose of UV rays, which can damage skin.)*

6. Remove the UV bead from near the window (or outside) and pass it around.

   Discussion Prompts:
   - ***What do you notice?*** *(The bead changed color!)*
   - ***What property does the bead have in common with human skin?*** *(Skin sometimes changes color when it's exposed to UV radiation—and so does the bead!)*
   - ***How could we set up an experiment using UV beads and sunscreen to find out whether sunscreen really works?***

7. If you haven't already done these steps as Prep:
   a. Put the two small bags of beads on a brown kraft plate. Seal the bags.
   b. Spread a thick layer of sunscreen on top of one of the bags.
   c. Cover the plate with an upside-down plate.

Act. 4, Sunscreen Beads. Go outside. Uncover the bags of beads and solar graphics paper (optional). Expose to the light for 1-3 minutes, then flip the sunscreen-covered bag of beads over and immediately compare. The beads inside the bag with sunscreen will be significantly lighter in color.

d. Optional: put a piece of Solargraphics paper in a Ziploc sandwich bag. Spread sunscreen on top of half of the bag. Keep the bag covered (e.g., on the same plate as the small bags of UV beads).

TIPS:
- **Put the sunscreen on the outer surface of the bag,** not directly on the beads. Make sure the sunscreen fully covers the area above the beads.

8. Ask students: ***Why do we care about making a bag without sunscreen, if we already know what's going to happen to those beads?*** *(The beads in the bag without sunscreen are the Control group and the beads in the bag with sunscreen are the Experimental group.)*

9. For a more thorough explanation of the above, you could explain to students that in many experiments, you want to find out if taking a particular action causes a change that wouldn't have happened otherwise. You want to be sure that any changes you see are a result of the action you took, rather than a product of random chance or an error. To do that, it helps to be able to compare at least two samples (the Control and Experimental samples.) If you keep everything the same between two samples—and only do one thing differently between them—it's more likely that any difference in the end result is due to the action you took.

10. Take the class outside to an open area. Bring the covered plate with you.
11. Uncover the bags of beads (and the Solargraphics paper if using).
12. Watch until the beads in the bag without sunscreen have fully turned colors.
13. After 1-3 minutes, flip both bags over on the plate (or hold both bags up in midair) and immediately observe the differences in bead colors between the two bags.

TIPS:
- **The beads from the bag with sunscreen will start to deepen in color quickly when exposed to direct sunlight,** so it's good to compare the beads within 15-20 seconds after flipping the bags over.
- **The beads in both bags will have turned color, but there should be a visible difference in the amount of color.** If needed, hold both bags up against a dark background so it's easier to see the difference in color.

Discussion Prompts:
- ***What happened?*** *(The beads in the bag with sunscreen didn't change color as much as the beads in the bag without sunscreen.)*
- ***Why do you think that is?*** *(The sunscreen absorbed some of the UV rays that would otherwise have reached the beads.)*

14. Give each student a bead and let them explore with it. (If you're testing the Solargraphics paper, cover it up once the visible part of the paper turns pale blue.)
15. To reactivate the beads: Have students hold their bead in a closed hand for a minute or two until it returns to its original off-white color, then re-expose it.
16. Each student can keep their bead to take home.
17. If you're testing the Solargraphics paper, develop it in water (away from sunlight) for 1 minute. The paper color will vary based on where the sunscreen covered it.

Activity Five – Daily Debrief — Time: 5 Minutes

Supplies	#
Lab Notebooks	16
Pencils	16

Suggested Reading: *Color Me Science* by Scholastic Books

Goal: To draw today's activities together through a thoughtful question and give students an opportunity to ask their own questions.

Procedure:
1. Encourage students to reflect on what they learned in today's class and what new questions they might have.
2. Allow students a few seconds to think. Have them discuss their thoughts and questions with a partner, then share with the rest of the class and/or write down in their lab notebook.
3. If needed, feel free to offer prompts like:
   - ***What do you think would happen if we changed one thing about today's activities (for example: materials, speed, temperature, etc.)?***
   - ***If you could investigate (explore) one more thing about today's activities, what would you like to find out?***

4. If time allows, ask the following question:
   - ***How would you pass along a secret message? Would you use a code, chemicals, etc.?***
   - ***activities, what would you like to find out?***

Clean up: Make sure students help clean the room before they leave.

What to save:

Materials used	#	SAVE	Materials used	#	SAVE
Bags (Ziploc, sandwich)	17	0	Pans (9in, round, aluminum)	4	4

Bags (Ziploc, snack)	16	0	Pans (large, oval, aluminum)	2	2
Beads (UV, color-changing - 4 sets of 4 colors divided between 2 small bags)	16	0	Paper towels (large rolls)	1	1
Cardstock rectangles (2.5inx3in, heavyweight - 1 is extra)	10	0	Pitchers with lids	1	1
Cotton swabs (6in, wood handle)	8	0	Plates (10in, paper, high sides)	8	0
Cups (1oz, plastic)	8	8	Plates (9in, brown kraft)	18	18
Cups (1oz, plastic, calibrated)	1	1	Salt (oz, iodized)	4	0
Cups (9oz, plastic, punch)	4	4	Scissors (site provides)	16	16
Gloves (pairs - vinyl, disposable, small)	16	0	Solargraphics paper (3.5inx4in pieces - 3 are extra)	20	0
Hydrogen peroxide (oz, 3%)	1	0	Spoons (plastic)	4	4
Index cards (4inx6in)	16	0	Sunscreen (3.5-gram packets)	1	1
Index cards (half-size, 2.5inx3in - 1 is extra)	30	0	Tape (rolls, Scotch)	2	2
Iodine tincture (1oz bottles)	1	1	Transparencies (3.67inx4.25in pieces)	16	0
Newspaper			Water		

What goes home: UV color-changing bead & solar art paper in Ziploc sandwich bag; if desired, invisible ink index card in Ziploc snack bag

(Review safety guidelines with students: small items should always be kept away from children ages 3 and younger to avoid the risk of choking; supplies from AKA Science should never go in students' mouths, eyes, ears, or noses; note that the Solargraphics paper will keep darkening as it dries; note that the "invisible ink" on the cards will fade over time)

Cool Chemistry: Fizz, pop, WOW! (Grades 4-6)

Class 6: All About That Base (& Acid)

Supplies	#
Bags (Ziploc, sandwich)	16
Bags (Ziploc, snack)	24
Baking soda (oz)	2.5
Chalk (half-pieces, Crayola "dustless")	8
Colorful Cabbage Packs (40 strips of blue litmus paper (4 are extra for this class; save 20 for next class), 16 labeled 1oz cups (4 "B" for baking soda, 4 "M" for Milk of Magnesia, 4 "S" for soap & 4 "V" for vinegar), 16 unlabeled 2oz cups, 1 tapered vial of red cabbage juice powder (.18tsp) & 1 pipette labeled "M")	1
Cotton swabs (6in, wood handle)	32
Cups (1oz, plastic)	8
Cups (1oz, plastic, calibrated)	2
Cups (20oz, plastic)	1
Cups (9oz, plastic, punch)	15
Dish soap (20oz bottles, liquid)	1
Funnels (2oz, plastic)	1
Goldenrod color-changing paper (quarter-sheets)	32
Markers (black, wet erase)	1
Milk of Magnesia (12oz bottles)	1
Newspaper	
Oil (oz, vegetable)	6
Pans (9in, round, aluminum)	4
Paper towels (large rolls)	1
Pipettes (1mL, plastic)	16
Pipettes (1mL, plastic, for vinegar, labeled "V")	8
Pitchers with lids	1
Plates (9in, brown kraft)	16
Spoons (plastic)	2
Tape (rolls, Scotch)	2
Vials (7-dram, clear plastic, with lids)	24
Vinegar (oz)	24
Water	

Worksheets:

See next page.

Prep (prior to class):

- **<u>Act. 2a</u>:** Use the funnel to fill twenty-four vials approx. 1/3-full of oil.
- **<u>Act. 2b (Optional)</u>:** For <u>eight</u> of the vials of oil above, add water until the vials are 2/3-full total.
- **<u>Act. 2c</u>:** Fill four 9oz cups half-full of water.
- **<u>Act. 2d</u>:** Fill four 9oz cups half-full of vinegar. Put a pipette labeled "V" in each cup, and use the wet-erase marker to label each cup "V."
- **<u>Act. 3a</u>:** Fill a 9oz cup < ¼ -full of Milk of Magnesia (shake before using). Put the pipette labeled "M" in it.
- **<u>Act. 3b</u>:** Use the calibrated cup to put .5oz of baking soda in a 9oz cup. Put a spoon in the cup.
- **<u>Act. 3c</u>:** Fill a 20oz cup half-full of water. Add the cabbage juice powder. Stir with a new spoon.
- **<u>Act. 3d</u>:** Divide the cabbage juice liquid evenly into four 9oz cups.
- **<u>Act. 4</u>:** If you do Act. 4 the same day as Act. 2-3, you don't need to prep for Act. 4 before class (you'll reuse supplies). If you do Act. 4 a different day, fill four 9oz cups a quarter-full of water, add .5oz of baking soda to each cup, and stir the cups with a single spoon.

OPTIONAL: Human Connection — Time: 1 Minute

<u>Goal:</u> To share important and interesting discoveries made by scientists and communities identifying as Indigenous, Black, Brown, Melanated, Latino/Hispanic, Immigrant, Asian, LGBTQIA+ and female, and to encourage students to see themselves in science. **A**ll **k**ids **a**re scientists!

<u>Read-Aloud Narrative:</u>

What do you picture when you think of a chemist? Do you imagine someone brewing neon-colored acids bubbling in beakers? Do you see someone in a long white lab coat, wearing giant goggles and making powders explode? While some chemistry might look like this, there is a whole world of chemistry that happens outside of a laboratory - no lab coats or goggles required!

In class today, we will learn about acid-base reactions. The **First Nations of Saskatchewan**, Indigenous people in Northern Canada, have used acid-base chemistry for centuries. The **Cree** of Central Saskatchewan use acid-base reactions to create natural bleach. Natural bleach is made by boiling the ashes of poplar wood in water to create a basic solution called lye. This bleach is used to dye clothes and purify unsanitary water. On the other hand, by boiling the ashes of the cedar tree, the **Anishinabek** and **Saulteaux** Nations learned to create strong acids. White corn, also known as mahndawmin, is the most abundant grain in Canada. White corn has a hard outer husk that must be removed before it is edible. These First Nations use cedar acids to dissolve this outer husk, which turns white corn into popcorn. White (pop)corn is then made into corn soup, the most popular food among the Anishinabek and Saulteaux Nations.

Cool Chemistry: Fizz, pop, WOW! (Grades 4-6)

Class 6: All About That Base (& Acid)

Worksheets: Cabbage Juice Indicator pH Scale (eighth-sheet, color)	16

First Nations people understand the world of chemistry through the science of synthesizing acids and bases from tree ashes. This knowledge was acquired through experiential learning thousands of years before the first chemistry lab was even established and is still used today!

Activity One – Pair & Share Time: 10 Minutes

Supplies	#	Supplies	#
Pencils	16	Lab notebooks	16

Goal: To engage students' thinking and questioning related to the day's activities.

Procedure:

1. Prepare a quiet space for students to give them a physical area to think. The space can be an area set aside from the activity area, where students sit in a circle to ponder the *Pair & Share* question.
2. Make lab notebooks and pencils available.
3. Ask students a *Pair & Share* question:

    - ***Can you think of something you might see/hear/smell that means something else is also close by?*** *(Smoke and fire; thunder and lightning; sulfur odor and gas leak, etc.)*

4. Ask students to discuss their ideas with their neighbor before inviting students to share what they came up with. This is a "challenge by choice" opportunity and no one is required to share with the class if they are not comfortable.

Survey Connection Note: *All* activities are linked to these survey questions:

★ **Q.** ____________is everything around us in the form of solids, liquids, and gasses.
A. Matter

★ **Q.** What type of chemical is vinegar?
A. Acid.

★ **Q.** Fill in the blank: When you combine two or more things and they change into something new, that's called a chemical ____________.
A. Reaction.

Activity Two – Acid/Base Behavior Time: 15 Minutes

Supplies	#	Supplies	#
Bags (Ziploc, snack)	24	Oil (oz, vegetable)	6
Chalk (half-pieces, Crayola "dustless")	8	Pans (9in, round, aluminum)	4
Cups (1oz, plastic)	8	Paper towels (large rolls)	1
Cups (1oz, plastic, calibrated)	1	Pipettes (1mL, plastic)	16
Cups (9oz, plastic, punch)	8	Pipettes (1mL, plastic, for vinegar, labeled "V")	4
Dish soap (20oz bottles, liquid)	1	Pitchers with lids	1
Funnels (2oz, plastic)	1	Tape (rolls, Scotch)	2
Markers (black, wet erase)	1	Vials (7-dram, clear plastic, with lids)	24
Newspaper		Vinegar (oz)	16
		Water	

Goal: To explore acids and bases by comparing how vinegar vs. soap affects vials of oil and water and how vinegar vs. soap affects pieces of chalk.

Source: *200 Illustrated Science Experiments for Children* by Robert J. Brown

Background:

You might have heard the saying, "Oil and water don't mix." This is because water molecules are more attracted to other water molecules, and oil molecules are more attracted to other oil molecules. When you pour the two into the same container, they might swirl together at first, but after a while, the molecules will move around until they are separated again.

A mix of things that you wouldn't normally be able to combine is called an emulsion. You can make an emulsion of oil and water with soap. Soap is a molecule with two different ends. One end loves water, and the other end loves oil. When you put soap in bowl of oil and water, one end of the soap attaches to the water, and the other end attaches to oil. You end up with oil mixed through the water, held there by soap. The same thing happens when you wash your hands. The soap clumps around the oil and dirt on your hands, then washes away with the stream of water. (https://bit.ly/3CIAmJY)

Procedure:

1. Ask students:
   - ***Can all substances be combined?*** *(No.)*
   - ***What are some examples you've seen of things that don't mix together?*** *(Magic Sand and water, Liquid Layers, etc.)*

2. Put students in 4 groups.
3. Give each group a 9oz cup half-full of water to share (from Prep). If desired, give each group a 9in pan to hold cups of liquid (including the cup of water).

Act. 2 Acid/Base Behavior. The vial with oil, water, and <u>vinegar</u> (left) separated out the same way as the regular oil/water vials. The vial with oil, water, and <u>soap</u> (right) helped the oil and water mix better and stay mixed longer. (The top layer on the right is soap bubbles.)

4. Give each student a vial 1/3-full of oil (from Prep), a lid, a pipette, a piece of paper towel, and a Ziploc snack bag

   <u>Discussion Prompts:</u>
   - ***What do you think this liquid is?*** *(Vegetable oil.)*
   - ***Can you think of another substance that that doesn't mix with oil?*** *(Water!)*

5. <u>Have students</u>:
   a. Use a pipette to add water to their vial until the vial is 2/3-full of liquid.
   b. Observe the contents of their vial.

   <u>Discussion Prompts:</u>
   - ***What happened?*** *(The water formed bubbles in the oil and eventually sank to the bottom of the vial. Now the oil is floating on top of the water, just like in Liquid Layers and the Lava Lamp.)*
   - ***Is there any way you can try to mix the water and oil together?***

6. <u>Have students</u>:
   a. Put the lid on the vial, put the vial in the Ziploc bag, and seal the bag.
   b. Hold the lid on the vial (through the bag) and shake the vial vigorously.
   c. Stop shaking, remove the vial from the bag, and put it on a paper towel.
   d. Observe the contents of their vial.

   <u>Discussion Prompts:</u>
   - ***What do you see?*** *(The oil and water looked like they had combined, but then they started to separate back out into layers.)*
   - ***Do you think we could add an ingredient to force the water and oil to mix together? Let's try!***

7. Give each group two more vials 1/3-full of oil (from Prep), two more lids, and two more snack bags. (If you didn't do the optional prep of adding water, have groups use their pipettes to add water to each vial until each vial is 2/3-full of liquid.)
8. <u>Tell students:</u> ***These will be our experimental vials. Let's try adding vinegar to one vial and soap to the other.***

   <u>Discussion Prompt:</u>
   - ***What do you think will happen when we add them and shake the vials?***

9. Give each group a 9oz cup half-full of vinegar (from Prep) with a "V" pipette in it.
10. Have one student in each group add a full pipette of vinegar to one of the vials, then put the lid on the vial, put it in the bag, and seal the bag.
11. Walk around and have one student in each group add a large squeeze of soap to the other vial (about .25oz of soap). If desired, use the wet-erase marker to label that vial "S."
12. Have that student put the lid on vial, put it in the other bag, and seal the bag.
13. Tell students: ***Let's see what happens when we shake the vials this time!***

14. In each group, have the students who *didn't* add vinegar or soap:
    a. Hold the lid on one of the vials (through the bag) and shake it vigorously.
    b. Stop shaking (ideally at the same time), remove their vial from the bag, and put it on a paper towel.

15. Have groups observe the vials for a few minutes and compare the vial with soap, the vial with vinegar, and the original vials (see photo).

    Discussion Prompts:
    - ***What happened?*** *(Soap helped the oil and water mix better and stay mixed longer.)*
    - ***How did the soap do that?*** *(When you shook the original oil/water vials, you caused the oil and water to form an emulsion in which tiny droplets of oil were suspended in the water. However, the emulsion wasn't stable, so the oil and water separated back out. Soap acted as an emulsifier to help stabilize the emulsion and slow down separation.)*
    - ***What properties of soap helped it do that?*** *(We've learned that soap molecules have one end that's hydrophobic, or water-repelling, and one end that's hydrophilic, or water-attracting. The soap was able to grab molecules of oil and help them stay suspended in the water.)*
    - ***What did the vinegar do?*** *(Not much. The vial with vinegar looked the same as the original oil/water vials.)* ***Let's see what happens with a different reaction!***

Act. 2, Acid/Base Behavior. Add a large squeeze of soap into one of the 1oz cups with chalk in them (left) and observe that nothing happens. Add 5 drops of vinegar to the piece of chalk in the other 1oz cup. Watch as it reacts (right). Acids react to minerals like those found in chalk, while bases do not.

16. Give each group two 1oz cups and a half-piece of chalk. As you walk around, break the chalk in half (to make two quarter-pieces per group), or have a student in each group break the chalk in half.
17. Ask students: ***What do you think will happen if you add vinegar vs. soap to the chalk? Let's find out!***

18. Have students make a hypothesis about how vinegar vs. soap will affect the chalk.

19. Walk around and have one student in each group add a <u>large</u> squeeze of soap to the chalk in one of the cups.
20. <u>In each group, have students</u>:
    a. Take turns adding five drops of vinegar on the other piece of chalk.
    b. Compare the two pieces of chalk.

    <u>Discussion Prompts:</u>
    - ***What do you notice?*** *(The vinegar made the chalk bubble and dissolve. The soap didn't do much to the chalk.)*
    - ***Why do you think that is?*** *(Vinegar is an <u>acid</u>, and soap is a <u>base</u>, which means they interact with other substances in different ways.)*
    - ***Have you ever heard of acids and bases? What are they?*** *(<u>Acids</u> are chemical compounds that break down things like <u>metals and minerals</u>. Strong acids feel like they burn; the ones that are OK to eat taste sour. Examples of acids include vinegar, citrus fruits, battery acid, etc. <u>Bases</u> are known for their slippery texture; the ones that are OK to eat taste bitter. Bases make good cleaners because they break down <u>fats and oils</u>. Examples of bases include soap, bleach, ammonia, etc.)*

21. Give each student a piece of tape (or make rolls of tape available to share).
22. Have students tape the lid securely on their original oil/water vial, put the vial in their Ziploc snack bag, and seal the bag.
23. Keep the cups of water, cups of vinegar, and both sets of pipettes handy for the next activities. If you used the 9in pans, keep them handy, too.

Activity Three – Colorful Cabbage — Time: 20 Minutes

Supplies	#	Supplies	#
Baking soda (oz)	0.5	Pans (9in, round, aluminum)	4
<u>Colorful Cabbage Packs</u> (40 strips of blue litmus paper (4 are extra for this class; save 20 for next class), 16 labeled 1oz cups (4 "B" for baking soda, 4 "M" for Milk of Magnesia, 4 "S" for soap & 4 "V" for vinegar), 16 unlabeled 2oz cups, 1 tapered vial of red cabbage juice powder (.18tsp) & 1 pipette labeled "M")	1	Paper towels (large rolls)	1
Cups (1oz, plastic, calibrated)	1	Pipettes (1mL, plastic - from previous activity)	6
Cups (9oz, plastic, punch - 4 with vinegar & 2 with water are from previous activity)	13	Pipettes (1mL, plastic, for vinegar, labeled "V" - 4 are from previous activity)	8
Cups (20oz, plastic)	1	Pitchers with lids	1
Dish soap (20oz bottles, liquid)	1	Plates (9in, brown kraft)	16

Markers (black, wet erase)	1	Spoons (plastic)	2
Milk of Magnesia (12oz bottles)	1	Vinegar (oz) - from previous activity	16
Newspaper		Water	
		Worksheets: Cabbage Juice Indicator pH Scale (eighth-sheet, color)	16

Goal: To learn about acid/base pH by testing liquids with red cabbage juice indicator.

Source: Carolina Biological Supply

Background:

Certain types of dyes act as acid-base indicators. Scientists call these dyes "indicators" because they "indicate" whether a chemical is acidic or basic. Acid-base indicators are very important to chemists! They can be used to determine a chemical's pH.

A chemical's pH is a measure of how acidic or basic it is. pH exists on a spectrum, similar to temperature. For instance, sometimes the air can be very cold or very hot—but other times, it can just be just a little bit cool or a little bit warm. We can tell how hot or cold it is by checking the temperature on a thermometer. Just like the temperature of the air, chemicals can be very acidic, very basic, just a little acidic or basic, or even right in the middle, like water!

Red cabbage juice extract is one type of acid-base indicator, but there are many different types. Each one has a specific chemical reaction that causes a color change in the presence of acids versus bases, so it's important to use a pH scale that matches the particular indicator you're using.

Did you know that there are acid-base indicators in nature? One cool example is hydrangeas: their flowers are blue when they grow in soil that's acidic, and they're pink or red when they grow in soil that's basic. (https://bit.ly/3RvAEbF, https://bit.ly/3QVEURw)

Procedure:

TIPS:
- **If preferred, you could do the first part of this activity (up to the step of neutralizing vinegar with Milk of Magnesia) as a whole class instead of in groups.**
- **Alternately, if preferred, you could do the first part of the activity in groups, but skip the tests with litmus paper, baking soda, and soap.** You could just focus on vinegar and Milk of Magnesia for the full activity.
- **If you want to monitor the red cabbage juice indicator more closely,** instead of giving each group their own cup of liquid, you could walk around and have groups access the indicator from a single cup as needed.

1. Ask students: ***How can you tell whether something is an acid or base? Let's find out!***

Act. 3, Colorful Cabbage. Create four stations all on Styrofoam plates: 1)Baking soda, a spoon, and a cup of water with a pipette (top left). 2)Milk of Magnesia, the "M" pipette, and a cup of water with a pipette (top right). 3)Bottle of dish soap and a cup of water with a pipette (bottom right). 4)Cup of Vinegar with a "V" pipette (bottom left).

2. Put students in 4 groups.
3. Give each group a brown kraft plate. Make sure each group has a 9in pan (cups of liquid can be put in the pan to protect against spills).
4. Show students the blue litmus paper.
5. <u>Ask students:</u> ***How do you think blue litmus paper works?*** *(Litmus paper is a chemical indicator. It contains a special dye that's sensitive to acids and bases. Blue litmus paper turns pink when dipped in an acid, and it stays blue when dipped in a base. Here's a helpful way to remember what the color of litmus paper tells you: it stays <u>bl</u>ue for <u>b</u>ases!)*

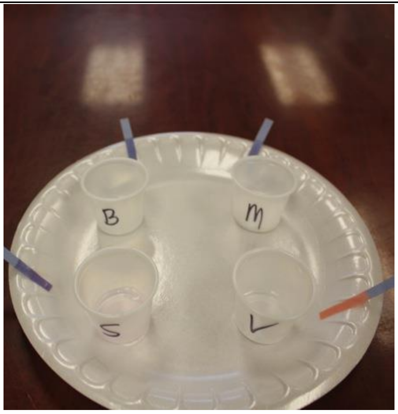
6. <u>Tell students:</u> ***We're going to test four different liquids to find out if they're <u>acidic</u> (acid-like) or <u>basic</u> (base-like). I'm going to set up a station for each liquid in a different part of the room.***

7. <u>Put the following items on separate brown kraft plates, making a station for each</u>:
   a. <u>**Baking soda (B)**</u>**:** 9oz cup with .5oz of baking soda & a spoon in it (from Prep).
   b. <u>**Milk of Magnesia (M)**</u>**:** 9oz cup less than a quarter-full of Milk of Magnesia with an "M" pipette in it (from Prep). *Explain that Milk of Magnesia is an antacid.*
   c. <u>**Soap (S)**</u>**:** The bottle of dish soap.
   d. <u>**Vinegar (V)**</u>**:** 9oz cup half-full of vinegar (from previous activity) and a "V" pipette.
   e. <u>**At each station *except* the Vinegar station**</u>, put a 9oz cup of water with a regular pipette (some from previous activity). If desired, use the marker to label plates.

8. Give each group four labeled 1oz cups (one each labeled "B," "M," "S," & "V.")
9. <u>Explain to students:</u> ***Your group is going to gather a sample of each of these liquids to test. Decide who will gather the sample from each station and make sure each person has the right cup(s).***

<u>**TIPS**</u>:
- **If preferred, you could put the labeled 1oz cups at their respective <u>stations</u>.** Students could get their cup when they go to their station.
- **Alternately, if preferred, <u>you</u> could prepare the samples at each station.** You could either pass the samples out or have students come retrieve them from each station.

10. <u>At each station, have a student from the group put the following in their 1oz cup:</u>
    a. <u>**Baking soda (B)**</u>**:** Just enough baking soda to cover the bottom of the 1oz cup **+** one full pipette of water.
    b. <u>**Milk of Magnesia (M)**</u>**:** 1 full pipette of Milk of Magnesia **+** 1 full pipette of water.



Act. 3, Colorful Cabbage. Dip a piece of blue litmus paper in each of the four, labeled 1oz cups. Observe the color immediately after it's dipped as the color can shift. The strips dipped in B, M, and S will remain mostly blue. The strip dipped in V will turn pink. Of the liquids tested, vinegar is the only acid.

c. **Soap (S):** One *drop* of soap (a tiny amount) **+** 1 full pipette of water.
d. **Vinegar (V):** One full pipette of vinegar.
e. **At each station *except* the Vinegar station,** while the 1oz cup is flat on the desk, have students swirl their cup gently to mix the contents.

11. Have students return to their group and put their 1oz cup on the brown kraft plate.
12. Give each group four pieces of blue litmus paper.
13. In each group, have students:
    a. Dip a piece of litmus paper *halfway* into the liquid in their 1oz cup.
    b. Lay the wet strip of litmus paper on the brown kraft plate (near the cup).

TIPS:
- **Students may need to gently scrape any clinging Milk of Magnesia onto the rim of the cup to see the litmus color.**
- **If the litmus paper is dipped in an acid, it will turn an obvious pink color.**
- **If the litmus paper is dipped in a base, it will stay blue, though it will look wet** (and in some cases, it may look bluish-purple).
- **It's important to check the color of the litmus paper immediately after it's dipped in the liquid.** (The color can shift after that.)
- **There's an extra piece of litmus paper per group if a retest is needed.**

Discussion Prompts:
- ***What happened?*** *(The paper turned pink in the vinegar! It stayed mostly blue in the baking soda, Milk of Magnesia, and soap.)*
- ***Which liquid is an acid?*** *(The vinegar.)*
- ***Which liquids are bases?*** *(The baking soda solution, Milk of Magnesia, and soap.)*
- ***Do you think some bases are stronger than others?*** *(Yes! For instance, magnesium hydroxide is a base used in antacid, which people take when they have an upset stomach. However, sodium hydroxide is a base used in drain cleaner, which is very unsafe to drink.)*
- ***Some acids are stronger/safer than others, too. How do scientists measure how strong an acid or base is?*** *(They use different types of indicators and a tool called the pH scale.)*

14. Show students a cup of cabbage juice indicator.

Discussion Prompts:
- ***Does anyone know what this is?*** *(Cabbage juice!)*
- ***What does it do?*** *(Cabbage juice is a chemical indicator. It works like litmus paper to tell us if a liquid is an acid or a base. However, cabbage juice provides more information than*

litmus paper: it can also tell us if something is a strong or weak acid, a strong or weak base, or neutral.)

15. Give each group a 9oz cup with cabbage juice indicator (from Prep) and a regular pipette (from the previous activity).

> **<u>CAUTION</u>: <u>Cabbage juice indicator can stain clothes and surfaces</u>.**
> - **Make sure students are careful when transferring cabbage juice indicator via pipette from the 9oz cup to other liquids.** Also, make sure groups keep their cup of cabbage juice indicator in the 9in pan to protect against spills.

16. <u>Tell students:</u> ***Based on the litmus paper tests, we already know whether each of these liquids is an acid or base. Let's see what extra info the cabbage juice indicator can provide!***

17. <u>In each group, have students take turns doing the following</u>:
    a. Use the pipette to add <u>two</u> full pipettes of cabbage juice to the liquid in their 1oz cup.
    b. While keeping the 1oz cup on the plate, gently swirl the liquid.

18. Have the group observe the color of each liquid on the plate (see photo).

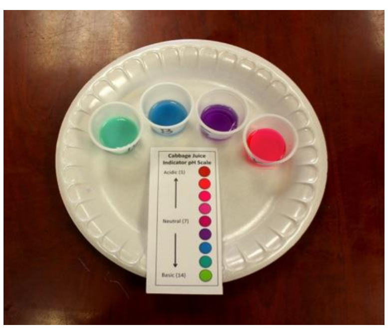
<u>Discussion Prompts:</u>
- ***What happened when you added the cabbage juice indicator?*** *(The liquids in the cups changed color!)*
- ***How can we figure out what the colors mean?*** *(Consult the pH scale!)*

19. Give each student a Cabbage Juice Indicator pH Scale (see left).
20. Have students compare the colors of the liquids to the pH scale.

> **<u>TIP</u>:**
> - **When students compare the color of each liquid to the pH scale, have them look for a *rough* match.** The colors may be close but not exact.

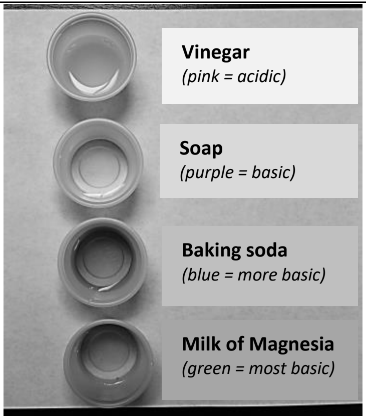
<u>Discussion Prompts:</u>
- ***Based on your results, which of the three bases you tested is the strongest?*** *(Milk of Magnesia.)*
- ***Which base is the weakest?*** *(Baking soda.)*
- ***Do you think water is acidic, basic, or neutral?*** *(Water is neutral. The cabbage juice indicator is already mixed into water, so that color can be roughly matched up with the pH scale for water; however, note that the indicator contains a preservative that makes the solution slightly more acidic than pure water.)*
- ***What do you think will happen if you combine your 1oz cup of vinegar/indicator with your 1oz cup of baking soda/indicator? Do you think the pH will change?***

Act. 3, Colorful Cabbage. Use a pipette to add two pipettes of cabbage juice indicator to each of the 1oz cups. While keeping the cup on the Styrofoam plate, gently swirl the indicator to ensure even color and mixing. Observe the color changes: baking soda is blue (top left), milk of magnesia is green (top right), soap is purple (bottom left), and vinegar is pink (bottom right).

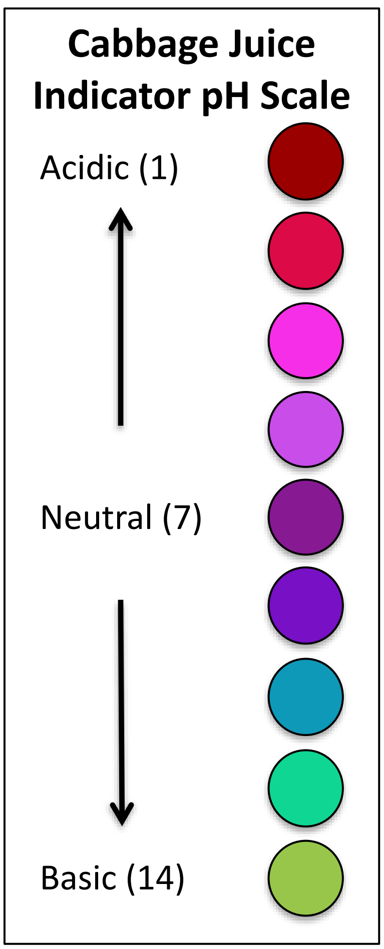


Act. 3, Colorful Cabbage. Use the Cabbage Juice Indicator pH Scale to compare the colors of the liquids to the pH scale. Above the liquids are ranked from most basic(left) to acidic (right)in the following order: milk of magnesia (green), baking soda (blue), soap (purple), and vinegar (pink).

Cool Chemistry: Fizz, pop, WOW! (Grades 4-6)
Class 6: All About That Base (& Acid)



Act. 3 Colorful Cabbage. Of the liquids tested, vinegar is the only acid. Soap, baking soda, and Milk of Magnesia are shown above in order of how basic they are.



Colorful Cabbage. This worksheet (provided in color) helps students match up the color of each liquid with its pH, i.e., how acidic or basic it is.

21. Have groups:
    a. Make a hypothesis about what will happen.
    b. Slowly pour the 1oz cup of vinegar into the 1oz cup of baking soda.

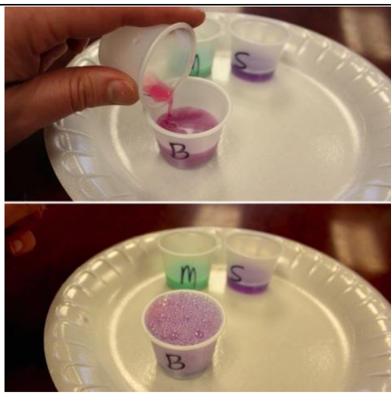
    Discussion Prompts:
    - ***What happened?*** *(The mixture bubbled and fizzed. The blue base and the pink acid combined to make a new purple liquid.)*
    - ***What pH does this new liquid have?*** *(Something closer to the neutral range, in between the acid and the base.)*
    - ***Do you think you could change where another solution falls on the pH scale?***
    - ***What do you think will happen if you add acid to the strongest base we've tested: the Milk of Magnesia? Let's try!***

22. Give each group two "V" pipettes (four of the eight pipettes are from the previous activity) and a 9oz cup half-full of vinegar (take one cup from the station you set up; the other three are from the previous activity).
23. Have each group put their cup of vinegar in the 9in pan to share.
24. Have students get into pairs within their group.
25. Give each pair an empty 2oz cup and a brown kraft plate.
26. In each pair:
    a. Have one student gather a sample of Milk of Magnesia in the 2oz cup (add two full pipettes of Milk of Magnesia this time, and don't add water).
    b. Have the student bring the sample back and put it on the pair's plate.
    c. Have the other student add two full pipettes of cabbage juice indicator to the Milk of Magnesia in the 2oz cup.

27. Ask students: ***What do you think will happen if you add vinegar directly to the Milk of Magnesia?***

28. Have students make a hypothesis about what will happen.
29. Have one student in each pair add a full pipette of vinegar to their cup, while both students watch the cup closely. Pairs can swirl their cup on the table if needed.

    Discussion Prompts:
    - ***What happened****? (When the vinegar first went into the Milk of Magnesia/indicator, it turned pink. After a moment, though, as the vinegar mixed in, the liquid turned purple. After another moment, the liquid shifted to blue, then back to green.)*
    - ***Why do you think that happened?*** *(Milk of Magnesia is used to neutralize stomach acids. It's a strong enough base that it neutralized the vinegar.)* ***What do you think will happen if you add even more vinegar?***



Act. 3, Colorful Cabbage. Slowly pour the 1oz cup of vinegar into the 1oz cup of baking soda. Watch the mixture fizz and combine to make a purple liquid, becoming more neutral.

Act. 3, Colorful Cabbage. Add two full pipettes of cabbage juice indicator to the 2oz cup with milk of magnesia. Mix well, then add one full pipette of vinegar to the cup. Observe what happens.

Act. 3, Colorful Cabbage. Observe the changes in the milk of magnesia. It starts green, then turns pink with the vinegar. It turns purple, blue, then back to green as milk of magnesia neutralizes the acid. Keep adding vinegar to see more changes.

- ***Can you eventually make the basic liquid acidic? Let's try!***

30. In each pair:
    a. Have the other student add a full pipette of vinegar to their cup, while both students watch the cup closely.
    b. Have students take turns continuing to add vinegar to the cup.

TIP:
- **Have pairs stop adding vinegar to their cup after about 12-13 pipettes have gone in (i.e., before the cup gets all the way full).** The liquid will be consistently purple after about the 5th pipette of vinegar, and it will be a light pinkish-purple color after the 12th or 13th pipette of vinegar.

Discussion Prompt:
- ***Did it work?*** *(Yes! The liquid is now weakly acidic.)*

31. If time allows, while the cabbage juice indicator is available, you could test other items from the kit, such as baking powder/water (if any is left) and eye contact solution (it's OK to use up to 1oz). You can also keep experimenting with the bottle of Milk of Magnesia and the vinegar that's already been poured; you'll use a small amount of Milk of Magnesia in the next activity, but the rest is extra.
32. Keep the 9oz cups of vinegar, water, and Milk of Magnesia (plus the 9in pans) handy for the next activity. Rinse and dry the plates as needed.
33. Save all the pipettes. Rinse the ones that were used with the cabbage juice indicator. (To rinse a pipette, pull clean water up into the pipette, shake the pipette vertically up and down so the water gets inside the bulb, then squeeze the water out. Repeat as needed.)
34. Save the remaining blue litmus paper (at least 20 pieces) and all the 2oz cups.
35. Discard the labeled 1oz cups and the "M" pipette in a trash can with a liner (or pour out the liquids first if preferred). Pour out the indicator and save the cups.

Activity Four – Groovy Goldenrod — Time: 15 Minutes

Supplies	#	Supplies	#
Bags (Ziploc, sandwich)	16	Newspaper	
Baking soda (oz)	2	Pans (9in, round, aluminum)	4
Cotton swabs (6in, wood handle)	32	Paper towels (large rolls)	1
Cups (1oz, plastic, calibrated)	1	Pitchers with lids	1
Cups (9oz, plastic, punch - 4 with vinegar & 4 with water are from previous activities)	8	Plates (9in, brown kraft - dried & reused from previous activity)	16

Goldenrod color-changing paper (quarter-sheets)	32	Spoons (plastic)	1
Milk of Magnesia (12oz bottles)	1	Vinegar (oz) - refill cups from previous activities	8
		Water	

Goal: To explore acid-base reactions using Goldenrod Color-Changing Paper.

Source: https://bit.ly/3cpnGNq

Background:

Goldenrod color-changing paper is an indicator: you can think of it like a giant strip of yellow litmus paper! However, this paper uses a different type of acid-base indicator than blue litmus paper, so red = base and yellow = acid. Different indicators turn different colors when exposed to acids and bases. The secret ingredient in this paper is actually a spice called turmeric, which is a natural acid-base indicator. (https://bit.ly/3cpnGNq)

Survey Connection:

★ **Q.** What type of chemical is vinegar?
A. **Acid.**

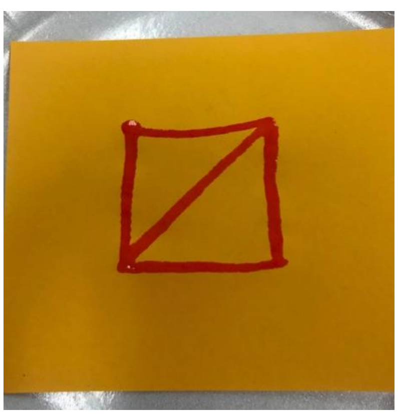
Procedure:

1. Give each student a quarter-sheet of goldenrod color-changing paper.

   Discussion Prompts:
   - ***What are some ways you could change this piece of paper if you wanted to?*** *(Tear it, crumple it, draw on it, burn it, etc.)*
   - ***Are there any other ways to change it? Let's find out!***

2. Put students in 4 groups.
3. Make sure each group has the following items: a 9in pan (to put cups of liquid in if desired) and a 9oz cup a quarter-full of water (adjust the amount of water in the cups as needed from previous activities).
4. Use the calibrated cup to add about .5oz of baking soda to each group's quarter-cup of water. Stir with the spoon.
5. Give each student a brown kraft plate (dried off from the previous activity) and a cotton swab.
6. Have students:
   a. Put their piece of goldenrod paper on top of their brown kraft plate.
   b. Dip their cotton swab in the shared baking soda/water solution.
   c. Swipe the cotton swab across a small area of their goldenrod paper.

Act. 4, Groovy Goldenrod. Provide a 9in pan (place the vinegar and baking soda solution inside), a Styrofoam plate, a quarter piece of goldenrod paper, and a cotton swab.



Act. 4, Groovy Goldenrod. Dip a cotton swab into the baking soda solution and make a test line or shape to see what happens. Watch as the design darkens for 1-2 minutes. Design a second shape on a different piece of goldenrod paper, which will go home.

d. Watch what happens to the mark on the paper for 1-2 minutes.

TIP: • **For best results, dip the swab so the tip touches the bottom of the cup.**

Discussion Prompts:

- ***What happened?*** *(The paper gradually darkened to red where the baking soda touched it.)*
- ***Why do you think that happened?*** *(The baking soda chemically reacted with an ingredient in the paper and caused a color change. The paper's golden color comes from a dye that's an acid-base indicator. The indicator turns red when it reacts with a base.)*

7. Have students set this "tester" quarter-sheet of goldenrod paper aside.

Discussion Prompt:

- ***Could you use what you learned about the paper to make a design to take home?***

8. Give each student a new quarter-sheet of goldenrod paper.
9. Have students:
   a. Put the paper on their plate and create a design to take home.
   b. Set their take-home design aside to dry (or at least partially dry).
   c. Retrieve their previous "tester" quarter-sheet of goldenrod paper and put it on their plate.

10. Ask students: ***Since baking soda is a base, what do you think will happen if you trace over the red line you made before with an acid? What's an acid we've used today?*** *(Vinegar!)*

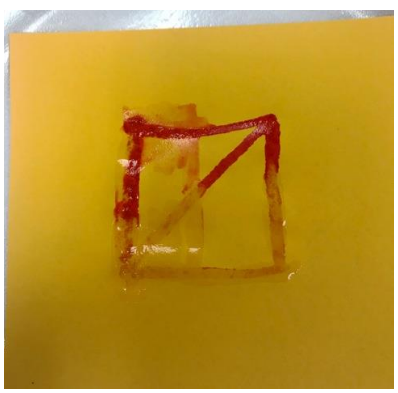
11. Give each group a 9oz cup a quarter-full of vinegar (refill the cups of vinegar from the previous activity as needed).
12. Give each student another cotton swab.

TIP: • **Tell students to use a separate cotton swab for each liquid** (i.e., don't cross the same swab between the vinegar and the baking soda solution).

13. Have students dip their new cotton swab in the shared cup of vinegar, then trace over the red mark on their "tester" sheet of goldenrod paper.

TIP: • **To change the color back, it may help to go over the red mark with vinegar a few times.**

Discussion Prompts:



Act. 4, Groovy Goldenrod. On the test paper dip a new cotton swab into the vinegar and retrace the lines made by the baking soda. Watch as the red lines turn back to yellow. Explore more shapes and liquids as time allows.

- ***What happened?*** *(The red turned back to yellow—at least partially, and at least temporarily! There was also some bubbling/hissing.)*
- ***Why do you think that happened?*** *(The vinegar caused another chemical reaction on the paper, which made the color change back. The bubbling/hissing is because the vinegar and dried-on baking soda reacted to produce carbon dioxide.)*

14. Give students time to explore using the two liquids on their "tester" paper.
15. If desired, put a cotton swab in the 9oz cup of Milk of Magnesia (from the previous activity) and refill the cup as needed. Walk around (or set up a station) and have students experiment with making a mark on their "tester" paper with Milk of Magnesia, then tracing over it with vinegar. (The red marks from Milk of Magnesia initially get "erased" more smoothly than the ones made with baking soda.)

    Discussion Prompt:
    - ***Do you think this type of change happens with all goldenrod paper?*** *(No. Most goldenrod paper contains a different dye than the acid-base indicator in the color-changing paper.)*

16. Give each student a Ziploc sandwich bag for their damp take-home design. (If needed, have students use a paper towel to brush off any residual baking soda from their paper before putting it in the bag.)
17. Have students discard their "tester" sheet.

Activity Five – Daily Debrief — Time: 5 Minutes

Supplies	#
Lab Notebooks	16
Pencils	16

Suggested Reading: *The pH Scale* by Mary Griffin.

Goal: To draw today's activities together through a thoughtful question and give students an opportunity to ask their own questions.

Procedure:
1. Encourage students to reflect on what they learned in today's class and what new questions they might have.
2. Allow students a few seconds to think. Have them discuss their thoughts and questions with a partner, then share with the rest of the class and/or write down in their lab notebook.
3. If needed, feel free to offer prompts like:

- ***What do you think would happen if we changed one thing about today's activities (for example: materials, speed, temperature, etc.)?***
- ***If you could investigate (explore) one more thing about today's activities, what would you like to find out?***

4. If time allows, ask the following question:
   - ***Do you think the chemicals we used today would react the same way in outer space?***

Clean up: Make sure students help clean the room before they leave.

What to save:

Materials used	#	SAVE	Materials used	#	SAVE
Bags (Ziploc, sandwich)	16	0	Milk of Magnesia (12oz bottles)	1	1
Bags (Ziploc, snack)	24	0	Newspaper		
Baking soda (oz)	2.5	0	Oil (oz, vegetable)	6	0
Chalk (half-pieces, Crayola "dustless")	8	0	Pans (9in, round, aluminum)	4	4
Colorful Cabbage Packs (40 strips of blue litmus paper (4 are extra for this class; save 20 for next class), 16 labeled 1oz cups (4 "B" for baking soda, 4 "M" for Milk of Magnesia, 4 "S" for soap & 4 "V" for vinegar), 16 unlabeled 2oz cups, 1 tapered vial of red cabbage juice powder (.18tsp) & 1 pipette labeled "M")	1	all 2oz cups and remaining blue litmus paper (at least 20 strips)	Paper towels (large rolls)	1	1
Cotton swabs (6in, wood handle)	32	0	Pipettes (1mL, plastic)	16	16
Cups (1oz, plastic)	8	8	Pipettes (1mL, plastic, for vinegar, labeled "V")	8	8
Cups (1oz, plastic, calibrated)	2	2	Pitchers with lids	1	1
Cups (20oz, plastic)	1	1	Plates (9in, brown kraft)	16	16
Cups (9oz, plastic, punch)	15	15	Spoons (plastic)	2	2
Dish soap (20oz bottles, liquid)	1	1	Tape (rolls, Scotch)	2	2
Funnels (2oz, plastic)	1	1	Vials (7 dram, clear plastic, with lids)	24	8
Goldenrod color-changing paper (quarter-sheets)	32	0	Vinegar (oz)	24	0
Markers (black, wet-erase)	1	1	Water		
			Worksheets: Cabbage Juice Indicator pH Scale (color)	16	0

What goes home: Oil/water vial in snack bag, goldenrod paper in sandwich bag & pH scale

(Review safety guidelines with students: small items should always be kept away from children ages 3 and younger to avoid the risk of choking; supplies from AKA Science should not go in students' mouths, eyes, ears, or noses; don't leave the oil/water vial somewhere where it could leak; note that the design on the goldenrod paper will fade over time)

AKA SCIENCE IMPACT NW

Cool Chemistry: Fizz, pop, WOW! (Grades 4-6)

Class 7: Carbonation Craze

Supplies	#
Alka-Seltzer (tablets)	4
Bags (Ziploc, snack)	16
Baking soda (oz)	6
Balloons (9in - 1 is extra)	9
Cups (1oz, plastic)	32
Cups (1oz, plastic, calibrated)	2
Cups (2oz, plastic - from Colorful Cabbage Pack)	16
Funnels (2oz, plastic)	1
Lemon juice (oz)	7
Lids (1oz)	32
Litmus paper (blue strips - from Colorful Cabbage Pack; 4 are extra)	20
Newspaper	
Pans (9in, round, aluminum)	4
Pans (large, oval, aluminum)	2
Paper (half-sheets, white)	1
Paper towels (large rolls)	1
Pencils	16
Pipettes (1mL, plastic)	16
Pitchers with lids	1
Plates (9in, brown kraft)	8
Spoons (plastic)	2
Tape (rolls, Scotch)	2
Vials (7-dram, clear plastic, with lids)	8
Vinegar (oz)	14
Water	

Printed Materials

Worksheets: Post-Survey	16
Worksheets: Survey Answers	1

Prep (prior to class):

- **Act. 2a:** Fill eight vials slightly more than half-full of water.
- **Act. 2b:** Break four Alka-Seltzer tablets in half.
- **Act. 2c:** Prep eight balloons by gently stretching their necks (this will help them stretch over vial openings more easily; you can also stretch the round parts to help the balloons inflate).
- **Act. 2d (Optional):** Prep a piece of tape to go partway around each pair's vial.
- **Act. 2e (Optional):** If your students may struggle to break up half-pieces of Alka-Seltzer into smaller pieces and insert them into a balloon, you could do that as prep. If needed, after inserting the pieces, you could also stretch the neck of each balloon over a vial half-full of water (leave the balloon hanging down so the pieces don't fall into the water yet).
- **Act. 3a:** Use a calibrated cup to put 1/8oz of baking soda apiece in sixteen 2oz cups.
- **Act. 3b:** Use the second calibrated cup to put .25oz of lemon juice apiece in four 1oz cups.
- **Act. 3c:** Wash out a calibrated cup, then use it put .25oz of vinegar apiece in four 1oz cups.

OPTIONAL: Human Connection — Time: 1 Minute

Goal: To share important and interesting discoveries made by scientists and communities identifying as Indigenous, Black, Brown, Melanated, Latino/Hispanic, Immigrant, Asian, LGBTQIA+ and female, and to encourage students to see themselves in science. **A**ll **k**ids **a**re scientists!

Read-Aloud Narrative:

Observing nature can inspire a lifelong passion for science, whether you're watching an ant on the sidewalk, inspecting a budding flower, or staring at the clouds. Take **Katsuko Saruhashi**, for example. Born in Tokyo in 1920, young Katsuko would stare out the window for hours to watch raindrops pool on the glass. Her passion for watching raindrops developed into a drive to learn all she could about meteorology– the study of the atmosphere. Saruhashi was especially fascinated by the chemistry of weather: what molecules were kept inside of raindrops and snowflakes that we couldn't see? At the age of 21, Saruhashi left her stable job in finance to study geochemistry at the University of Toho. This was particularly daring because chemistry funding was rare in the early 1940s. Saruhashi's bravery proves she lived up to her name, which translates to "strong-minded."

Saruhashi devoted her 60-year career to studying environmental pollution in Japan caused by World War II. She conducted groundbreaking research on carbon dioxide and nuclear isotopes in water. Her most significant contribution remains "Saruhasi's Table," an equation that identifies the composition of acids in polluted water. Developing innovative methods to quantify water pollution laid the foundation for today's environmental initiatives. Saruhashi harnessed a problem she, her family, and her country faced and solved it using chemistry. Just think of all of the environmental problems we could solve today!

Activity One – Pair & Share Time: 10 Minutes

Supplies	#	Supplies	#
Pencils	16	Lab notebooks	16

Goal: To engage students' thinking and questioning related to the day's activities.

Procedure:

1. Prepare a quiet space for students to give them a physical area to think. The space can be an area set aside from the activity area, where students sit in a circle to ponder the *Pair & Share* question.
2. Make lab notebooks and pencils available.
3. Ask students a *Pair & Share* question:
    - ***What happens when something gets too full?*** *(It can overflow, burst, etc.)* ***What are some examples?*** *(Flooded riverbanks, popped bubble gum bubbles, etc.)*
4. Ask students to discuss their ideas with their neighbor before inviting students to share what they came up with. This is a "challenge by choice" opportunity and no one is required to share with the class if they are not comfortable.

Survey Connection Note: ***All* activities are linked to these survey questions:**

★ **Q.** ____________is everything around us in the form of solids, liquids, and gasses.
A. Matter

★ **Q.** What type of chemical is vinegar?
A. Acid.

★ **Q.** Fill in the blank: When you combine two or more things and they change into something new, that's called a chemical ____________.
A. Reaction.

Activity Two – Alka-Seltzer Balloons Time: 15 Minutes

Supplies	#	Supplies	#
Alka-Seltzer (tablets)	4	Paper towels (large rolls)	1
Balloons (9in - 1 is extra)	9	Pitchers with lids	1
Funnels (2oz, plastic)	1	Plates (9in, brown kraft)	8
Newspaper		Tape (rolls, Scotch)	2

Paper (half-sheets, white)	1	Vials (7-dram, clear plastic, with lids)	8
		Water	

Goal: To investigate how Alka-Seltzer reacts with water and creates carbon dioxide gas by using trapped gas to inflate a balloon stretched over a vial.

Source: *Jr. Boom Academy* by Wild Good Co., *Chemistry for Every Kid* by Janice Van Cleave & www.alkaseltzer.com/food-fun/faqs/

Background:

As a reminder, there are two types of changes in chemistry: physical and chemical. A physical change only affects the physical properties of a substance. It doesn't cause the substance to change at a molecular level. Breaking a glass is a physical change: the pieces are still made of glass–they're just smaller. Other physical changes include slicing bread, sanding wood, and crushing cans.

At the end of a chemical change – also called a chemical reaction – you get a new substance (or substances). Burning a candle is a chemical change: lighting the candle kicks off a reaction between the wax of the candle and oxygen in the air, and the reaction creates byproducts of heat, light, and smoke. It's a change at a molecular level that alters the identity of the substances involved. Other examples of chemical changes include baking a cake, letting iron rust, and digesting food.

Some common signs that a chemical reaction has occurred include: the formation of gas bubbles, a noticeable odor after the reaction has begun, the formation of a solid byproduct called a precipitate, and/or a change in color or temperature. However, it's worth noting that a change in color or temperature doesn't *always* mean a chemical reaction has occurred. (https://bit.ly/3CAFIqJ)

Procedure:

TIP:	• **If preferred, students could do this activity in 4 groups instead of pairs.**

1. Ask students: **What are some ways you can change matter?** *(Melt ice, make chemicals react, etc.)*

2. Show students a half-sheet of white paper and rip it in half.

   Discussion Prompts:
   - ***Did the paper change?*** *(Yes.)*
   - ***What type of change was it?*** *(Physical. In a physical change, the basic identity of a substance stays the same. The paper is still paper—just in smaller pieces.)*
   - ***What if we lit the paper on fire? Would that be a physical change, or would the paper turn into something new?*** *(The fire would cause the paper to burn and turn into ashes. That would be an example of a chemical reaction. The paper*

Act. 2, Alka-Seltzer Balloon. Insert the small pieces of Alka-Seltzer into the balloon.

Act. 2, Alka-Seltzer Balloon. Without letting the Alka-Seltzer drop into the vial of water, stretch the balloon over the mouth of the vial and tape it part way around the vial.

Act. 2, Alka-Seltzer Balloon. Lift the balloon up so that all the Alka-Seltzer pieces fall into the vial. Step back. Don't touch the balloon or vial until the reaction stops. Watch as the balloon fills and the water in the vial bubbles and reacts with the Alka-Seltzer.

wouldn't be paper anymore.) ***Let's explore some chemical reactions and physical changes!***

3. Pair students.

<u>**TIPS**</u>:	• **If you'd like this activity up to be more experimental,** have half the student pairs use <u>room temperature</u> water, and have the other half use <u>warm</u> (not hot) water. *The balloons on vials with warm water will inflate more & faster.* • **Students won't need the vial lids for this activity; however, you may want to keep the lids handy as an option for Activity 4: Popping Canisters.**

4. Give each pair a brown kraft plate, a vial that's slightly more than half-full of water (from Prep), a half-piece of Alka-Seltzer (from Prep), and a balloon.
5. <u>Ask students:</u> ***Can you think of a way to blow up the balloon using these supplies?***

6. <u>Have pairs</u>:
   a. Break their half-piece of Alka-Seltzer into several smaller pieces on top of the plate. *(All pieces need to slide easily inside the neck of the balloon.)*
   b. Insert their small pieces of Alka-Seltzer into their balloon.
   c. Work together to stretch the neck of the balloon over the open end of the vial, <u>without</u> letting the Alka-Seltzer pieces fall from the balloon into the vial (keep the balloon hanging down so the pieces don't fall in).

<u>**TIP**</u>:	• **Pairs may need help stretching the neck of their balloon around their vial.**

7. Give each pair a piece of tape that will go partway around the vial (or make rolls of tape available to share).
8. <u>Have pairs</u>:
   a. Put their vial on a plate with a flat surface.
   b. Tape *partway* around the neck of the balloon on the vial

<u>**TIPS**</u>:	• **When taping around the neck, lift the balloon only <u>partway up</u> or *pinch the base of the balloon closed* so the Alka-Seltzer pieces don't fall in.** • **<u>Don't</u> tape all the way round the vial,** or the tape will be hard to remove.

<u>Discussion Prompt:</u>
- ***What do you think will happen if you lift up the balloon so the Alka-Seltzer pieces fall into the vial?***

9. <u>Have pairs</u>:
   d. Lift their balloon up so all the Alka-Seltzer pieces fall into the vial. (If some pieces don't fall in easily, students may need to move/crush the pieces through the balloon to get them to slide into the vial.)

e. Step back. Don't touch the balloon or vial until the reaction stops.
f. Observe what happens. (Pay attention to both the vial and the balloon.)

Discussion Prompts:

- ***What happened?*** *(The Alka-Seltzer bubbled in the water, and the balloon filled with gas!)*
- ***Was this a physical or chemical change?*** *(Both! Two things happened. The Alka-Seltzer and water reacted with each other to make something new: bubbling carbon dioxide gas. That was a chemical reaction. Because of that reaction, carbon dioxide gas rose up and started to fill the balloon. The stretching of the balloon material was a physical change.)*
- ***Why do you think Alka-Seltzer reacts chemically in water?*** *(An Alka-Seltzer tablet contains several ingredients, including citric acid, which is an acid, and baking soda, which is a base. In tablet form, the acid and base don't react with each other. However, when the tablet dissolves in water, the acid and base react and create carbon dioxide gas.)*
- ***Did you know baking powder works the same way?*** *(Baking powder contains an acid, a base, and a filler. When it dissolves in water, the acid (cream of tartar) reacts with the base (baking soda) to make carbon dioxide bubbles. The bubbles help cakes and muffins rise!)*

10. If desired, you can save the vials for Activity 4. If so, remove the balloons from the vials away from your face (since the balloons can pop), and wash out the vials.

Activity Three – Foaming CO_2 Time: 10 Minutes

Supplies	#	Supplies	#
Cups (1oz, plastic)	8	Litmus paper (blue strips - from Colorful Cabbage Pack; 4 are extra)	20
Cups (1oz, plastic, calibrated)	2	Newspaper	
Cups (2oz, plastic - from Colorful Cabbage Pack)	16	Pans (9in, round, aluminum)	4
Baking soda (oz)	2	Paper towels (large rolls)	1
Lemon juice (oz)	7	Spoons (plastic)	1
		Vinegar (oz)	8

Goal: To explore two chemical reactions that produce carbon dioxide (vinegar/baking soda & lemon juice/baking soda) & observe how adding more acid makes them overflow.

Source: AKA Science

Background:

Acids release hydrogen ions (H^+), and bases release hydroxide ions (OH^-). The presence of these ions is what the pH scale actually measures. Acids and bases easily give up their ions, which makes acids and bases highly reactive. When acids and bases combine, they react to produce water and a salt—and usually a gas. The reaction can be explosive if strong acids and bases are used!

When you mix baking soda (a base) with vinegar/lemon juice (acid), they continue to foam up if there is some acid or base present that hadn't already reacted. Acids and bases react by neutralizing each other. If the quantities of the acid and base are fully balanced, the final product is a neutral mix of water, salt, and usually gas, with no remaining acid or base left to react.

When baking soda reacts with vinegar, there are 3 products: water, sodium acetate (a type of salt), and carbon dioxide gas. The larger the quantities of baking soda and vinegar that are mixed together, the more gas gets produced. The biggest mix ever made was in England. They used 3,382 ounces of vinegar and baking soda each—and the foam went 328 feet into the air! (https://bit.ly/3cqUENC)

Survey Connection:

★ Q. What type of chemical is vinegar?
A. Acid.

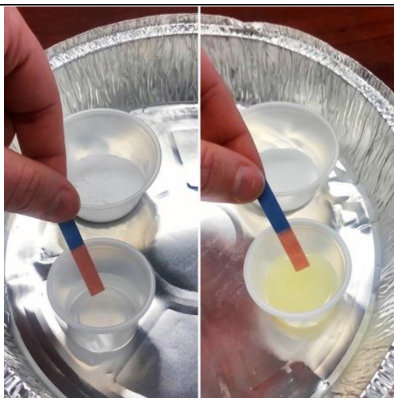
Procedure:

1. Ask students:
   - ***What are some chemical reactions you've seen that fizz and release gas?*** *(Vinegar reacts with baking soda, baking powder, and chalk. Alka-Seltzer reacts in water.*
   - ***How do different types and amounts of acid affect how much fizz there is? Let's find out!***

2. Put students in 4 groups.
3. Give each group a 9oz pan. In each group's pan, put two 2oz cups that each contain 1/8oz of baking soda (from Prep).
4. Have students spread the two cups apart from each other in the pan.
5. Give each group a 1oz cup with .25oz of vinegar (from Prep), a 1oz cup with .25oz of lemon juice (from Prep), and two pieces of litmus paper.
6. Ask students: ***Do you think lemon juice is an acid, a base, or neutral? How could we test it?*** *(With an acid-base indicator. In this case, we'll use blue litmus paper.)*

7. Have groups:
   a. Use the pieces of litmus paper to test the lemon juice and vinegar.
   b. Put each piece of litmus paper on the plate next to its corresponding cup.

Act. 3, Foaming CO_2. Provide a 9in pan with two, 2oz cups with 1/8oz of baking soda. Spread the cups apart in the pan.



Act. 3, Foaming CO_2. Provide the 1oz cups with vinegar and lemon juice in them and two pieces of litmus paper. Use the litmus paper to test the vinegar (left) and the lemon juice (right). Notice they both turn pink, demonstrating the liquids are acids. Save the litmus paper.

Act. 3, Foaming CO_2. Pour the .25oz of vinegar (right) into one cup of baking soda. Pour the .25oz of lemon juice into the other cup (right). Notice that both reactions bubble and fizz.

Discussion Prompts:

- ***What happened?*** *(Both litmus papers turned pink.)*
- ***Why did that happen?*** *(Both liquids are acids.)*
- ***What happens when you add vinegar to baking soda?*** *(It reacts and makes bubbles of carbon dioxide gas.)*
- ***How do you think the vinegar/baking soda reaction will compare with a lemon juice/baking soda reaction? Let's find out!***

8. In each group, have the first student pour the vinegar into one of the 2oz cups of baking soda. Observe what happens.
9. Have the next student pour the lemon juice into the other 2oz cup of baking soda. Observe what happens.

Discussion Prompts:

- ***What happened?*** *(Both reactions bubbled and fizzed.)*
- ***Why did that happen?*** *(Both liquids are acidic, so they reacted with the baking soda base.)*

10. Explain to students:
    - ***In a chemical reaction, the things you mix together are called reactants. What were the reactants we just used?*** *(Vinegar/baking soda and lemon juice/baking soda.)*
    - ***When reactants are combined and they chemically change into something new, that "something new" is called a product. What was a product you could see from the reactions you just made?*** *(Bubbling carbon dioxide gas.)*
    - ***Now that the reactions between acids and bases occurred, do you think the leftover liquid is acidic, basic, or neutral? Let's find out!***
11. Give each group two more pieces of litmus paper.
12. Have groups:
    a. Predict how the reacted liquids will affect the litmus paper.
    b. Use the pieces of litmus paper to test each liquid.
    c. Compare the litmus results to the earlier tests of vinegar and lemon juice.

TIPS:
- **If preferred, you could skip this follow-up test with the litmus paper if you think students would find it confusing.**
- **There's an extra piece of litmus paper per group if a retest is needed.**

Discussion Prompts:

- ***What happened?*** *(The litmus paper stayed blue!)*
- ***What does that mean?*** *(The reacted liquids aren't acidic. However, we don't know if they're basic or neutral, since blue litmus paper stays blue either way.)*

Act. 3, Foaming CO_2. Use the two new pieces of litmus paper and test each of the reacted liquids. Compare these pieces to the first round of litmus paper. Notice the paper stays blue this time, so the liquids are neutral or basic. Add .25-.5oz more vinegar and lemon juice to determine which one it is—they're still basic.

Act. 2, Foaming CO_2. Provide two new 2oz cups of baking soda and repeat the experiment with a full ounce of both vinegar and lemon juice. Compare this reaction to first two and notice that this one is much larger than both of the previous ones.

13. <u>Ask students:</u> ***How can we test whether the liquids are basic or neutral?*** *(We could use a different pH indicator, like cabbage juice. If we don't have any cabbage juice, though, we can add more acid to the liquids! If the acid causes a reaction, it will tell us that the liquids were still basic. If a reaction happens, it will mean the liquids contained some baking soda that didn't fully react and get used up the first time.)*

14. Refill each group's vinegar and lemon juice cups <u>a little less than half-full</u>.
15. Have the next student pour the vinegar into the baking soda/vinegar liquid. Observe what happens.
16. Have the next student in each group pour the lemon juice into the baking soda/lemon juice liquid. Observe what happens.

<u>Discussion Prompts:</u>

- ***What happened?*** *(Both liquids bubbled and fizzed again.)*
- ***Did they react more or less than the first round?*** *(Less.)*
- ***What does that mean?*** *(The liquids were basic, but they had less baking soda remaining for the acids to react with than the first round.)*
- ***Now that we know there was still unreacted base leftover, what if we add more acid from the start?***

17. Have students push the original 2oz cups to one side of the pan.
18. Put two more 2oz cups with 1/8oz of baking soda (from Prep) in each group's 9oz pan (so there are four cups total in the pan).
19. Refill each group's vinegar and lemon juice cups <u>all the way full</u>.
20. In each group, have the first student pour the full cup of vinegar into one of the 2oz cups of baking soda. Observe what happens.
21. Have the next student pour the full cup of lemon juice into the other 2oz cup of baking soda. Observe what happens.

<u>Discussion Prompts:</u>

- ***What happened?*** *(Both reactions were bigger and overflowed! Both reactions also lasted longer.)*
- ***What does that mean?*** *(Using more acid caused more of the base to react, which produced more carbon dioxide gas. Changing the reactants affected the products!)*

22. Keep the 1oz cups handy for the next activity.

Activity Four – Popping Canisters Time: 20 Minutes

Supplies	#	Supplies	#
Alka-Seltzer (tablets - from earlier activity)	any leftover	Pans (large, oval, aluminum)	2
Bags (Ziploc, snack)	16	Paper towels (large rolls)	1
Baking soda (oz)	4	Pipettes (1mL, plastic)	16

Cups (1oz, plastic - 8 are from previous activity)	32	Pitchers with lids	1
Lemon juice (oz - from previous activity)	any leftover	Spoons (plastic - 1 is from previous activity prep)	2
Lids (1oz)	32	Vials (7-dram, clear plastic, with lids - from earlier activity)	8
Newspaper		Vinegar (oz)	6

Goal: To explore how the carbon dioxide gas produced by the chemical reaction of vinegar with baking soda can build up enough pressure to make a 1oz cup pop into the air.

Source: https://bit.ly/3ASKPBC

Background:
If you've ever shaken a can of soda before, the soda probably exploded out when you opened the can. That's because shaking the can released the carbon dioxide gas from the soda, and the gas built up inside the can. When you opened it, you released the gas all at once! The same thing happened with the popping canister. The baking soda (base) and vinegar (acid) reacted to produce water and carbon dioxide gas. That gas built up more and more until the lid of the cup couldn't hold it in anymore. Then it popped the lid off the cup—which sent gas and liquid whooshing out and lifted the cup into the air! (https://bit.ly/3RvMXon)

Survey Connection:

Q. What type of chemical is vinegar?
A. Acid.

Procedure:

TIPS:
- **If possible, it's ideal to do this activity outside.** If you can't go outside, choose an area where students can stand back from the experiment and put newspapers and/or the tablecloth on the floor.
- **Depending on your group of kids, consider whether to do this activity as a demo for the whole class, or whether to have students take turns participating directly.** If you want students to participate, but they would struggle to flip the cups, one option is to put students in pairs and have each pair decide what ratio of ingredients they want you to try (and/or have them prepare the ingredients) before you flip the cup.

1. Ask students: ***In the last activity, the baking soda/vinegar reaction created bubbles that foamed up out the cup. What do you think would happen if the cup had a lid on it? Let's find out!***

2. Set the large oval pan on the ground.
3. Have students stand back from the pan (they can spread out in a semi-circle).

Act. 4, Popping Canisters. Set the large, oval pan on the ground. Put the 1oz lid with baking soda upside down, so that the center full of baking soda is facing up. Place the 1oz cup quarter full of vinegar next to the lid.

Act. 4, Popping Canisters. Hook the edge of the lid onto the rim of the cup. Flip the lid into place securely on the cup, then flip the whole cup upside-down inside the pan, and stand back. Watch as it explodes upward and pops.

4. Put a 1oz lid upside-down in front of you, with the flat part down.
5. Put a small amount of baking soda in the center of the lid. (It works well to put some baking soda on the tip of a spoon and fill the inner circle of the lid.)
6. Fill a 1oz cup about a quarter-full of vinegar (you can pour or use a pipette).
7. With a quick, smooth motion:
    a. Hook the edge of the lid onto the rim of the cup (you can angle the cup toward the lid briefly if it's helpful).
    b. Flip the lid into place *securely* on the cup, so the baking soda falls into the cup and the lid snaps on tightly.
    c. Flip the whole cup upside-down inside the pan and **stand back**.

TIPS:
- **It can take some practice to get the lid on the cup quickly and securely.** Using an empty cup, you (and/or students) may want to practice the motion of quickly putting the lid on the cup and flipping the whole cup upside-down. Be patient and encourage your students to be patient!
- **Avoid smashing the lid onto the cup.** The motion is quick, but not forceful.

Discussion Prompts:
- ***What happened?*** *(If you were able to snap the lid on securely, the cup flew up into the air and made a popping sound.)*
- ***Why?*** *(The chemical reaction between baking soda and vinegar produced carbon dioxide gas. The pressure of the gas built up inside the cup as the reaction took place, until it forced the lid off the cup and popped the cup into the air.)*

8. Have students take turns trying the activity or repeat the demo but get students involved in selecting and/or preparing ingredients.
9. If time allows, you can try using a vial instead of the 1oz cup. (Definitely stand back—and have the kids stand back—for that.) It's OK to use up most of your remaining vinegar (just save 2oz for Class 8). If you have leftover Alka-Seltzer and/or lemon juice, feel free to experiment and use those up. You can also try different ingredient ratios to see what makes the best and/or highest pop.
10. Give each student a dry pipette and a 1oz cup/lid in a snack bag to take home.

Activity Five – Daily Debrief — Time: 5 Minutes

Supplies	#	Supplies	#
Pencils	16	Worksheets: Survey Answers	1

Worksheets: Post-Survey	16		

Suggested Reading: *Burn: Michael Faraday's Candle* by Darcy Pattison.

Goal: To gauge how students' attitudes and knowledge about science have changed.

Procedure:
1. Ask the following question: ***What is chemistry?*** *(The study of matter—all the "stuff" in the universe—and how it changes and interacts with energy.)*
2. Take a few minutes to review what students have learned about chemistry.
3. Give each student a **Post-Survey** worksheet and a pencil.
4. Read each survey question aloud and allow students a few seconds to think.
5. Have students write their answers on the worksheet.
6. Review the correct answers with students.
7. **REMEMBER TO SAVE STUDENTS' SURVEYS TO GIVE TO YOUR SITE COORDINATOR/ MANAGER.**

Clean up: Make sure students help clean the room before they leave.

What to save:

Materials used	#	SAVE	Materials used	#	SAVE
Alka-Seltzer (tablets)	4	0	Pans (large, oval, aluminum)	2	2
Bags (Ziploc, snack)	16	0	Paper (half-sheets, white)	1	0
Baking soda (oz)	6	0	Paper towels (large rolls)	1	1
Balloons (9in - 1 is extra)	9	0	Pencils	16	16
Cups (1oz, plastic)	32	0	Pipettes (1mL, plastic)	16	0
Cups (1oz, plastic, calibrated)	2	2	Pitchers with lids	1	1
Cups (2oz, plastic)	16	0	Plates (9in, brown kraft)	8	8
Funnels (2oz, plastic)	1	1	Spoons (plastic)	2	2
Lemon juice (oz)	7	0	Tape (rolls, Scotch)	2	2
Lids (1oz)	32	0	Vials (7-dram, clear plastic, with lids)	8	0
Litmus paper (blue strips - from Colorful Cabbage Pack; 4 are extra)	20	0	Vinegar (oz)	14	0
Newspaper			Water		
Pans (9in, round, aluminum)	4	4	Worksheets: Post-Survey	16	16
			Worksheets: Survey Answers	1	1

What goes home: Dry pipette & empty/dry 1oz cup with lid (both in Ziplock snack bag)

Remember to administer your Post-Surveys then give completed surveys to your site supervisor!

(Tell students to always get adult help if they'd like to try an experiment at home.)

REMINDER: If any students were absent today, please have them do the Post-Survey at the last class.

Cool Chemistry: Fizz, pop, WOW! (Grades 4-6)

Class 8: Bubbles & Goop

Supplies	#
Baking soda (oz)	0.5
Bowls (20oz, sturdy paper)	4
Bubble solution (16oz bottles)	1
Bubble solution (mini bottles, neon)	16
Bubble Mania Packs (16 two-foot pieces of string, 16 neon pipe cleaners, 2 two-foot pieces of yarn, 2 four-foot pieces of yarn & 1 forty-foot ball of yarn)	1
Chopsticks (pairs, round)	16
Cups (1oz, plastic)	4
Cups (1oz, plastic, calibrated)	2
Cups (3oz, paper, Dixie)	4
Cups (9oz, plastic, punch)	1
Dish soap (20oz bottles, liquid)	1
Eye contact solution (4oz bottles)	1
Gloves (extra pairs - vinyl, disposable, multiple sizes)	6 + any left in kit
Glue (4oz bottles, Elmer's Washable School Glue)	4
Newspaper	
Pans (9in, round, aluminum)	4
Pans (large, oval, aluminum)	2
Paper clips (sets of 50, regular size)	4
Paper towels (large rolls)	1
Pencils	16
Pepper (packets)	32
Pitchers with lids	1
Plates (9in, brown kraft)	20
Popsicle sticks (jumbo)	4
Scissors (site provides)	16
Sticks (approx. 2ft, bamboo)	4
Straws (half-pieces, drinking)	48
Vinegar (oz)	2
Water	

Worksheets:

See next page.

Prep (prior to class):

- **Act. 2:** Fill the pitcher at least half-full of water.
- **Act. 3:** Use a calibrated cup to put .5tsp of baking soda apiece in four 1oz cups. (Alternately, if you want students to play with flubber but not make it, you could make four portions of flubber right before class and put each portion in a sealed container – see activity instructions. If you do this, change the activity order and do the flubber activity first.)
- **Act. 4 (Optional):** If desired, create two large bubble wands as prep (see activity instructions).

OPTIONAL: Human Connection — Time: 1 Minute

Goal: To share important and interesting discoveries made by scientists and communities identifying as Indigenous, Black, Brown, Melanated, Latino/Hispanic, Immigrant, Asian, LGBTQIA+ and female, and to encourage students to see themselves in science. **A**ll **k**ids **a**re scientists!

Read-Aloud Narrative:

Oswaldo Luiz Alves was one of the first scientists to develop, research, and teach nanotechnology. Nanotechnology is a cutting-edge scientific field that combines microscopic robots with chemistry to improve our daily lives. Alves was born in São Paulo, Brazil, and was drawn to chemistry during after-school science classes, like AKA Science! In high school, Alves took college-level chemistry courses on a state fellowship. He finished his bachelor's in industrial chemistry in 1973 at a public university. While working in France, Alves said he got "infected" with a love for nanotechnology. Alves brought this love back to Brazil, where he established a chemistry laboratory. Here, Alves figured out how to reliably arrange carbon atoms into cylinders called "nanotubes." As a result, scientists have used nanotubes to weave indestructible fabrics, absorb atmospheric pollution, and strengthen bone development.

By combining his chemical training with his ingenuity, Alves helped establish the field of nanotechnology. Who knows what the area Alves launched will bring to humanity in the coming years? If you were a chemist studying nanotechnology, what would you build to help the world?

Activity One – Pair & Share — Time: 10 Minutes

Supplies	#	Supplies	#
Pencils	16	Lab notebooks	16
Post-Surveys	Any left		

Goal: To engage students' thinking and questioning related to the day's activities.

Procedure:

Worksheets: Post-Survey (for any students who haven't already done it)	any left

1. Prepare a quiet space for students to give them a physical area to think. The space can be an area set aside from the activity area, where students sit in a circle to ponder the *Pair & Share* question.
2. Make lab notebooks and pencils available.
3. Ask students a *Pair & Share* question:
   - ***Can you think of any types of matter that are surprisingly stretchy?*** *(Pizza dough, melted mozzarella cheese, bubble gum, taffy, rubber bands, balloons, elastic, etc.)*
4. Ask students to discuss their ideas with their neighbor before inviting students to share what they came up with. This is a "challenge by choice" opportunity and no one is required to share with the class if they are not comfortable.
5. **Have any students who haven't already completed the Post-Survey do so while you prep and/or begin the next lesson.**

Survey Connection Note: *All* activities are linked to this survey question:

★

Q. _____________is everything around us in the form of solids, liquids, and gasses.
A. Matter

Activity Two – Serious Surface Tension   Time: 10 Minutes

Supplies	#	Supplies	#
Cups (3oz, paper, Dixie)	4	Paper towels (large rolls)	4
Cups (9oz, plastic, punch)	1	Pepper (packets)	32
Dish soap (20oz bottles, liquid)	1	Pitchers with lids	1
Newspaper		Plates (9in, brown kraft)	20
Paper clips (sets of 50, regular size)	1	Water	

Goal: To explore surface tension by dropping paper clips into a full cup of water and making pepper scatter away from soap.

Source: Oregon Health Career Center & https://bit.ly/3PNpdus

Background:

A single drop of water is made up of billions of tiny, tiny little water molecules! Water molecules are special because they act like super-small magnets. A water molecule has both a positive and negative end. That means the little water molecules like to stick to each other (cohesion), and also stick to other things that have positive and negative ends (adhesion). (https://on.doi.gov/3RaDvXd)

Surface tension is a force created by the cohesion between the water molecules. The water molecules like each other so much that they stick together and form a hump rather than spread out. You saw surface tension in action when you added paper clips to a full cup of water. Instead of

Act. 2, Serious Surface Tension. Add one paperclip at a time to the Dixie cup very full of water. Notice how the "bubble" (curved dome of water) caused by surface tension rises higher about the rim of the cup as more paperclips are added. (This can be done on a plate or in a pan as pictured here.)

spilling over, the water molecules stuck together and formed a dome above the rim of the cup!

You also saw surface tension in action with the floating pepper flakes. Before something can sink in water, it has to break through the layer of surface tension. That's really easy for heavy objects, but light objects like pepper flakes tend to float on top instead of breaking through and sinking.

Adding soap changes the story! A soap molecule has one end that's attracted to water (hydrophilic), and another end that's *not* attracted to water (hydrophobic). The hydrophobic end tries to move away from the water. The only way it can go is up. As the soap spreads in the water, the hydrophobic ends of the soap molecules point up and out of the water, breaking the water's surface tension. As the soap molecules move, the water is pushed away, carrying the pepper flakes with it. (https://bit.ly/3e0HqHz)

Procedure:

TIP:	• **If preferred to help contain spills, groups could do this activity in a 9in pan instead of on a brown kraft plate.**

1. Ask students: ***What are some properties of water?*** *(It's colorless, see-through, liquid at room temperature, runny, can be turned into ice or steam, refreshing to drink!)* ***Let's explore some other properties of water!***

2. Put students in groups of 4.
3. Give each group a brown kraft plate, a 3oz paper cup, and a set of 50 paper clips.
4. Have each group set their paper cup in the middle of the plate.
5. Fill each group's cup to the brim with water. (Avoid getting water on the rim.)
6. Ask students: ***How many paper clips could fit in this very full cup before the water would overflow?***

7. Have students make a hypothesis.
8. Tell students: ***Let's have a contest! How many paper clips can your group put in the cup without making the water spill out?***

9. Have groups:
    a. Carefully add one paper clip at a time and keep track of how many have gone in (see photo).
    b. Observe the cup of water during the activity to notice any changes.

TIP:	• **Make sure students don't bump the desk during the activity.**

Discussion Prompts:

- ***What happened?*** *(A lot of paper clips went in! If students were careful, they might have been able to add all 50 paper clips without making the water overflow.)*
- ***Did you notice anything that changed during the activity?*** *(The "bubble" or curved dome of water above the rim of the cup stretched and rose even higher as more paper clips were added.)*
- ***Why do you think so many paper clips went in? And what does it have to do with that dome on top?*** *(Water molecules love to stick to each other. Scientists call this property <u>cohesion</u>. The cohesion of the water molecules creates a strong force on the surface of water called <u>surface tension</u>. Surface tension is what creates that dome, like a "skin" on top of the water that holds the water together. 50 paper clips don't take up much total space. You would need to add an even larger total volume of paper clips—or add them with more force—to overcome the surface tension and displace the water, i.e., push it out of the cup.)*

10. If time allows, students can investigate whether adding a large number of paper clips to the cup *at once* affects the outcome of the experiment. (It shouldn't.) Groups can also pool their paper clips together to try to reach the spilling point.
11. Empty the water from the cups (you can pour the water back into the pitcher—use your fingers as a strainer so the paper clips don't go in the pitcher). Leave a shared brown kraft plate for each group.
12. <u>Tell students:</u> ***Let's keep exploring surface tension!***

<u>TIP</u>:	**If preferred, you could do the next part of this activity outside.** (If you don't want to make two trips outside with students, you can bring these materials with you when you go outside for Activity 4: Bubble Mania.)

13. Keep students in groups.
14. Give each student a brown kraft plate and two packets of pepper.
15. Walk around with the pitcher and a 9oz cup and add a half-full cup of water to each student's plate (it will cover the bottom of plate but not overflow).
16. Have students sprinkle their two packets of pepper in the center of their plate. (Have them add the pepper close to the surface of the water.)

<u>Discussion Prompts:</u>

- ***What do you notice about the pepper flakes?*** *(They're spread across the surface of the water, mostly floating on top.)*
- ***Why do you think they're floating?*** *(A combination of reasons: surface tension, it's less dense than water, pepper is hydrophobic)*

Act. 2, Serious Surface Tension. Provide a Styrofoam plate and two packets of pepper. Pour the water into the Styrofoam plate. Add the two packets of pepper to the water. Notice how the pepper moves.

Act. 2, Serious Surface Tension. Walk around with the soap and put a squeeze of soap onto the shared Styrofoam plate.

Act. 2, Serious Surface Tension. Touch the soap with the index finger so there is a small amount of soap on the fingertip. Touch the fingertip to the center of the water on the plate and observe as all the pepper rushes to the edges and sank down off of the surface.

17. Walk around with the bottle of soap and put a squeeze of soap on the rim of each group's shared brown kraft plate.
18. One at a time, have each student in the group:
    a. Touch the soap with their index finger so they get a small amount of soap on their fingertip.
    b. Use their soapy fingertip to touch the center of the water on their plate.
    c. Observe what happens.

Discussion Prompts:

- ***What happened?*** *(The pepper flakes shot out to the sides of the plate! Also, it may or may not be possible to see that more of the flakes sank.)*
- ***Why do you think that happened?*** *(The soap lowered the surface tension of the water. Without as much surface tension, the "dome" of the water flattened out. As it spread out, it carried the pepper flakes with it away from the soap and out to the sides of the plate. Also, the soap attached to some of the pepper flakes, similar to what happened with the food coloring experiment in "Milk Motion.")*

19. Walk around with the pitcher and have students carefully pour the water from their brown kraft plate back into the pitcher.
20. Have students use paper towels to dry off their paper plate (and remove any clinging pepper flakes) to reuse the plates for the next activity.

Activity Three – Fantastic Flubber Time: 20 Minutes

Supplies	#	Supplies	#
Baking soda (oz)	0.5	Glue (4oz bottles, Elmer's Washable School Glue)	4
Bowls (20oz, sturdy paper)	4	Newspaper	
Cups (1oz, plastic, calibrated)	2	Paper towels (large rolls)	1
Cups (1oz, plastic)	4	Plates (9in, brown kraft - from previous activity)	16
Eye contact solution (4oz bottles)	1	Popsicle sticks (jumbo)	4
Gloves (extra pairs - vinyl, disposable, multiple sizes)	6 + any left in kit	Vinegar (oz)	2

Goal: Explore properties of a stretchy polymer (flubber) made from glue.

Source: https://bit.ly/3wyOvFO

Background:

The stretchy flubber you made is a polymer. A polymer is a substance made from long chains of repeating molecules all linked together. Unlike the Instant Snow and Fortune Teller Fish polymers you explored on first day of class, flubber does not absorb water. You made flubber by taking glue (which contains polymer chains in a liquid state) and adding contact solution.

The borate ions in the contact solution linked the glue polymer chains together. These woven-together polymer chains had a harder time sliding past each other (though they still had room to move). The resulting substance—flubber—is a different type of polymer!

Flubber is considered a non-Newtonian fluid. That means it's actually a fluid that flows at a different rate depending on how much force or pressure is applied to it. Another common example of a non-Newtonian fluid is Ooblek. The more pressure is put on it, the more it acts like a solid. (Newtonian fluids, on the other hand—like water—have a consistent viscosity.) Flubber has some pretty unique properties—and as you've learned in this class, identifying properties helps us understand the wild world of matter! (https://bit.ly/3Ar30Nh)

Survey Connection:

★

Q. When you combine two or more things and they change into something new, that's called a chemical ____________.

A. Reaction.

Act. 3, Fantastic Flubber. Provide a paper bowl and a 4oz bottle of glue.

Act. 3, Fantastic Flubber. Empty the bottle of glue into the bowl. Provide a 1oz cup with baking soda and a jumbo popsicle stick. Add the baking soda to the glue and stir with the popsicle stick.

Procedure:

1. Ask students:
   - ***Do you remember some properties of the polymers you've explored, like Instant Snow and Fortune Teller Fish?*** *(Instant Snow and Fortune Teller Fish were both solids, and they both absorbed lots of water.) Glue is also made of polymer chains—but glue is a liquid, and it's non-absorbent.*
   - ***Do you think we could combine glue with something else to make a new polymer? Let's try!***
2. Put students in 4 groups.
3. If any students have skin sensitivities or irritations on their hands (cuts, scrapes, etc.), have them wear gloves. (If preferred, you can have all students wear gloves.)
4. Give each group a paper bowl and a 4oz bottle of glue.
5. Have the first student empty the glue into the paper bowl.
6. Give each group a 1oz cup with .5tsp of baking soda (from Prep) and a jumbo popsicle stick.
7. Have the next student add the baking soda to the glue and stir.
8. Walk around to each group with the eye contact solution. For each group, fill a calibrated cup to the unmarked line between 1/4oz and 1/2oz (this line = 3/8oz).

TIP:
- **Although the consistency of flubber in this activity should work for any grade level, if you want to minimize stickiness/sliminess/mess** (i.e., have flubber that's more solid/stiff before students start playing with it), use a full 1/2oz of contact solution in each group's bowl instead of 3/8oz.

Act. 3, Fantastic Flubber. Pour the contact solution into the bowl. Stir the bowl until it starts to ball up and form a glob (within about 5 stirs). Let the mixture sit for about 60 seconds without stirring. Then, resume stirring until the mix only sticks to each other and not the bowl—you have flubber!

Act. 3, Fantastic Flubber. When ready the flubber will not stick to the bowl anymore. Take turns playing with the flubber. Start by rolling it in the hands to help it not stick to the skin.

9. Carefully pour the contact solution into each group's bowl.
10. Have the next student in the group gently stir the contents of the bowl, then stop as soon as it starts to ball up and form a glob.

TIP:
- **The glue will stick to the sides of the bowl at first but keep mixing the contact solution into the glue.**
- **Stop stirring once a glob forms.** (This happens within about 5 stirs.)

11. Have groups observe their newly formed glob for about 60 seconds without stirring *(this is important to let the glob to gel & makes it much easier to handle)*.
12. Have the next student continue to stir the mixture until the contents of the bowl all stick to each other and stop sticking to the bowl—this is flubber.

Discussion Prompt:
- ***What is this?*** *(Flubber/slime, also called "polymer putty.")* ***Let's explore its properties!***

13. Give each student a brown kraft plate to use as a play surface.
14. In each group, have students:
    a. Take turns rolling the flubber into a ball between their hands. This helps the flubber not stick to their fingers.
    b. Play with the flubber as a group.
    c. Divide the flubber so each student gets a piece.

15. Allow time for students to explore the properties of their piece of flubber.

Discussion Prompts:
- ***What happens when your flubber is stretched?***
- ***What else can it do?***
- ***What happens to flubber over time as you play with it?*** *(It gets stiffer and harder to stretch.)*

TIP:
- **If needed, vinegar dissolves flubber from clothes, hair, carpet, furniture, etc.** (For clothes, another option is to soak the affected area with dish soap and then gently rub the fabric together to remove the flubber.)
- **If you don't end up needing your remaining vinegar to dissolve stuck-on flubber, you could put some flubber in a bowl, add vinegar, and stir to see how the flubber dissolves.** Additionally, as a demo for comparison, you could put some flubber in a different bowl, add more contact solution, and stir to see how it makes the flubber even stiffer.

16. At the end of the activity, discard the flubber in a trash can with a liner. *(Don't send flubber home with students.)*
17. Have any students who are wearing gloves remove them.
18. **Have *all* students wash their hands thoroughly**.

Activity Four – Bubble Mania Time: 20 Minutes

Supplies	#	Supplies	#
Bubble Mania Packs (16 two-foot pieces of string, 16 neon pipe cleaners, 2 two-foot pieces of yarn, 2 four-foot pieces of yarn & 1 forty-foot ball of yarn)	1	Pans (large, oval, aluminum)	2
Bubble solution (32oz bottles)	1	Paper towels (large rolls)	1
Bubble solution (mini bottles, neon)	16	Scissors (site provides)	16
Chopsticks (pairs, round)	16	Sticks (approx. 2ft, bamboo)	4
Pans (9in, round, aluminum)	4	Straws (half-pieces, drinking)	48

Goal: Learn about bubbles by exploring different ways to make them.

Source: *Chemistry Experiments* by Louise V. Loeschnig

Background:

Previously, we learned that water has surface tension. That means the water molecules like to stick together. Bubble solution is mostly water, but it also has soap and other chemicals added to it. Soap is made up of tiny molecules with a very special property. Half of each soap molecule likes water (hydrophilic) and the other half of the molecule doesn't like water (hydrophobic). These molecules interact with the water molecules and decrease the surface tension of the water, allowing the water to spread out.

When you blow air into the bubble solution, you create a sphere with three layers. From the outside in, you have a layer of soap, a layer of water and another layer of soap. The soap layers trap the water layer in between them, with the parts of the soap molecules that *like* water facing in, and the parts of the soap molecules that *dislike* water facing out.

Bubbles are always spheres. Spheres form naturally because they're the shape that lets the molecules stay in contact the most. Did you notice that the dome above the rim of the paper clip cup also formed a half-sphere? A sphere allows the molecules to stick together the most – and since water molecules love to stick together, bubbles will always form spheres! In fact, water will always form spheres! Drops of water are spheres, air bubbles blown underwater form spheres, rain beads up on surfaces as spheres, etc. (https://bit.ly/3wyVY85)

Procedure:

TIP:	• **This activity needs to be done outside.** You may need to adjust the timing of the activity to coincide with good weather. (It shouldn't be raining or windy, though slight humidity is A-OK and actually a bonus.)

1. Ask students:
   - ***Have you ever played with bubbles?***
   - ***What are bubbles?*** *(A solution of water, soap, and sometimes other ingredients.)*

- ***What shape are bubbles?*** *(Round/spheres.)*
- ***Could you make bubbles in a different shape? Let's try!***

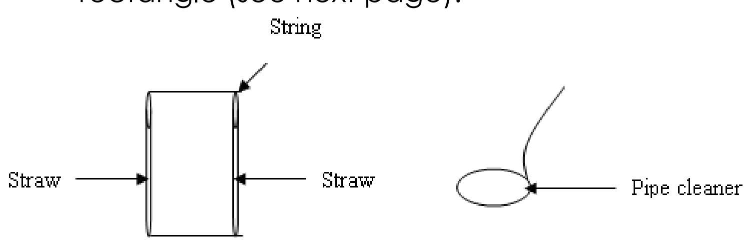
2. Take students outside. Have students help you carry the supplies for this activity.
3. Put students in 4 groups.
4. Give each group twelve half-straw pieces, four pairs of chopsticks, four pipe cleaners, four pieces of string, and a 9in pan filled partway with bubble solution.
5. Make scissors and the 40ft ball of yarn available to share.
6. Ask students: ***Can you blow bubbles using a half-piece of straw?***

7. Have students:
   a. Dip one end of a half-piece of straw in the bubble solution.
   b. Remove the straw, then blow through the other end to try to blow a bubble in the air. (Make sure students don't drink the bubble solution.)

Discussion Prompts:

- ***What shape are the bubbles?*** *(Spheres.)*
- ***What size are they?*** *(Small.)*
- ***Can you make a bubble wand that makes them a different shape or size?***

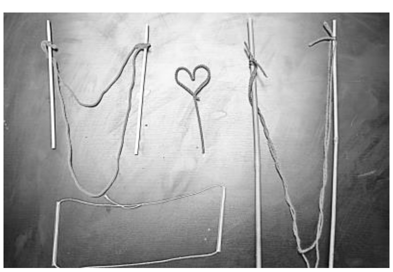
8. Have students work in groups to create their own bubble wands.
9. Encourage students to use their imagination! *This is a chance to explore freely.*
10. Ideas: use a pipe cleaner to make a flat shape with a handle; thread string through 2 straw pieces & tie the ends together to form a rectangle (see next page).



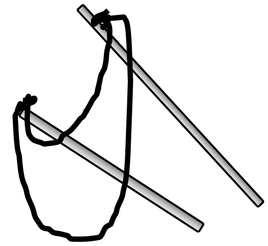
Discussion Prompts:

- ***Were you able to make bubbles that were a different size or shape?*** *(Various methods made bigger bubbles. However, all the bubbles ended up becoming spheres, even when the bubble wand was something other than a circle. Soap bubbles always form spheres! A sphere is the best shape for bubble molecules to stay in contact.)*
- ***Have you ever made giant bubbles? Let's try!***

Bubble Mania. Lift the sticks out of the bubble solution, then slowly and gently spread them apart from each other so that the loop of yarn opens up between them. Move forward or backwards to allow a bubble to emerge, then gently bring the sticks back together to close off the bubble. *(Your sticks are shorter than the ones shown here, but the process is the same.)*



Bubble Mania. If desired, students can create a smaller version of the jumbo wand (upper left corner), in addition to the other types of wand options.



11. To make a jumbo bubble wand, tie one end of a 2ft piece of yarn near the top of one of the bamboo sticks. Tie the other end of yarn near the top of the other stick.
12. Tie the 4ft piece of yarn directly below the 2ft piece on both sticks. (See diagram at right.)
13. Hold both sticks in one hand.
14. Starting with one stick, grasp both pieces of yarn near the place where they're tied to the stick. Hold the pieces of yarn together, bring them toward you, then loop them around the outside of the stick to the back.
15. Repeat for the other stick. You should have a loop of yarn in between the sticks.
16. Place the tops of the sticks in the bubble solution. Move them around to fully saturate the yarn.
17. Lift the sticks out of the bubble solution.
18. Slowly and gently, spread the sticks apart from each other so that the loop of yarn opens up between them (see top photo).
19. Move forward or backwards to allow a bubble to emerge, then gently bring the sticks back together to close off the bubble. (It takes some practice to get the hang of the bubble-making motion. Repeat as needed.)
20. After you demonstrate how the jumbo wand works, students can take turns using it. You also have enough supplies to make a second jumbo wand to share.

<u>TIP</u>: • You may need to refill the pans of bubble solution periodically.

<u>Discussion Prompts:</u>

- ***Were you able to make a really large bubble?*** *(Yes!)*
- ***What shape was it?*** *(It may have looked like a sphere, or it may have had more of a wobbly, oblong shape.)*
- ***We know that bubbles are always trying to form a sphere. Why might a larger bubble look less like a sphere?*** *(It has a large surface area, so wind currents can affect its shape as it moves through the air. The soap and water molecules are still trying to form a sphere, though!)*

21. If desired, students can use 2 chopsticks and some of the remaining yarn to create a smaller version of the jumbo wand. (Students are free to experiment, but it usually works best if the bottom piece of yarn is twice as long as the top piece – see bottom photo in the upper left corner.)
22. If time allows, experiment with making another jumbo wand with even longer yarn. How does the overall size of the yarn loop affect the bubble size? (In general, bigger loop = bigger bubbles.)
23. Allow students the remaining class time to experiment with their bubble wands.
24. Each student can take home a mini bottle of bubble solution.

Activity Five – Wrap-Up! Time: 5 Minutes

Suggested reading: *The Solid Truth About States of Matter with Max Axiom, Super Scientist* by Agnieszka Jòzefina Biskup.

Procedures:

1. Pass out post-surveys & pencils and administer post-surveys to students.
2. Collect all surveys and ensure names are on surveys and legible. If not legible, please write in their names.

Clean up: Make sure students help clean the room before they leave.

What to save: ***ALL COMPLETED STUDENT SURVEYS***

- **Please give all completed student surveys to your Site Coordinator/ Manager.**
- The Coordinator/ Manager submits surveys to AKA Science.

What goes home: ***ALMOST EVERYTHING!***

- Never send students home with items that they can't be expected to use safely while unsupervised.

For leftover supplies that aren't sent home with students:

- Please ask if your site has a use for them. If so, the site can keep them!
- **If there are some supplies the site can't use, we're happy to put them back in our inventory!** You're welcome to bring the leftover supplies to the next Class Leader training, drop them at our office, etc. 10055 E Burnside St Portland OR 97216
- **Please note that we can't use food products or items that are soiled or damaged.** We appreciate you weeding those out!

THANK YOU FOR TEACHING AKA SCIENCE!!!!!!!!

AKA Science is funded by our generous community partners.

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