AKA SCIENCE

Cool Chemistry: Fizz, pop, WOW!
Grades K-3

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Cool Chemistry: Fizz, pop, WOW! (Grades K-3)

Class 1: Polymer Power

Supplies	#
Bags (Ziploc, snack)	16
Butcher paper (sheets)	1
Color fizzers bags labeled "Colorful Crystals 1 and 2"	2
Cups (9oz, plastic, punch)	12
Fortune Teller Fish	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, brown kraft)	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
Water	

Worksheets:

Worksheets: Take-Home Supplies Advisory (half-sheet)	16
Worksheets: Consent Form for Publicity	16

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, watch color rain, 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! You decide which activities to shorten, lengthen, or skip if needed.

- **Reserve "Suggested Reading" books at your local library in advance.** These are picture books that relate to each day's topic and may be useful as you transition into the *Pair & Share* question. If you cannot reserve the books in advance, we also have *Human Connection* read-alouds available. Human Connections may or may not be appropriate for your grade levels (depending on whether you have more K-1 or 2-3 in your class.) Please use your best judgement!

- **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.
- **<u>Atom</u>**: 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.

Cool Chemistry: Fizz, pop, WOW! (Grades K-3)
Class 1: Polymer Power

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 about the best way to send home the "Take-Home Supplies Advisory" and "Consent Form for Publicity" so it reaches parents/guardians.
- **Act. 2:** Sharpen pencils (or you could have students do this).
- **Act. 3a:** Fill sixteen 9oz cups half-full of water. After that, fill the pitcher ¾-full of water.
- **Act. 3b:** Use a calibrated cup to put ¼oz of polymer crystals apiece in eight 1oz paper cups.
- **Act. 4:** 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.

Activity Two – 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.

Suggested Reading: *Every Day, Chemistry* by Julia Sooy

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.)*
   - ***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. Before you move on to the next activity, please remind students that scientists never eat or drink their supplies. Mystery substances can be harmful, and even the supplies you're familiar with may be contaminated.

Activity Three – Colorful Crystals — Time: 15 Minutes

Supplies	#	Supplies	#
Color fizzers labeled "Colorful Crystals 1" and "Colorful Crystals 2" from Snow Day Pack	2 bags	Snow Day Packs (16 paper 1oz cups, 4oz Instant Snow, 2oz polymer crystals, 2 calibrated 1oz plastic cups & 1 disposable diaper)	1

Cups (2oz plastic)	16	Pipettes	16
Cups (9oz, plastic, punch)	8	Plates (9in, brown kraft)	8
Markers (black, wet erase)	2	Spoons (plastic)	3
Newspaper		Tape (rolls, Scotch)	2
Paper towels (large rolls)	1	Water	

Goal: To explore states and properties of polymers by investigating polymer crystals.

Source: AKA Science, Dr. Carrie Buo, 2022

Background:

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. 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 physical change 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 chemical change – also called a chemical reaction – 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)

Procedure:

TIPS:	• **It's great for science activities to be *as hands-on as possible*—but it's also important to modify activity instructions as needed** based on your group of students (and your space) to manage messes & ensure safety. • **For this activity, if preferred, you could have students share plates in groups of 4 instead of pairs.**

1. Ask students:

- ***When scientists do chemistry experiments, they often wear glasses or goggles. Why do you think that is?*** *(To protect their eyes from things that might splash or fly into the air.)*
- ***How else do you think scientists protect their eyes?*** *(By handling supplies carefully, not touching or rubbing their eyes during experiments, and washing their hands afterwards.)*
- ***Since we don't have safety glasses, we will protect our eyes by not touching them during experiments and washing our hands when we are done.***

2. Pair students.
3. Give each pair a 1oz paper cup with polymer crystals (from Prep).
4. Have pairs examine the polymer crystals.

   Discussion Prompts:
   - ***Scientists make observations about the world. What do you notice about these items?***
   - ***Great work, scientists! When you describe the features or traits that something has, you're identifying its properties.***

Act. 3, Colorful Crystals. Examine the dry polymer

5. Give each child a cup with water and a pipette for each child.

   Discussion Prompts:
   - ***What do you notice about the properties of this water?*** *(It's clear, it flows, etc.)*
   - ***Does it act the same as the crystals?*** *(No).*

Act. 3, Colorful Crystals. Add water to the crystals to see them expand.

6. Ask students:
   - ***Have you ever heard of matter? What is it?*** *(Matter is everything around us, including solids, liquids, and gasses. Matter is all the "stuff" in the universe. Everything that has mass and takes up space is matter, including you!)*
   - ***What do you notice about the properties of this matter? Are they liquids or solids?*** *(The crystals are solids, and the water is a liquid. When you put many crystals together, they can look like a liquid).*
   - ***Are physical properties always obvious based on how something looks? How could you test some of its properties?***
   - ***What do you think will happen if you add water to it? Let's find out!***

7. Give each pair a brown kraft plate.
8. Have pairs use a 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 – middle photo.)*
   - ***What do you think will happen if you add more water?***

9. Have pairs use their pipettes to slowly drip a bit more water over the crystals.

   Discussion Prompts:
   - ***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!)*

10. Ask students: ***Do you think the crystals can also absorb water if it is a different color? Let's try it!***

TIPS:
- **There are 2 sets of pipettes in your kit: 1 set for water & 1 set for vinegar.** Please keep the sets separate to prevent mixing of liquids.
- **You may need to show students how to use the pipettes.** To use a pipette, squeeze the bulb, place the tip in a liquid, then loosen your grip on the bulb. The pipette should fill with the liquid. To eject the liquid, squeeze the bulb again.


Act. 3, Colorful Crystals. Pipette drops of colorful water onto the crystals and watch them slowly absorb the color.


Act. 3, Colorful Crystals. Add a dropper full of two different colors of water to one pile of crystals. If you let them soak up the water, they will blend the colors!

11. Give each pair one color fizzer from the bag labeled "Colorful Crystals 1" and one color fizzer from the bag labeled "Colorful Crystals 2".
12. Ask each child to take one of the two color fizzers and place it in their cup of water. Have them observe what is happening.

    Discussion Prompt:
    - ***What is happening?*** *(The color fizzer is changing the color of the water, making bubbles).*

13. While the students are observing the color fizzers, go around to each group and divide each cup of polymer crystals into 3 piles on the brown kraft plate using a plastic spoon. NOTE: *If you have older students, you may give them spoons and have them divide it into piles themselves.*
14. Have each student drip one of the two colors onto one of the three piles of crystals.

    Discussion Prompts:
    - ***Are the crystals changing color?*** *(Yes).*
    - ***Is the color the same as the water you are using?*** *(Yes).*
    - ***Are the crystals still growing?*** *(Yes).*

15. Have the students add a full pipette of colored water to their pile of crystals. The water will pool around the crystals.

    Discussion Prompts:

- ***What do you think will happen to the water we added to the crystals?*** *(It will soak up into the crystals).*
- ***What about the color?*** *(The crystals will turn the color of the water).*
- ***What if we add both colors to the same pile of crystals?*** *(The colors will combine to make a new color!)*

16. Now have both students add a full pipette of each color to the 3rd pile of crystals.
17. Set the paper plates aside to allow the water to absorb during the next activity.
18. Dump out colored water and refill with clear, or you can allow students to use the colored water with the Instant Snow! The Instant Snow will also absorb the color of the water.
19. Before the end of class, check on the crystals. Did they absorb the liquid? Are they the predicted colors?
20. Scrape the crystals into the trash to dispose. DO NOT put them down the drain. If any accidentally go down the drain, pour salt down the drain. The paper cups that held the crystals should also be disposed of.
21. Wipe off brown kraft plates and save for later.

Activity Four – Snow Day! Time: 15 Minutes

Supplies	#	Supplies	#
Cups (9oz, plastic, punch)	8	Plates (9in, sturdy paper, brown)	8
Newspaper		Salt (packets)	32
Pans (large, oval, aluminum)	1	Scissors (site provides)	1
Paper towels (large rolls)	1	<u>Snow Day Packs</u> (16 paper 1oz cups, 4oz Instant Snow, 2oz polymer crystals, 2 calibrated 1oz plastic cups & 1 disposable diaper)	1
Pipettes (1mL, plastic)	8	Spoons (plastic)	8
Pitchers with lids	1	Water	

<u>Goal</u>: To further explore the properties of polymers by adding water to Instant Snow and a disposable diaper.

<u>Source</u>: Educational Innovations (www.teachersource.com)

<u>Background:</u>

Instant Snow, polymer crystals and the insides of diapers are made of a polymer that swells up when water is added to it. A <u>polymer</u> 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 or use the Salt Dough Pack as a replacement activity. • **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. Tell students: ***Let's test another polymer!***

2. Give each pair a 1oz paper cup with Instant Snow (from Prep), a brown paper plate, and a plastic spoon.
3. Have each pair pour their Instant Snow powder into the center of their plate.
4. Ask students: ***How much do you think this polymer will expand if you add water to it? Let's make a hypothesis! A hypothesis 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.***

5. Have students predict how much the polymer will expand if they add water to it.
6. Have pairs:
   a. Use their pipette to slowly drip water over the Instant Snow.
   b. Observe and explore the Instant Snow. (Pairs can use their spoon to gently move the snow around without removing it from the plate.)

TIPS:	• **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.)

7. Ask students: ***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!)*

   Discussion Prompts:
   - ***What does this polymer look like?*** *(Snow – bottom photo.)*
   - ***Can you think of a way we could get the polymer to release (let go of) the water?***

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.

Act. 4, Snow Day. Observe how the Instant Snow expands to fill the plate. Interact with the Instant snow using the plastic spoon.

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 then place the opened-up diaper in the large oval pan, and gradually pour 9oz cups of water into the diaper.

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

   <u>Discussion Prompts:</u>
   - ***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!)*

10. Show students a disposable diaper.
11. <u>Ask students:</u> ***What material do you think is inside this diaper that helps it absorb liquid? Let's find out!***

12. 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.)

13. <u>Ask students:</u> ***How much water do you think the diaper can absorb?***

14. Have students predict how many 9oz cups of water the diaper can hold.
15. Place the diaper in the large oval pan.
16. 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.
17. Refill the 9oz cup with water and repeat as needed.

    <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.)*

18. Discard the following items in a trash can with a liner: the plates with 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.

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

Activity Five – Flexible Fish Time: 5 Minutes

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


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

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

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

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

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).


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.

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.)*

5. Have students put the fish on a dry part of their desk (it will stop moving).
6. Ask students:
   - ***What do you think caused the fish to move?***
   - ***Could it be heat or moisture from your hand?***
   - ***How could you figure out whether heat vs. moisture is causing the effect?***

7. Tell students: ***Let's test for heat first!***
8. 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.)*
   - ***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.)

9. Give each student a piece of paper towel.
10. Tell students: ***Let's test for moisture now!***
11. Walk around with a pitcher of water (or place the pitcher in a central location).
12. 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?***

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

<u>Discussion Prompts:</u>

- ***What happened?*** *(The fish curled up even more than before.)*
- ***What does this mean for our hypothesis that it is moisture that makes the fish curl?*** *(We were correct! It's moisture!!)*
- ***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 very absorbent polymers!)*

14. 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.
15. Have students put their fish back in its wrapper and put the wrapped fish in the Ziploc bag with the half-piece of chalk 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

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. <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 up the room before they leave.

- **Remember: Instant Snow & polymer crystals <u>don't</u> go home or down the drain.**

- **Please keep the sets of regular vs. vinegar pipettes separate.**
- **Many supplies are intended to be washed and reused from one class to another** (brown kraft plates will be reused often; have students handle them gently.)
- **Be thoughtful about your clean-up strategy.**

WHAT TO SAVE:

Materials used	#	SAVE	Materials used	#	SAVE
Bags (Ziploc, snack)	16	0	Pitchers with lids	1	1
Color fizzers bag labeled "Colorful Crystals 1 and 2"	2	0	Plates (9in, sturdy paper, brown)	16	8
Cups (9oz, plastic, punch)	12	12	Salt (packets)	32	0
Fortune Teller Fish	16	0	Scissors (site provides)	1	1
Markers (black, wet erase)	2	2	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
Newspaper			Spoons (plastic)	11	3
Pans (large, oval, aluminum)	1	1	Tape (rolls, Scotch)	2	2
Paper towels (large rolls)	1	1	Water		
Pencils	16	16	Worksheets: Take-Home Supplies Advisory (half-sheet)	16	any left
Pipettes (1mL, plastic)	8	8	Worksheets: Consent Form for Publicity	16	Any left

What goes home: Cellophane fish in wrapper (in Ziploc 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 not go in students' mouths, eyes, ears, or noses.)

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* of the supplies, and they won't necessarily take supplies home after *every* day of class.

3. **Instruct students that they should <u>never</u> put AKA Science supplies in their mouths, eyes, ears, or noses, or use them in a way that could hurt anyone.**
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.**

<u>Reminder</u>:

- Ask your Site Coordinator / Manager how to send home the **<u>Take-Home Supplies Advisory</u>** and the **<u>Consent Form for Publicity</u>.**

Cool Chemistry: Fizz, pop, WOW! (Grades K-3)

Class 2: Mix it Up!

Supplies	#
Balloons (7in - 1 is extra)	9
Bowls (20oz, sturdy paper)	8
Coffee filters (paper, round)	16
Coffee filters prepped with black ink circles (paper, round)	16
Color fizzers (small tablets labeled "Mix & Separate")	4
Cornstarch (oz)	4
Cotton swabs (6in, wood handle)	16
Cups (1oz, plastic, calibrated)	2
Cups (2oz, plastic)	16
Cups (9oz, plastic, punch)	28
Dish soap (20oz bottles, liquid)	1
Markers (black, wet erase)	2
Milk Motion Packs (8oz of powdered milk & 2 small bottles of food coloring (different colors))	1
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	
Oil (oz)	16
Paper towels (large rolls)	1
Pencils	16
Pitchers with lids	1
Plates (9in, brown kraft)	20
Plates (10in, paper, high sides)	8
Spoons (plastic)	12
Stir sticks (small straws)	16
Tape (rolls, Scotch)	2
Water	

Worksheets:

Worksheets: Take-Home Supplies Advisory (half-sheet)	any left

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.)

- **Act. 2a**: Inflate and tie off 8 balloons. **NOTE:** *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.
- **Act. 3 (Optional)***: Put water in sixteen 9oz cups just up to the indent at the base of each cup.
- **Act. 4**: Measure 1oz oil into sixteen 2oz cups.
- **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 during Act. 2 & 5.
- **For Act. 2,4, & 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.*

Activity Two – Pair & Share — Time: 5 Minutes

Supplies	#	Supplies	#
Pencils	16	Lab notebooks	16

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

Suggested Reading: *Libby Loves Science: Mix & Measure* by Kimberly Derting

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. Before you move on to the next activity, please remind students that scientists never eat or drink their supplies. Mystery substances can be harmful, and even the supplies you're familiar with may be contaminated.

Activity Two – Mix & Separate Time: 15 Minutes

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 together, 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)

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.)

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).

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.)

   Discussion Prompt:
   - ***What do you think will happen after a few minutes? Let's wait and see!***

10. Have groups set their cup aside in a location where it won't spill or get jostled.

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.

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

12. Pair students.
13. Give each pair a brown kraft plate. Make tape available.

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. 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.
15. Give each pair an eighth sheet of paper.
16. Have pairs rip their paper so both students have a half-piece, then rip those halves into tiny pieces next to their plate.

    Discussion Prompt:
    - ***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.)*

17. Give each pair an inflated balloon (from Prep).
18. 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.**

19. 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.

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.

Discussion Prompts:

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

20. 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!***

21. Give each pair a 10in paper plate with high sides.
22. 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?***

23. 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.)*

24. Have pairs brush the puffed rice off the balloon and onto the plate, then repeat.
25. Tell students: ***Let's go back and look at our first concoction.***
26. 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!)*

27. 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.)
28. 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 (paper, round)	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.

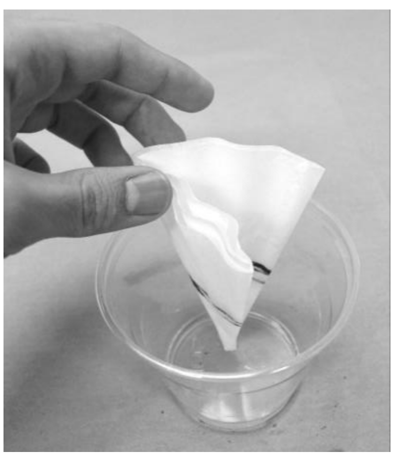
Chromatography can be used in real life to figure out what things are used to make up ink and other liquids. You can use chromatography to separate out all the ingredients, then you can use different tests to find out what those ingredients are. Chromatography was used to figure out what makes leaves 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:

1. Ask students:
   - ***What is the color black?***
   - ***Is it just one color or a mixture of different colors? Let's explore!***

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.

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).
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).

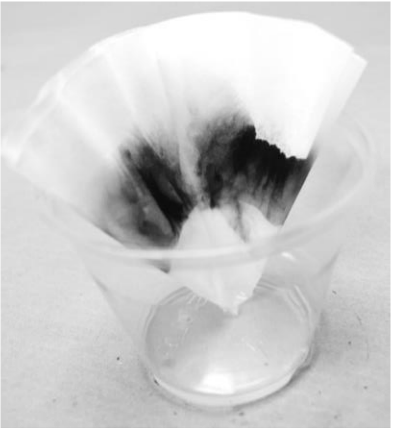


Cool Chromatography. Place the folded coffee filter wedge in the cup, point down. The tip of the wedge will be submerged in the small amount of water in the cup.

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.)

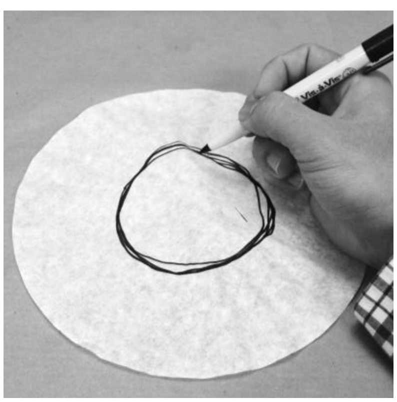
4. Have students watch as the water travels up the filter (see bottom photo).

   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.)*



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

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



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. Dump water out of cups and refill them to half full for the next activity.

Activity Four – Color Rain   Time: 15 Minutes

Supplies	#	Supplies	#
Cups (2oz, plastic)	16	Oil (oz)	16
Cups (9oz, plastic, punch)	16	Paper towels (large rolls)	1
Cups (1oz, plastic, calibrated)	1	Stir sticks (small straws)	8
Liquid food coloring bottles from Milk Motion packs	2	Water	
Newspaper			

Goal: To explore how oil and water interact with each other and to test if liquid food coloring is made with water or oil.

Source: http://bit.ly/3B8dAd2

Background:

Like the vinegar and oil in salad dressing, water and oil don't mix. Water is a polar molecule – this means it has a positive charge at one end and a negative charge at the other, like a battery. Things like salt and coffee molecules are polar, which allows them to bind with water (or dissolve). Oil has a neutral charge, which makes it unable to bind with water. Instead, it clumps together on the surface of water, binding to itself. When we add the liquid food coloring to the water, we're simply trying to mix water and oil, similar to shaking up salad dressing (https://bit.ly/3P4Dzrt).

Act. 4, Color Rain. Add drops of liquid food coloring to a 2oz cup ½ full of oil.

Act. 4, Color Rain. Have students try to stir the food coloring into the oil – the four large drops of color will turn into many small droplets.

Procedure:

1. Ask students: ***Earlier today we saw how we can make mixtures with water and cornstarch, but not everything will dissolve in water. Can you think of any times you have seen two liquids that don't mix?*** *(Salad dressing made from vinegar and oil, lava lamps).* ***Oil doesn't mix with water, and it is less dense than water which makes it float on top. You will learn more about this next week.***

2. Make sure each student has a 9oz plastic cup half full of water.
3. Pass out one stir stick and one 2oz cup containing 1oz of oil to each student.

   Discussion Prompts:
   - ***Has anyone ever used food coloring before?***
   - ***Does it dissolve in water?*** *(Yes).*
   - ***What do you think will happen if we put food coloring in oil? Why?***

4. Tell students you will be walking around and putting 2 drops of each food coloring color in their oil (they will have 4 drops of food coloring total). Have them observe what happens to the food coloring, but not do anything else at this moment.

   Discussion Prompts:
   - ***What happens to the food coloring when I drip it into the oil?*** *(It stays in a blob, doesn't dissolve into the oil).*
   - ***Why do you think this happened?*** *(The food coloring is made with water, and water and oil don't mix).*

5. Have students use their stir sticks to stir the food coloring droplets up into the oil. It is best to do this on a surface covered with newspaper or paper towels in case of spills.

   Discussion Prompts:
   - ***What is happening to the food coloring?*** *(It is breaking into tiny droplets, but not dissolving. The oil will look muddy, but you should be able to see tiny drops still floating in the oil).*
   - ***What do you think will happen if we dump this oil into our water cups? Let's find out!***

Act.4, Color Rain. After dumping the oil into the cup of water, the food coloring droplets will dissolve into the water in a burst of color.

6. Have students dump the oil and food coloring mixture into the 9oz plastic cup that is half full of water. The best method is to dump it in all at once.
7. Observe what is happening – the oil will quickly move to the top of the glass. Then the droplets of food coloring will settle to the bottom of the oil. As the food coloring touches the water it will dissolve into the water in a burst of color!

   Discussion Prompts:
   - ***Now what is happening to the food coloring?*** *(It is dissolving into the water, leaving the oil).*
   - ***Why do you think the food coloring dissolves into the water and not the oil?*** *(Food coloring is made with water, oil and water don't mix!)*
   - ***What do you think would happen if the food coloring was made with oil instead of water?***

8. Allow students to observe the color "rain" in the cups until it is finished
9. Have them leave their cup for you to dispose of the oil. DO NOT dump oil down the drain, instead remove any remaining materials from the large Ziploc bag containing the Class 2 supplies. Dump all contents of the 9oz cups into the bag and seal the bag. Throw bag away in a trash can with a liner.
10. Keep liquid food coloring for the next activity.
11. Plastic 9oz cups will need rinsed and wiped clean to use in a future class.

Activity Five – Milk Motion Time: 10 Minutes

Supplies	#	Supplies	#
Bowls (20oz, sturdy paper)	8	Milk Motion Packs (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)	8	Pitchers with lids	1
Dish soap (20oz bottles, liquid)	1	Spoons (plastic)	8
		Water (oz)	

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

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

Background:

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).

Procedure:

1. Tell students: ***You've separated mixtures in different ways today: letting them settle out, using static electricity, and using chromatography. Now let's explore a surprising way to mix some things together!***

2. Pair students.
3. Give each pair a bowl with powdered milk (from Prep), a 9oz cup, and a plastic spoon.
4. 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).
5. Have the first student in each pair dip the cup in the pitcher and add 1oz of water to their bowl.
6. 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.)
7. Walk around and give each pair a small squeeze of soap in their 9oz cup and collect back their spoon.
8. Ask students: ***Do you know how soap works?*** *(Soap molecules have a polar, hydrophilic (water-loving) head and a non-polar, hydrophobic (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!***

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. 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).

CAUTION: Food coloring will stain hands and clothes.
- **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.**

Discussion Prompts:
- ***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. Tell students: ***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 of 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

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 clean up the room before they leave.

Cool Chemistry: Fizz, pop, WOW! (Grades K-3)

Class 2: Mix it Up!

What to save:

Materials used	#	SAVE	Materials used	#	SAVE
Balloons (7in - 1 is extra)	9	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
Bowls (20oz, sturdy paper)	8	0	Newspaper		
Coffee filters (paper, round)	16	0	Oil (oz)	16	0
Coffee filters prepped with black ink circles (paper, round)	16	0	Paper towels (large rolls)	1	1
Color fizzers (small tablets labeled "Mix & Separate")	4	0	Pencils	16	16
Cornstarch (oz)	4	0	Pitchers with lids	1	1
Cotton swabs (6in, wood handle)	16	0	Plates (9in, brown kraft)	20	20
Cups (1oz, plastic, calibrated)	2	2	Plates (10in, paper, high sides)	8	8
Cups (2oz, plastic)	16	0	Spoons (plastic)	12	12
Cups (9oz, plastic, punch)	28	28	Stir sticks (small straws)	8	0
Dish soap (20oz bottles, liquid)	1	1	Tape (rolls, Scotch)	2	2
Markers (black, wet erase)	2	2	Water		
Milk Motion Packs (8oz of powdered milk & 2 small bottles of food coloring (different colors))	1	0	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: 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 K-3)

Class 3: Liquid Tricks

Supplies	#
Bags (Ziploc, sandwich)	16
Bottles (8oz water bottles)	16
Color fizzers (labeled "Does It Absorb?")	4
Color fizzers (labeled "Liquid Layers")	1
Corn syrup (oz, light)	16
Cotton balls	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)	16
Paper towels (large rolls)	1
Pencils	16
Pipettes (1mL, plastic)	16
Pitchers with lids	1
Plates (9in, brown kraft)	16
Salt (packets)	4
Spoons (plastic)	20
Toothpicks (flat)	16
Transparency pieces	16
Water	
White paper, ¼ sheets	16

Worksheets:

Worksheets: Take-Home Supplies Advisory (half-sheet)	any left

Prep (prior to class):

TIP: • **When a Prep step says to prepare sixteen items**, if there are fewer than 16 students in your class, just prepare one item for each student.

- **Act. 2a:** Use a calibrated cup to put 1/8z of Magic Sand apiece in sixteen 4oz cups.
- **Act. 2b (Optional)*:** Fill sixteen 9oz cups half-full of water.
- **Act. 3 (Optional)*:** Fill a 20oz cup ¾-full of water.
- **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.*

Activity One – Pair & Share — Time: 5 Minutes

Supplies	#	Supplies	#
Pencils	16	Lab notebooks	16

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

Suggested Reading: *The Secret of Water* by Masaru Emoto

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. Before you move on to the next activity, please remind students that scientists never eat or drink their supplies. Mystery substances can be harmful, and even the supplies you're familiar with may be contaminated.

Activity Two – Does It Absorb? Time: 10 Minutes

Supplies	#	Supplies	#
Bags (Ziploc, sandwich)	16	Pipettes (1mL, plastic)	16
Color fizzers (labeled "Does It Absorb?")	4	Pitchers with lids	1
Cotton balls	16	Plates (9in, brown kraft)	16
Cups (9oz, plastic, punch)	4	Transparency pieces	16
Newspaper		Water	
Paper towels (large rolls)	1	White paper, ¼ sheets	16

Goal: To test if different materials can absorb water.

Source: Little Bins, Little Hands: *Fun Water Absorption For Kids*. https://bit.ly/3gVFyBV

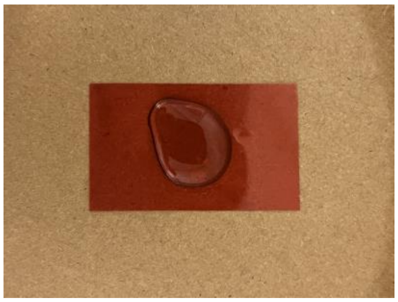
Background:
Materials interact with water in different ways. Many natural surfaces are hydrophilic and easily take up or absorb water, such as paper made from wood and cloth made from cotton. These plant-based materials have once-living cells that are specialized to allow water to soak into the surface. Hydrophobic substances, such as the plastics in your activity materials, prevent water from absorbing into the surface, like rubber rain boots. You will learn more about hydrophobic and hydrophilic materials in the next activity (https://bit.ly/3FN7sJU).

Act. 2, Does It Absorb? Give each student a cotton ball, plastic bag, transparency piece, and ¼ sheet paper.

Procedure:
1. Tell students: ***We have used water in our experiments the last two weeks in different ways. Now let's take a closer look at what happens when water touches different materials.***

2. Put students in 4 groups.
3. Give each group a 9oz cup half-full of water. Add one color fizzer from the "Does It Absorb" bag to the water and let it dissolve.
4. Give each child a brown kraft plate with a pipette, a cotton ball, a transparency piece, a ¼ sheet of white paper, and a Ziploc bag on it.
5. Ask students:
   - ***What do you think will happen if we drip water onto these different materials?***
   - ***Will the water stay on the top or will it soak (absorb) into the material? Why?***


Act. 2, Does It Absorb? Have students drip colorful water onto their materials.


Act. 2, Does It Absorb? Observe which materials absorb the water and which ones don't.


Act. 2, Does It Absorb? Repeat with other materials on hand if desired, such as paper towels or felt.

- ***To test your hypotheses, we will drip water from the cups onto our materials. Why do you think I added color to the water?*** *(It's easier to see what happens to the water).*

6. Tell students to keep the materials on the plate during the experiment.
7. Have the students slowly drip water onto the different materials.
8. If you have other materials in the classroom that would be easy to clean up or dispose of, allow the kids to try those as well (felt scraps, newspaper, tissues, even the plates their materials are on!) The more things they can test, the better.

   Discussion Prompts:
   - ***What happened to the water? (****It stayed on top of the transparency and plastic bag, soaked into the paper and the cotton ball.)*
   - ***What do you notice about the materials that absorbed water?*** *(They are softer, made of natural materials like cotton and wood).*
   - ***What about the materials that didn't soak up the water?*** *(Both are very smooth plastic).*

9. Tell students: ***These materials that didn't absorb the water are called hydrophobic, which means they don't mix with water. Let's explore another hydrophobic material in the next experiment.***

10. Collect the plates with all items except the pipettes. Rinse pipettes with plain water.
11. Dry the Ziploc bags and transparencies and keep them for later experiments.

Activity Three – Magic Sandbox Time: 25 Minutes

Supplies	#	Supplies	#
Cups (4oz, plastic, clear)	16	Pipettes (1mL, plastic)	16
Cups (9oz, plastic, punch)	16	Pitchers with lids	1
Dish soap (20oz bottles, liquid)	1	Salt (packets)	4
Magic Sand (oz, blue)	2.5	Spoons (plastic)	20
Newspaper		Toothpicks (flat)	16
Paper towels (large rolls)	1	Water	

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

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

Background:

As you may have noticed, magic sand is very different from regular sand. While regular sand likes water (in other words, it's "hydrophilic"), magic sand doesn't like water (it's "hydrophobic"). The 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 hydrophobic means "water-fearing," from the Greek words "hydro" (water) and "phobia" (fear). The word hydrophilic 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. 3, 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.

Act. 3, 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.

Procedure:

1. Ask students: ***In the last class, we experimented with mixing and separating things. But did you know some substances have properties that prevent 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. Have groups:
    a. Empty the packet of salt into the water.
    b. Use the spoon to stir thoroughly and observe what happens to the salt.

    Discussion Prompt:
    - ***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!***

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?*** *(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.)

- ***What do you think will happen if you take the sand out of the water?***

8. 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!***

9. Give each student a 4oz cup with Magic Sand (from Prep), a pipette, and a toothpick.
10. Have four students use the spoons from the cups of Magic Sand and give spoons to the remaining students.
11. Give each pair of students a 9oz cup half-full of water (or, if preferred, students can share cups of water in groups).
12. 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.

Act. 3, 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. 3, Magic Sandbox. Experiment moving and shaping the sand underwater using the toothpick or spoon as tools.

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

14. Have students return to their groups and retrieve the 9oz cup with Magic Sand.
15. Walk around and put a small squeeze of soap in each group's cup.
16. 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.)*

17. 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**.

18. Have students wash their hands.

Activity Four – 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
Labeled Liquid 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 you found, 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.

Solid objects aren’t the only things that have different densities! Liquids can also have different densities, as you saw 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)

<u>Procedure:</u>

<u>TIP</u>:	• **If preferred, you could do this activity as a <u>whole class</u>.** 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. <u>Ask students:</u>
    - ***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. <u>Density</u> 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 <u>24oz bottle of oil</u>, 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. Tell students that they will be adding color to the water to make it easier to see.
4. Put the color fizzer labeled "Liquid Layers" in the cup of water and let it dissolve as you continue.
5. Line up four <u>empty</u> 20oz cups and have students watch or gather around.
6. <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?***

7. Have students make a hypothesis about what will happen with the liquids.
8. <u>Ask students:</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.

10. Ask students:
    - ***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?***

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

TIPS:
- **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.

Discussion Prompts:
- ***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!)*

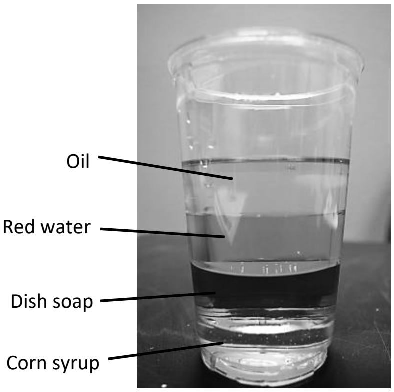
13. Show students the Liquid Layers Pack.
    Discussion Prompts:
    - ***Which of these objects do you think are the densest?***
    - ***Which do you think are the least dense?***
    - ***How do you think their densities compare to the liquids in the cup? Let's find out!***

14. Put students in 4 groups.
15. 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?***

16. 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:



Liquid Layers. The liquids stack up inside the cup.

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. 4, 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.

- ***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?***

17. Give each group a plastic spoon.
18. 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.

19. 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.)
20. 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.

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

Activity Six – Daily Debrief   Time: 5 Minutes

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

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?***
- ***If you could investigate one more thing about today's activities, what would you like to find out?***

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

Clean up: Make sure students help clean up 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
Bags (Ziploc, sandwich)	16	0	Oil (oz, vegetable)	16	0
Bottles (8oz water bottles)	16	0	Paper towels (large rolls)	1	1
Color fizzers (small tablets, labeled "Does It Absorb?")	4	0	Pencils	16	16
Color fizzers (small tablets, labeled "Liquid Layers")	1	0	Pipettes (1mL, plastic)	16	16
Corn syrup (oz, light)	16	0	Pitchers with lids	1	1
Cotton balls	16	0	Plates (9in, brown kraft)	16	16
Cups (20oz, plastic)	5	1	Salt (packets)	4	0
Cups (4oz, plastic, clear)	16	0	Spoons (plastic)	20	20
Cups (9oz, plastic, punch)	16	12	Toothpicks (flat)	16	0
Dish soap (20oz bottles, liquid)	1	1	Transparency pieces	16	16
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	Water		
Magic Sand (oz, blue)	2.5	0	White paper, ¼ sheets	16	0
Newspaper			Worksheets: Take-Home Supplies Advisory (half-sheet)	any left	any left

What goes home: Nothing today!

Cool Chemistry: Fizz, pop, WOW! (Grades K-3)

Class 4: Get a Reaction!

Supplies	#
Alka-Seltzer (tablets)	16
Bags (Ziploc, sandwich)	16
Bottles (8oz water bottles)	20
Cold packs (instant)	1
Color fizzers, labeled "Lava Lamp"	16
Cups (1oz, plastic)	4
Cups (1oz, plastic, calibrated)	2
Cups (6-12oz, paper)	4
Dish soap (20oz bottles, liquid)	1
Funnel (plastic)	1
Gloves (pairs - vinyl, disposable, small)	16
Glow sticks (thick, safety style)	1
Hand warmers (instant)	1
Hydrogen peroxide (oz, 3%)	12
Markers (black, wet erase)	1
Newspaper	
Oil (oz)	48
Pans (9in, round, aluminum)	4
Paper towels (large rolls)	1
Pencils	16
Pitchers with lids	1
Plates (9in, brown kraft)	8
Spoons (plastic)	16
Water (including some warm)	
Yeast packets (8.75g, active dry)	4

Worksheets:

None.

Prep (prior to class):

- **<u>Act. 3a</u>:** Remove the labels from sixteen water bottles.
- **<u>Act. 3b</u>:** Empty sixteen water bottles (feel free to empty them into the pitcher to use the water).
- **<u>Act. 3c</u>:** Use the <u>48oz bottle of oil</u> and a funnel to add oil to each water bottle up to the 2nd indented line from the top of the bottle. (<u>Tip</u>: 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.)
- **<u>Act. 3d</u>:** Make sure the pitcher is full of water.
- **<u>Act. 3e (Optional)</u>:** Break sixteen Alka-Seltzer tablets in half.
- **<u>Act. 4a</u>:** Remove the labels from four water bottles. Empty the water bottles.
- **<u>Act. 4b</u>:** 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.
- **<u>Act. 4c</u>:** 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.

Activity One – Pair & Share — Time: 5 Minutes

Supplies	#	Supplies	#
Pencils	16	Lab notebooks	16

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

<u>Suggested Reading</u>: *Burn: Michael Faraday's Candle* by Darcy Pattison

<u>Procedure</u>:

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. <u>Ask students a *Pair & Share* question:</u>

   - ***Other than a candle or match burning, have you ever seen a chemical change with heat?*** *(Baking a cake, cooking an egg, 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.

Activity Two – 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.
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)

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. Ask students:
   - ***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.
6. Pass the cold pack around again 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.)

Discussion Prompts:

- ***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.

> **TIP:**
> - **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.

Discussion Prompts:

- ***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 and useful?***

10. Remove the glow stick from its package and show it to students (bottom photo).
11. Ask students: ***How do you think glow sticks work?***

12. Explain to students:
    - ***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.)***

13. Have the class be as quiet as possible to try to hear the "crack" of the tube.

14. 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.

15. 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 Three – Lava Lamp   Time: 20 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 (labeled "Lava Lamp")	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.

Background:

There are 3 things going on here! Alka-Seltzer's reaction with water is a chemical reaction, because it produces something new: bubbles of carbon dioxide gas. The color fizzer also creates a brief chemical reaction because it contains the same ingredient as Alka-Seltzer. 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).

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? What does it look like and what does it do?*** *(Most students won't know what this is.)*
    - ***Do you know how a lava lamp 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*

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.

Act. 3, Lava Lamp. Add a color fizzer to each bottle.

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.
3. Ask students:
   - ***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!***
4. 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.***

5. Give each student a color fizzer.
6. Have students drop the color fizzer into their 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 bubbles floated up into the layer of oil, the color fizzer only turned the water a different color—not the oil.)*

7. Give each student an Alka-Seltzer tablet (or 2 half-pieces if you did optional Prep.)
8. Have students:
   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.

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

Act. 3, 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.

<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.)*
- ***Do you think you could make the lava lamp react again if you add more Alka-Seltzer?***

9. 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?***

10. 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!)*

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

<u>**TIP**</u>:	• **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.

12. Give each student a Ziploc sandwich bag.

13. Have students screw the cap on their bottle, then put the bottle in the Ziploc bag.

<u>TIP</u>:
- **The lava lamps should be carried <u>outside</u> of students' backpacks** (this will protect the bottles from getting accidentally crushed and leaking).
- **<u>Don't</u> 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 Four – Elephant Toothpaste Time: 25 Minutes

<u>CAUTION</u>: <u>Hydrogen peroxide is toxic if ingested and may irritate eyes & skin</u>.
- ***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.**

Supplies	**#**	**Supplies**	**#**
Bottles (8oz water bottles)	4	Newspaper	
Cups (1oz, plastic)	4	Pans (9in, round, aluminum)	4
Cups (1oz, plastic, calibrated)	1	Paper towels (large rolls)	1
Cups (6-12oz, paper)	4	Pitchers with lids	1
Dish soap (20oz bottles, liquid)	1	Spoons (from previous activity)	4
Gloves (pairs - vinyl, disposable, small)	16	Water (very warm)	
Hydrogen peroxide (oz, 3%)	12	Yeast packets (8.75g, active dry)	4

<u>Goal</u>: To explore the yeast/hydrogen peroxide reaction by having the reaction bubble over the top of a water bottle.

<u>Source</u>: Steve Spangler Science, *Elephant Toothpaste Experiment Recipe Formula*. https://bit.ly/3wCc7td

<u>Background:</u>

When you mix hydrogen peroxide with yeast, the yeast causes the hydrogen peroxide molecule to break down into water and oxygen. The


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. Provide a small plastic water bottle with hydrogen peroxide inside. Add a large squeeze of soap into the bottle.


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.

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).

Procedure:

TIPS:	• **Review the cautions about hydrogen peroxide.** • **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 large amount of yeast and hydrogen peroxide together? 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.)

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 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 Six – Daily Debrief
Time: 5 Minutes

Supplies	#
Lab Notebooks	16
Pencils	16

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 up the room before they leave.

What to save:

Materials used	#	SAVE	Materials used	#	SAVE
Alka-Seltzer (tablets)	16		Hydrogen peroxide (oz, 3%)	12	0
Bags (Ziploc, sandwich)	16	0	Markers (black, wet erase)	1	1
Bottles (8oz water bottles)	4	0	Newspaper		
Cold packs (instant)	1	16	Oli (oz)	48	0
Color fizzers, labeled "Lava Lamp"	16	2	Pans (9in, round, aluminum)	4	4
Cups (1oz, plastic)	4	0	Paper towels (large rolls)	1	1
Cups (1oz, plastic, calibrated)	2	1	Pencils	16	16
Cups (6-12oz, paper)	4	0	Pitchers with lids	1	1
Dish soap (20oz bottles, liquid)	1	0	Plates (9in, brown kraft)	8	8
Funnel (plastic)	1	0	Spoons (plastic)	16	16
Gloves (pairs - vinyl, disposable, small)	16	0	Water (including some warm)		

Glow sticks (thick, safety style)	1	1	Worksheets: Take-Home Supplies Advisory (half-sheet)	an y left	any left
Hand warmers (instant)	1		Yeast packets (8.75g, active dry)	4	0

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)

Cool Chemistry: Fizz, pop, WOW! (Grades K-3)

Class 5: Color Surprise

Supplies	#
Bags (Ziploc, sandwich)	16
Bags (Ziploc, snack)	16
Baking soda (oz)	0.5
Birthday candles, white	16
Cardstock half sheets	16
Color fizzers (labeled "Wax Paintings")	8
Cotton swabs (6in, wood handle)	8
Cups (20oz, plastic)	1
Cups (1oz, plastic, calibrated)	1
Cups (9oz, plastic, punch)	17
Gloves (pairs - vinyl, disposable, small)	16
Index cards (half-size, 2.5inx3in - 1 is extra)	30
Newspaper	
Paintbrushes	16
Pans (large, oval, aluminum)	2
Paper towels (large rolls)	1
Pitchers with lids	1
Plates (10in, paper, high sides)	8
Plates (9in, brown kraft)	16
Scissors (site provides)	16
Solargraphics paper (3.5inx4in pieces - 4 are extra); **KEEP IN PACKAGE UNTIL READY TO USE**	20
Spoons (plastic)	5
Tape (rolls, Scotch)	2
Transparencies (3.67inx4.25in pieces)	16
Turmeric mixture (bag)	1
Water	

Worksheets:

None.

Prep (prior to class):

- **__Act. 2a__:** Dump the contents of the bag labeled "turmeric" into the 20oz cup. Mix with a spoon. The turmeric may not completely dissolve but that's OK. Divide the liquid into four 9oz plastic cups. You may need to restir the mixture before handing it out. Rinse spoon well before using for another experiment.
- **__Act. 2b__:** Use a calibrated cup to put 0.5oz of baking soda in a 9oz plastic cup. Fill the cup ¾ full of water and stir with a plastic spoon. Divide the baking soda mixture into four 9oz cups.
- **__Act. 2c (Optional)__:** Prep sixteen 2in pieces of tape ~or~ tape index cards 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__:** Fill eight 9oz plastic cups halfway with water.
- **__Act. 4b (Optional)__:** Add one color fizzer from the bag labeled "Wax Paintings" to each 9oz cup.

Activity One – Pair & Share — Time: 5 Minutes

Supplies	#	Supplies	#
Pencils	16	Lab notebooks	16

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

__Suggested Reading__: *Perkin's Perfect Purple* by Tami Lewis Brown

__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.

Activity Two – Invisible Ink **Time: 15 Minutes**

Supplies	#	Supplies	#
Bags (Ziploc, snack)	16	Newspaper	
Baking soda	0.5	Paintbrushes	16
Cotton swabs (6in, wood handle)	8	Paper towels (large rolls)	1
Cup (20oz, plastic)	1	Plates (10in, paper, high sides)	8
Cups (1oz, plastic, calibrated)	1	Spoons (plastic)	5
Cups (9oz, plastic, punch)	9	Tape (rolls, Scotch)	2
Gloves (pairs - vinyl, disposable, small)	16	Turmeric mixture (bag)	1
Index cards (half-size, 2.5inx3in - 1 is extra)	10	Water	

Goal: To reveal baking soda "secret messages" via a reaction with turmeric.

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

Background:

Turmeric is a natural pH indicator – it has a chemical in it called curcumin that turns red when the pH is above 7! Baking soda is a weak base with a pH of 8, which is just enough to change the color of the turmeric solution to red. You may also notice some white powder in the bags of turmeric. This is powdered milk. Turmeric is fat-soluble, which means it needs some fats to bind to help it dissolve in liquids. The powdered milk is in there to help the turmeric dissolve in water and make it easier for the students to use as "paint" (https://bit.ly/3VDWJan).

Procedure:

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. Put students in 4 groups to share cups of liquid. Pair off students within the groups to share plates.
3. Give each student a half-size index card.
4. Give each pair a cotton swab, a 10in paper plate with high sides, and two 2in pieces of tape.
5. Have pairs tape both index card halves onto the plate, blank side up. Students can label their index cards with their names if desired, but make sure they leave a lot of room on the card for the experiment.
6. Give each group a cup with the baking soda and water mixture (from prep).

Act. 2, Invisible Ink. Draw simple shapes on index cards with cotton swab and baking soda/water solution. Let dry for about 15 minutes.

7. Have students dip their cotton swabs into the mixture and paint a simple mark on the paper (this works best when swabs are dipped all the way to the bottom of the cup). Pairs will need to share cotton swabs. The first letter of their name or a simple shape would work well.
8. Have pairs observe for a minute or so and notice if anything changes.

Discussion Prompt:
- ***What's happening?*** *(The marks are clear, no color, wet but "invisible".)* ***Let's set these aside while they finish drying.***

9. Have pairs set their plate somewhere out of the way where it won't get jostled or have something spilled on it.
10. Go on to the next activity (or activities), then come back to the plates afterwards.

TIP:
- **It works best to wait at least 15 minutes for the baking soda marks to fully dry** (Longer is fine; shorter can work but won't react as well.)

11. After 15 minutes, have students retrieve their plates and observe the papers.

Discussion Prompts:
- ***What happened to the marks you made?*** *(They disappeared, the water dried, can't see it anymore.)*
- ***What could we do to see the marks again?***

Act. 2, Invisible Ink. Paint over the entire index card with the turmeric/water mixture. The areas with the baking soda will turn red, the rest of the paper will turn yellow.

12. Give each student a paintbrush and a pair of gloves. The materials used are not dangerous, but turmeric can stain hands. Have them put the gloves on.
13. Pass out the cups with the turmeric mixture to each group. The mixture may need stirred before use.
14. Have students dip their paintbrushes in the turmeric mixture and then paint over the marks they made on the index cards. They should completely cover the card with liquid.

Discussion Prompts:
- ***What happened?*** *(The markings that started out clear are now red, the rest of the paper is yellow. In some places the red may be darker than other places.)*
- ***Why do you think the "invisible ink" was revealed by the turmeric?*** *(Something in the first mixture reacted with the second mixture. The first mixture had baking soda, which reacts with the turmeric and changes it red. You will learn why this happens next week.)*

15. Dump cups of liquid in the sink and rinse well. Also rinse the paintbrushes very well to prepare for Activity 4.

16. 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. (www.sunprints.org/how-it-works/)

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.)*

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.

- ***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 <u>as little sunlight as possible</u> coming in from windows or skylights.

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

6. Have students place their brown kraft plate <u>upside-down</u> in front of them.
7. <u>Tell students:</u> ***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. <u>Have students</u>:
    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.

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. Gather all the items to go outside. Students will carry their plate (holding the index card flat), and you'll carry one of these sets of items:
    a. **Option #1:** 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. **Option #2:** 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.

TIPS: **Regardless of whether you choose Option #1 or Option #2:**
- **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 next 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.

16. Ask students: ***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!***

17. 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 flat against their plate until it's time to reveal the Solargraphics paper.
18. 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.)

19. 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.)

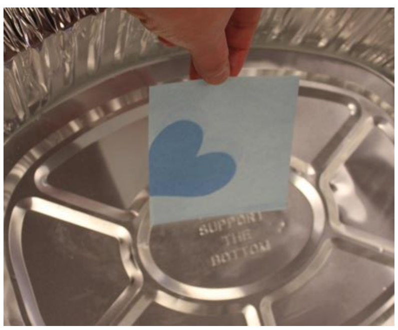
Discussion Prompt:

- ***What happened to your blue paper?*** *(It got lighter in the sun.)*

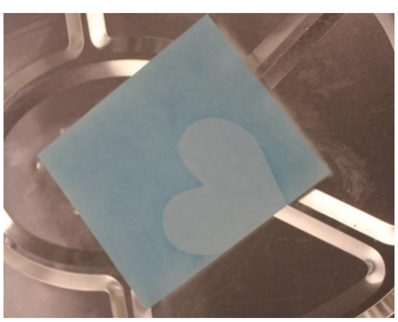
20. Tell students: ***We're going to take turns "developing" the papers to see what happened with everyone's designs!***

21. 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.**



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.



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.

22. 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?***

23. Explain to students: ***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.***

24. Ask students: ***What do you think will happen when we put the paper in water? Let's try!***

25. Give each student a piece of paper towel.
26. 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?***

27. Explain to students: ***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.***

28. 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.)
29. Dump out the water from the pans and bring the class back inside.
30. Have students wash their hands.
31. At the end of class, give each student a Ziploc sandwich bag to take their slightly-damp Solargraphics paper home.

Activity Four – Wax Paintings — Time: 10 Minutes

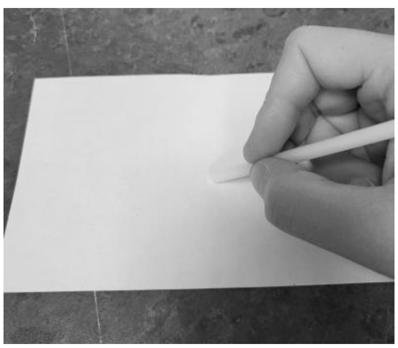
Supplies	#	Supplies	#
Bags (Ziploc, sandwich from previous activity)	16	Paintbrushes	16
Birthday candles	16	Paper towels (large rolls)	1
Cardstock, ½ sheets	16	Pitchers with lids	1

Color fizzers labeled "Wax Paintings"	8	Water	
Cups (9oz, plastic, punch)	8		

Goal: To test if a hydrophobic substance (wax) can make designs on paper.

Source: https://bit.ly/3Fxt5hg

Background:
Wax is a hydrophobic substance that doesn't bind with water. If you have ever gone skiing or snowboarding, you may have applied wax to your skis or board to repel water and make you go faster. The same concept is at work here – the wax from the candles is repelling the colorful water but the paper is hydrophilic and will bond with the water. The result is that the paper covered in wax is prevented from changing color (https://bit.ly/3VVdDRn).


Wax Paintings. Use the birthday candle to make a design or drawing on a piece of cardstock.


Wax Paintings. After drawing on the paper with wax, reveal the drawing by painting over it with the colorful water.

Procedure:
1. Tell students: ***In today's class, we've explored some chemical reactions that involved color changes. Now we are going to see if we can prevent white paper from changing color.***

2. If they aren't in groups already, make 4 groups of students.
3. Pass out two of the 9oz cups of water to each group.
    a. If you have already placed the color fizzers in the water during prep, make sure each group receives two different colors of water.
    b. If you did not put the color fizzers in the water, go around and give each group two different colors of color fizzers and have them put one in each cup.

    Discussion Prompts:
    - ***We have some different colors of water here. What do you think will happen if we use this water on a piece of white paper?*** *(The paper will change color).*
    - ***Can you think of a way to prevent the paper from changing color? Let's find out!***

4. Hand out one birthday candle and a ½ sheet of white cardstock to each student.

    Discussion Prompts:
    - ***What are these candles used for?*** *(Birthday cakes, to give light, decoration).*
    - ***What are they made of?*** *(wax).*
    - ***Do they remind you of anything you use for drawing?*** *(crayons)*. ***They are made of wax just like crayons, but they***

don't have any color in them. Let's find out if we can draw with them.

5. Tell the students to draw a picture on their cardstock with the birthday candle. It works best if they hold the candle upside down and use the flat end.
   a. If you have extra white crayons, you can have students use those instead of or in addition to the candles.

6. Allow them to draw for a few minutes.

   Discussion Prompts:
   - ***Can you see your drawings?*** *(No).*
   - ***What do you think will happen if we use our colorful water to paint over the drawings?*** *(The paper will turn colors; we might be able to see where the wax is on the paper).*

7. Hand out paintbrushes to each student.
8. Have students paint over their entire piece of cardstock with the colorful water. This will reveal the painting as a white drawing with a colorful background.

   Discussion Prompts:
   - ***What happened?*** *(The paper without the wax turned colors, the drawing stayed white).*
   - ***Why do you think that is?*** *(The paint can't stick to the wax, but it can absorb into the paper).*
   - ***What do we call a substance that doesn't like water?*** *(Hydrophobic).*
   - ***Do you think wax is hydrophobic?*** *(Yes!)*

9. Students can take home their drawings in the sandwich bags if they would like. Have them drain the excess liquid off the paper either into a sink or back into the cups of colorful water first.

Activity Six – Daily Debrief Time: 5 Minutes

Supplies	#
Lab Notebooks	16
Pencils	16

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. <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 would you pass along a secret message? Would you use a code, chemicals, etc.?***

<u>Clean up</u>: Make sure students help clean up the room before they leave.

<u>What to save</u>:

Materials used	#	SAVE	Materials used	#	SAVE
Bags (Ziploc, sandwich)	16	0	Paintbrushes	16	16
Bags (Ziploc, snack)	16	0	Pans (large, oval, aluminum)	2	2
Baking soda (oz)	0.5	0	Paper towels (large rolls)	1	1
Birthday candles	16	0	Pitchers with lids	1	1
Cardstock ½ sheets	16	0	Plates (10in, paper, high sides)	8	0
Color fizzers labeled "wax paintings"	8	0	Plates (9in, brown kraft)	16	16
Cotton swabs (6in, wood handle)	8	0	Scissors (site provides)	16	16
Cups (20oz, plastic)	1	1	Spoons (plastic)	5	5
Cups (1oz, plastic, calibrated)	1	1	Tape (rolls, Scotch)	2	2
Cups (9oz, plastic, punch)	17	17	Transparencies (3.67inx4.25in pieces)	16	0
Gloves (pairs - vinyl, disposable, small)	16	0	Turmeric mixture (bag)	1	0
Index cards (half-size, 2.5inx3in - 1 is extra)	30	0	Water		
Newspaper					

<u>What goes home</u>: Wax painting and 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 K-3)

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):

- **Act. 2a:** Use the funnel to fill twenty-four vials approx. 1/3-full of oil.
- **Act. 2b (Optional):** For eight of the vials of oil above, add water until the vials are 2/3-full total.
- **Act. 2c:** Fill four 9oz cups half-full of water.
- **Act. 2d:** Fill four 9oz cups half-full of vinegar. Put a pipette labeled "V" in each cup. If desired, use the wet-erase marker to label each cup "V."
- **Act. 3a:** Fill a 9oz cup less than ¼ -full of Milk of Magnesia. Put the pipette labeled "M" in it.
- **Act. 3b:** Use the calibrated cup to put .5oz of baking soda in a 9oz cup. Put a spoon in the cup.
- **Act. 3c:** Fill a 20oz cup half-full of water. Add the cabbage juice powder. Stir with a new spoon.
- **Act. 3d:** Divide the cabbage juice liquid evenly into four 9oz cups.
- **Act. 4:** 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.

Activity One – Pair & Share — Time: 5 Minutes

Supplies	#	Supplies	#
Pencils	16	Lab notebooks	16

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

Suggested Reading: *Ada Twist, Scientist* by Andrea Beaty

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 a problem that you could try to solve with chemistry?*** *(Making things turn hot or cold, creating new polymers, 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.

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

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).

Acid/Base Behavior. The vial with oil, water, and vinegar (left) separated out the same way as the regular oil/water vials. The vial with oil, water, and soap (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

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

5. Have students:
   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.

   Discussion Prompts:
   - ***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. Have students:
   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.

   Discussion Prompts:
   - ***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. Ask students: ***These will be our experimental vials. Let's try adding vinegar to one vial and soap to the other. 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.

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.

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 <u>large</u> 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. <u>Tell students:</u> ***Let's see what happens when we shake the vials this time!***

14. <u>In each group, have the students who *didn't* add vinegar or soap</u>:
    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).

    <u>Discussion Prompt:</u>
    - ***What happened?*** *(Soap helped the oil and water mix better and stay mixed longer.)*

16. <u>Ask students:</u>
    - ***How did the soap do that?*** *(When you shook the original oil/water vials, you caused the oil and water to form an <u>emulsion</u> 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 <u>emulsifier</u> 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!***

17. 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.

    <u>Discussion Prompt:</u>
    - ***What do you think will happen if you add vinegar vs. soap to the chalk?*** *(Students may remember putting vinegar on chalk*

in Class 1, though they probably haven't put soap on chalk before.) ***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.)*
21. <u>Ask students:</u>
    - ***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.)*

22. Give each student a piece of tape (or make rolls of tape available to share).
23. Have students tape the lid securely on their original oil/water vial, put the vial in their Ziploc snack bag, and seal the bag.
24. 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	1	Paper towels (large rolls)	1

red cabbage juice powder (.18tsp) & 1 pipette labeled "M")			
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 in soil that’s basic (https://bit.ly/3RvAEbF, https://bit.ly/3QVEURw).

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).

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.

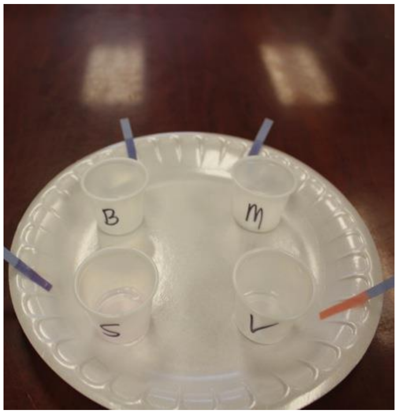
1. Ask students: ***How can you tell whether something is an acid or base? Let's find out!***

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. Ask students: ***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 basis. 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 blue for bases!)*

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

7. Put the following items on a brown kraft plate at each station:
   a. **Baking soda (B):** 9oz cup with .5oz of baking soda & a spoon in it (from Prep).
   b. **Milk of Magnesia (M):** 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. **Soap (S):** The bottle of dish soap.
   d. **Vinegar (V):** 9oz cup half-full of vinegar (from previous activity) and a "V" pipette.
   e. **At each station except the Vinegar station,** 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.")



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.

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).

9. Tell students: ***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).***

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

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

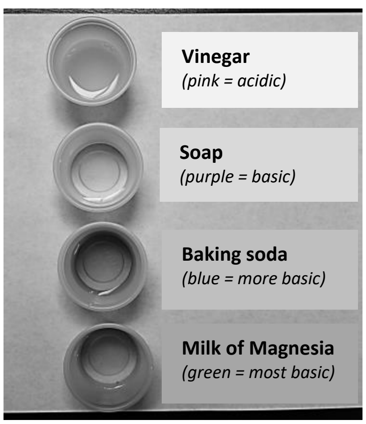
11. Have students return to their group and put their 1oz cup on the brown kraft plate.
12. Give each group four pieces of blue litmus paper.
13. In each group, have students:
    a. Dip a piece of litmus paper *halfway* into the liquid in their 1oz cup.
    b. Lay the wet strip of litmus paper on the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

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).



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.

- ***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.

    <u>Discussion Prompts:</u>
    - ***Does anyone know what this is?*** *(Cabbage juice!)*
    - ***What does it do?***

15. <u>Tell students:</u> ***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.***

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

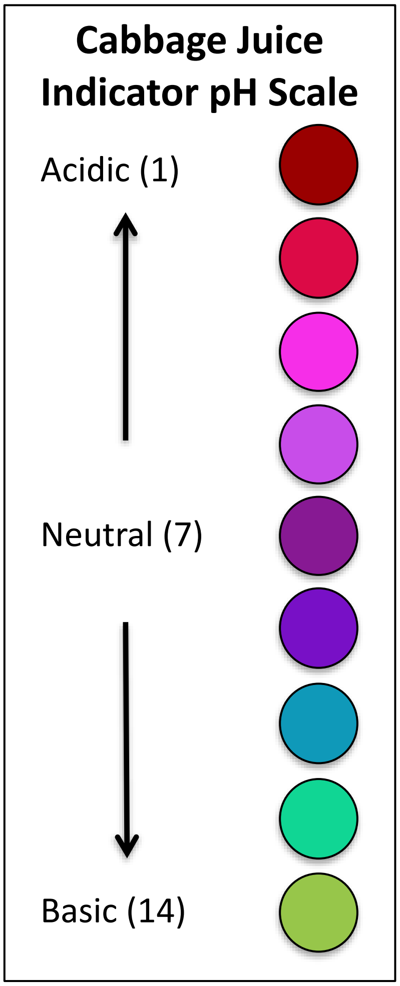
<u>CAUTION</u>: <u>Cabbage juice indicator can stain clothes and surfaces</u>.
- **Make sure students are careful when transferring cabbage juice indicator via pipette from the 9oz cup to other liquids.** Also, make sure groups keep their cup of cabbage juice indicator in the 9in pan to protect against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

17. <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!***

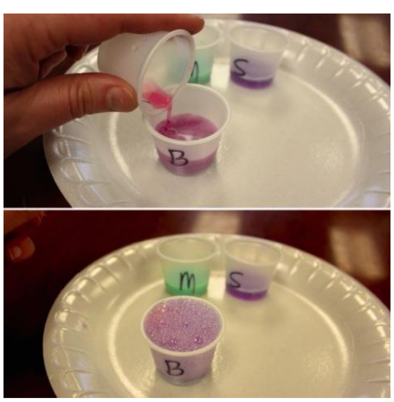
18. <u>In each group, have students take turns doing the following</u>:
    a. Use the pipette to add <u>two</u> full pipettes of cabbage juice to the liquid in their 1oz cup.
    b. While keeping the 1oz cup on the plate, gently swirl the liquid.

19. 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!)*



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.



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

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

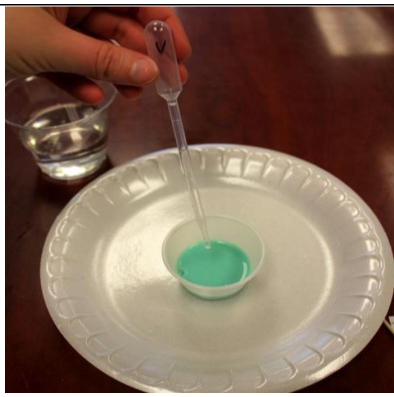
<u>TIP</u>:	• **When students compare the color of each liquid to the pH scale, have them look for a *rough* match.** The colors may be close but not exact.

22. <u>Ask students:</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.)*
    - ***Is 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?***

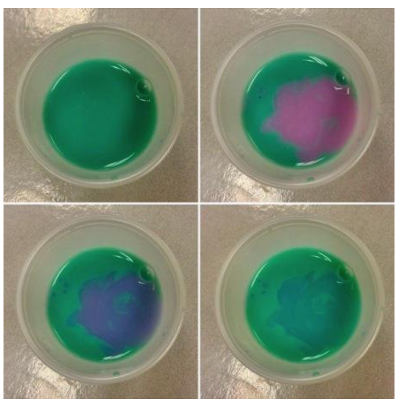
23. <u>Have groups</u>:
    a. Make a hypothesis about what will happen.
    b. Slowly pour the 1oz cup of vinegar into the 1oz cup of baking soda.

    <u>Discussion Prompts:</u>
    - ***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!***

24. 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).
25. Have each group put their cup of vinegar in the 9in pan to share.
26. Have students get into pairs within their group.
27. Give each pair an empty 2oz cup and a brown kraft plate.
28. <u>In each pair</u>:
    a. Have one student gather a sample of Milk of Magnesia in the 2oz cup (add <u>two</u> full pipettes of Milk of Magnesia this time, and <u>don't</u> add water).
    b. Have the student bring the sample back and put it on the pair's plate.
    c. Have the other student add <u>two</u> full pipettes of cabbage juice indicator to the Milk of Magnesia in the 2oz cup.



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.

<u>Discussion Prompt:</u>

- ***What do you think will happen if you add vinegar directly to the Milk of Magnesia?***

29. Have students make a hypothesis about what will happen.
30. 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.

<u>Discussion Prompts:</u>

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

31. <u>In each pair</u>:
    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.

<u>TIP</u>:
- **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.

<u>Discussion Prompt:</u>

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

32. 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.
33. 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.
34. 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.)

35. Save the remaining blue litmus paper (at least 20 pieces) and all the 2oz cups.
36. 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)	1.5	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 - 3 with vinegar & 3 with water from previous activities)	7	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	

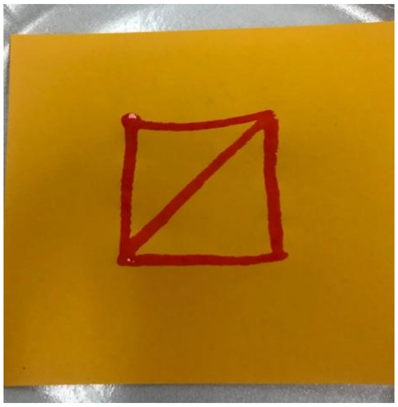
Goal: To explore acid-base reactions using Goldenrod Color-Changing Paper.

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).

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.

Procedure:
1. Give each student a quarter-sheet of goldenrod color-changing paper.
2. Ask students:
   - ***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!***
3. Put students in 3 groups.
4. 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



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.

(adjust the amount of water in the cups as needed from previous activities).

5. Use the calibrated cup to add about .5oz of baking soda to each group's quarter-cup of water. Stir with the spoon.
6. Give each student a brown kraft plate (dried off from the previous activity) and a cotton swab.
7. 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.
    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?***

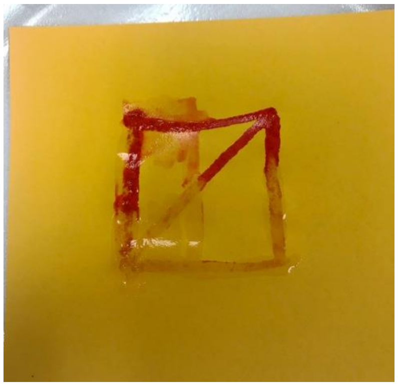
8. Explain to students: ***The baking soda chemically reacted with an ingredient in the paper and caused a color change. The paper's golden color comes from a dye that's an acid-base indicator. The indicator turns red when it reacts with a base.***

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

Discussion Prompts:

- ***Does this remind you of any other experiments we have done****? (The invisible ink from the last class. This paper is also made from turmeric.)*
- ***Could you use what you learned about the paper to make a design to take home?***

10. Give each student a new quarter-sheet of goldenrod paper.
11. 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.



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.

12. *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!)*

13. Give each group a 9oz cup a quarter-full of vinegar (refill the cups of vinegar from the previous activity as needed).
14. 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).

15. 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:

- ***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?***

16. Tell students: ***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.***

17. Give students time to explore using the two liquids on their "tester" paper.
18. 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; however, after a moment, the red color returns. Much like in the previous activity, the Milk of Magnesia partially neutralizes the acid in the vinegar.)

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.)*

19. 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.)

20. Have students discard their "tester" sheet.

Activity Six – Daily Debrief — Time: 5 Minutes

Supplies	#
Lab Notebooks	16
Pencils	16

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 up 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.

Cool Chemistry: Fizz, pop, WOW! (Grades K-3)
Class 7: Marvelous Molecules

Supplies	#
Bags (Ziploc, snack)	16
Glue (bottles, tacky)	4
Gumdrops kit (16 bags with 20 gumdrops and 20 toothpicks in each)	1
Newspaper	
Paper (strips, white)	16
Paper towels (large rolls)	1
Pencils	16
Pom poms (3 colors)	336
Scissors	16

Worksheets:

Worksheets: Awesome Atoms (½ sheet)	16
Worksheets: Make a Molecule	8
Worksheets: Meet the Atoms (1/2 sheet)	16

Prep (prior to class):

- **Act. 3a:** Make 16 piles of pom poms. Each pile will have 7 of each color pom poms for a total of 21. You can place them in Ziploc sandwich bags to hand out to the class. If you have fewer than 16 students, divide the pom poms evenly.

Activity One – Pair & Share — Time: 5 Minutes

Supplies	#	Supplies	#
Pencils	16	Lab notebooks	16

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

Suggested Reading: *Once Upon an Atom* by James Carter. The author has a video of himself reading the book here (https://bit.ly/3iGmYOE)!

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 the smallest thing you can think of?***
   - ***Can you think of anything smaller than that?***

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.

Activity Two – How Small is an Atom? — Time: 5 Minutes

Supplies	#	Supplies	#
Paper (strips, white)	16	Scissors	16

Goal: To demonstrate how small atoms are using a strip of paper.

Source: *https://bit.ly/3uyd6Jr*

Background:

Atoms, the building blocks of the universe, are so small that it's hard for kids (and adults!) to visualize their size. For example, a single cell from the human body contains 100 trillion atoms! This paper cutting activity is one way to help kids understand just how tiny these "building blocks" of matter are (https://bit.ly/3Bh0CK9).

How small: top paper strip is unfolded; bottom strip is folded in half.

<u>Procedure</u>:

1. <u>Ask students:</u>
    - ***We have spent some time talking about matter. Do you know what the smallest piece of matter is called?*** (Atoms).
    - ***Atoms are the smallest piece of matter in the universe. How small do you think they are? Do you think you can see atoms?*** (Only with a special kind of microscope!)

2. Hand out a paper strip and a pair of scissors to each student.
3. <u>Tell students:</u> ***We are going to try and see just how small an atom is. This piece of paper is made up of millions of atoms and we are going to try and cut it down to one atom.***

4. Demonstrate folding the strip of paper in half so that the two short ends are touching (see picture on left).
5. Cut the paper strip in half along the fold.
6. <u>Ask students:</u>
    - ***My strip of paper is now cut in half. If I keep folding and cutting it in half over and over, what do you think will happen?*** *(It will be very small).*
    - ***Do you think we can make the paper into the size of one atom? Let's find out!***

7. Have students try folding and cutting their paper strips as many times as they can. Tell them to only fold and cut the same way you demonstrated. They will eventually find it too difficult to cut the paper.

    <u>Discussion Prompts:</u>
    - ***How many times were you able to fold your paper before it was too small to fold anymore?*** *(Probably 4-7 times).*
    - ***Do you think this is how small an atom is?*** *(No!)*

8. <u>Tell students</u>: ***If we were able to fold and cut the paper 31 times, it would be the size of one atom. That's really small! Too small for us to see or for our scissors to cut. Now that we know how small an atom is, we are going to talk about what they are made of.***

9. Have students return their scissors and throw away any leftover bits of paper.

Activity Three – Awesome Atoms Time: 25 Minutes

Supplies	#	Supplies	#
Glue (bottles, tacky)	4	Worksheets: Awesome Atoms (½ sheet)	16
Pencils	16	Worksheets: Meet the Atoms (1/2 sheet)	16
Pom poms (3 colors)	336		

Goal: To model atom structure using different colors of pom poms.

Source: AKA Science, Dr. Carrie Buo

Background:

Atoms are made of positively charged protons, negatively charged electrons, and neutral neutrons. The protons and neutrons stick together in the center of the atom in the nucleus, while electrons orbit the nucleus. While the model we use here shows the electrons orbiting in a circle, they actually orbit in shells of various shapes. The innermost shell can only hold 2 electrons while the other shells hold up to 8 electrons. We have simplified the model to make it easier for children to understand the basic structure of an atom (https://bit.ly/3FeaGVi).

Procedure:

1. Ask students: ***We know that atoms make up all matter, but what are the parts of an atom?***

2. Tell students:
   - ***Atoms are made up of even smaller particles called protons, neutrons, and electrons.***
   - ***Protons have a positive charge and electrons have a negative charge, like the different ends of a battery.***
   - ***Neutrons don't have a charge.***

3. Have students sit in groups of 4, they will be sharing bottles of glue.
4. Hand out the *Meet the Atoms* worksheet to each student.
5. Tell students:
   - ***This worksheet shows some different atoms, also known as elements. Each box on the sheet is a different atom.***
   - ***You may recognize some, like oxygen and helium. The letters in the middle of the box are the symbols or nicknames for the atoms. This means the symbol for oxygen is a big O.***

   Discussion Prompts:
   - ***What else do you notice about the boxes?*** *(There are numbers in the top left corner, there are numbers on the bottom next to plus, minus, and equals signs. Some of the numbers are the same).*

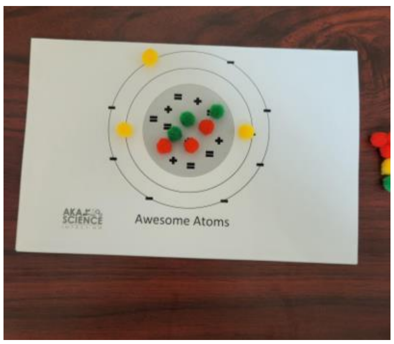
Act. 3, Awesome Atoms. Choose an atom (element) from the Meet the Atoms worksheet and count out the number of pom poms you will need. This is an example using lithium, which requires 3 protons, 3 neutrons, and 3 electrons.

6. Tell students: ***The numbers at the top of the box are called the atomic number, which is always the same as the number of protons in an atom.***

7. Ask students:
   - ***If protons are always a positive or plus charge, which sign would show us how many protons we have in each atom?*** *(The plus "+" sign.)*
   - ***What about electrons that always have a negative or minus charge?*** *(The minus "—" sign.)*
   - ***And the neutrons?*** *(The equal "=" sign.)*

8. Have students stand up and divide the students into 3 groups as evenly as possible. This will be a physical demonstration of an atom!

   a) Assign one group to be protons, one to be neutrons, one to be electrons. If needed, tear out a page from notebooks and write the symbol for each student to hold (+, =, or —).
   b) Have the protons and neutrons stand together in a group. This will be the nucleus.
   c) The students in the nucleus can move around a little bit and gently bump into each other, but they should remain in a group.
   d) Have the electrons walk in a circle around the outside of the nucleus. This is how the electrons orbit the nucleus!
   e) **OPTIONAL:** For an added challenge, try to figure out which element you made by referring to the *Meet the Atoms* worksheet! Just count the number of protons and electrons you had in your atom and find the matching box on the worksheet.



Act. 3, Awesome Atoms. Glue the pom poms to the worksheet in the areas indicated by the plus, minus, or equals signs on the Awesome Atoms worksheet. Don't forget to write the name or symbol of the atom on your worksheet, too!

9. Have students return to their seats and hand out a pile of pom poms (from prep, 7 of each color) and a copy of the *Awesome Atoms* worksheet to every student.
10. Give each group of 4 students a bottle of tacky glue. You may also want to spread newspaper if you are concerned about the glue making a mess.
11. Tell students: ***We have three different colors of pom poms: one color for protons, one for electrons, and one for neutrons. Let's decide which color we will use for each!***

TIP:	• **It may be helpful to write the colors you assign protons, electrons, and neutrons on a chalk board/white board if you have access.**

12. Ask students:
    - ***What do you notice about the worksheet?*** *(They have circles, there are* **+** *and* **=** *signs in the middle circle, and* **—** *signs along the other circles).*

- ***If there are plus and equals signs in the middle of the circle, which of the three parts of an atom go there?*** *(Protons for the plus signs and neutrons for the equals signs).* ***Protons and neutrons are found in the middle of an atom. This is called the <u>nucleus</u>.***
- ***What about electrons? Where do they go on the paper?*** *(Along the other circles).*

13. <u>Tell students:</u>
    - ***Electrons don't clump together like protons and neutrons, they spin around the outside of the atom, just like the moon orbiting earth or all the planets going around the sun.***

14. Have students look back at the *Meet the Atoms* worksheet and notice the first box with the big H in the middle.
15. The students will see a 1 next to the + sign, a zero next to the = sign, and a 1 next to the – sign. That tells us how many protons, neutrons, and electrons are in this atom called Hydrogen.
16. Have students pick one of the boxes from 1 to 7 and use the numbers to see how many protons, neutrons, and electrons their atom will have.
17. Allow students a few minutes to select an atom and count out their pom poms.
18. Have students place their pom poms on their *Awesome Atoms* worksheet to build an atom!
19. Once students do this, they can glue the pom poms in place if they wish.
20. Give the class time to try other atom configurations before gluing pom poms in place.
21. Have students write either the name or symbol for their atom on the paper.
22. Lay the Awesome Atoms worksheets aside to dry while you do the next activity.

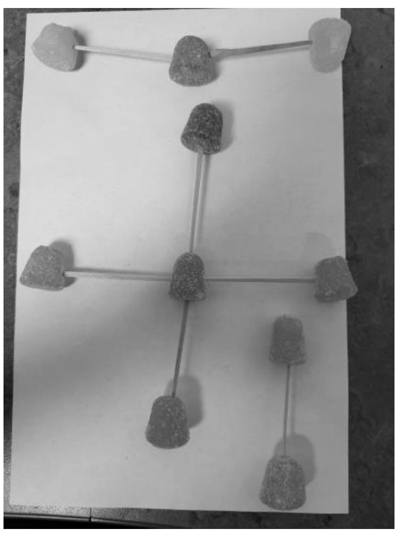
Activity Four – Meet the Molecules Time: 20 Minutes

Supplies	**#**	**Supplies**	**#**
Bags (Ziploc, snack)	16	Paper towels	1
Gumdrops kit (16 bags with 20 gumdrops and 20 toothpicks in each)	1	Worksheets: Make a Molecule!	8
Newspaper			

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

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

<u>Background:</u>


Examples of gumdrop molecules

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 molecules, which can be as simple as water or as complex as DNA.

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. 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) (https://n.pr/3AzRKhk, https://bit.ly/3e6b4vl).

Procedure:

1. Ask students:
   - ***Now that we know matter is made of*** *(Atoms)* ***and we know what atoms are made of*** *(protons, electrons, and neutrons),* ***we are going to look at how they can combine to create matter!***
   - ***Do you know what molecules are?*** *(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).*
   - ***What are the different states of matter?*** (Solid, liquid, and gas).

2. Tell students:
   - ***States of matter depend on how fast the molecules can move.***
   - ***The air we breathe is a gas, so the molecules move fast and are very spread out.***
   - ***Water is a liquid and has 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.***

   Discussion Prompts:
   - ***What is the molecule formula for water?*** *(H_2O)*
   - ***Have you heard of any other molecule formulas?*** *(Examples are carbon dioxide: CO_2, oxygen: O_2. Try looking up more examples online!)*

3. Have students form pairs.
4. Hand each group of two a *Make a Molecule!* worksheet.

   Discussion Prompt:
   - ***What do you notice about the items on this worksheet?*** *(They are gumdrops, each color stands for an atom, some things*

are liquid, solid, or gas, some colors of atoms are used more than once.)

5. Give each student a bag of gumdrops and a bundle of toothpicks.

TIP:	• **Once the activity is complete, the gumdrops are safe to take home and eat (if the kids are wondering if/when they can eat them!)**

6. Lay a sheet of newspaper or a paper towel over each workspace to contain the sugar from the gumdrops.
7. 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.
8. Students will 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.
9. Allow the students to trade gumdrop colors as needed and build as many molecules as they wish.
10. After they have finished building for several 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:
    - ***Did you notice that some colors of gumdrops were used more often than others? Why do you think that happened?*** *(Some atoms are more common or more useful in making molecules).*
    - ***Which gumdrop (atom) was used the most for building molecules on the worksheet?*** *(Purple, or hydrogen).*
    - ***What molecule(s) would you make with unlimited gumdrops?***

11. When removing the newspapers from the workstations, be aware that they will probably be covered in sugar granules.
12. Worksheets can either be sent home with students or collected at the end of the activity.

Activity Six – Daily Debrief — Time: 5 Minutes

Supplies	#
Lab Notebooks	16
Pencils	16

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. <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>
    - ***What's the weirdest, coolest, or most interesting thing you've experienced related to chemistry?***

<u>Clean up</u>: Make sure students help clean up the room before they leave.

<u>What to save</u>:

Materials used	#	SAVE	Materials used	#	SAVE
Bags (Ziploc, snack)	16	0	Pencils	16	16
Glue (tacky, bottles)	4	0	Pom poms (3 colors)	336	0
Gumdrops kit (16 bags with 20 gumdrops and 20 toothpicks in each)	1	0	Scissors	16	16
Newspaper			Worksheets: Awesome Atoms (½ sheet)	16	0
Paper (strips, white)	16	0	Worksheets: Make a Molecule	8	0
Paper towels (large rolls)	1		Worksheets: Meet the Atoms (1/2 sheet)	16	0

<u>What goes home</u>: Gumdrop molecule (in Ziplock snack bag) and *Awesome Atoms* worksheet with pom poms.

Cool Chemistry: Fizz, pop, WOW! (Grades K-3)

Class 8: Bubbles & Goop

Supplies	#
Baking soda (oz)	0.5
Bowls (20oz, sturdy paper)	4
Bubble solution (32oz 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 fifty-foot ball of yarn)	1
Chopsticks (pairs, round)	16
Cups (1oz, plastic)	6
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, Styrofoam)	20
Popsicle sticks (jumbo)	4
Scissors (site provides)	16
Sticks (approx. 2ft, bamboo)	4
Straws (half-pieces, drinking)	48
Vinegar (oz)	2
Water	

Prep (prior to class):

- **Act. 2:** 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).
- **Act. 3a:** Fill the 2 large oval aluminum pans halfway with water. It is helpful to set the pans where you will be using them before filling them, preferably outside.
- **Act. 3b:** Squeeze some dish soap into two 1oz plastic cups, filling them about halfway.
- **Act. 3c. (Optional):** If your students will find it difficult to cut out the boat shapes, do this before class begins.
- **Act. 4 (Optional):** If desired, create two bubble wands as prep (see activity instructions).

Activity One – Pair & Share — Time: 5 Minutes

Supplies	#	Supplies	#
Pencils	16	Lab notebooks	16

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

Suggested Reading: *The Secret Science Project That Almost Ate the School* by Judy Sierra

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 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.

Worksheets:

None.

Activity Two – 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, Styrofoam - 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: To explore the 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)

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 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.

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.

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!

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.

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 Prompts:
    - ***What is this?*** *(Flubber/slime, also called "polymer putty.")*
    - ***What do you notice about it? Let's explore its properties!***

13. Give each student a Styrofoam 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?***

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

- ***What happens to flubber over time as you play with it?*** *(It gets stiffer and harder to stretch.)*

<u>**TIP**</u>:	• **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.
    (<u>Don't</u> send flubber home with students.)
17. Have any students who are wearing gloves remove them.
18. <u>**Have *all* students wash their hands thoroughly**</u>.

Activity Three – Soap-Powered Boats Time: 10 Minutes

Supplies	#	Supplies	#
Cotton swabs	4	Scissors	16
Dish soap (20oz bottles, liquid)	1	Water	
Pans (large, oval, aluminum)	2	Worksheets: Soap Boats (1/2 sheet)	16
Pitcher, plastic with lid	1		

<u>**Goal:**</u> To further explore how soap interacts with water by making a paper boat move using dish soap.

<u>**Source**</u>: https://bit.ly/3W08VIt

<u>**Background:**</u>

Water molecules are strongly attracted to each other and stick close together. This creates a strong but flexible "skin" on the water's surface called **surface tension**. Surface tension allows the cardboard boat to float on top of the water.

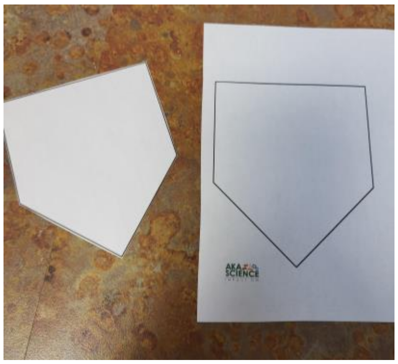
Adding soap disrupts the arrangement of the water molecules. The water molecules near the detergent are attracted to the detergent as well as to other water molecules, so the surface tension of the water behind the boat decreases. Water molecules move from areas of low surface tension to areas of high surface tension. The boat is pulled towards areas of high surface tension by the water in front of the boat (https://bit.ly/3PgkTp4).

<u>**Procedure**</u>:

<u>**TIP**</u>:	• **It is best to do this activity outside in case water spills out of the aluminum pans.**

1. Ask students: ***In Class 2 we talked about how soap works. Can anyone remind us?*** *(It has two tails, one water-loving (hydrophilic) and one that doesn't like water (hydrophobic). The hydrophilic end sticks to water but the hydrophobic end doesn't.)* ***Let's explore soap's hydrophobic properties more!***

2. Put students in 4 groups.
3. Give each student a Soap Boats worksheet (half sheet of paper, has outlines of 2 boats on it) and scissors.
4. If you have time, students can decorate ONE SIDE of their boats with crayon. Make sure they only color on one side.
5. If you didn't cut out the boat shapes during prep, have students cut both sheets out with scissors.



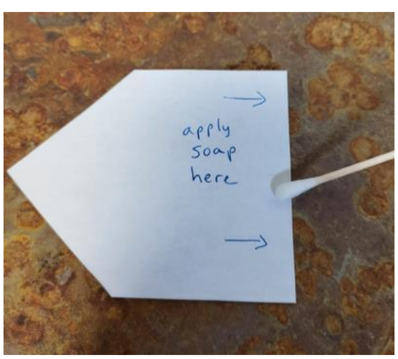
Act. 3, Soap-Powered Boats. Cut out two boats. See what happens when you float one in water.

Discussion Prompts:
- ***What do you think will happen if we put our boats in water?*** *(They will float, maybe sink).*
- ***Do you think something different would happen if there was soap on the boat?***

6. Have students make a hypothesis about what they expect to happen with the boat in the water with and without soap on them.
7. Have students try floating ONE of their boats in the water of one of the two pans. If the boats have been colored with crayons, have them put the blank side down on the water.

Discussion Prompts:
- ***What is happening to the boats?*** *(They are floating).*
- ***Are they moving around much?*** *(Not really, maybe just gently bobbing around.)* ***Let's see what happens when we put some soap on them.***

8. Have students remove their boats from the water.
9. Using their dry boats, have students spread a line of dish soap along the flat edge of their boat opposite the pointed edge (see photo left) using a cotton swab and the cups of dish soap from prep. Students will need to share cotton swabs.
    a. If students have used crayons on their boats, make sure they add soap to the blank side.



Act. 3, Soap-Powered Boats. Apply soap to the flat edge of the boat opposite the pointed side. Place this boat soap-side down in water and watch it zoom across the surface!

10. In groups of 2-3 students at a time per aluminum pan, have students set their boats on the water with the soap side down and toward the back of the pan.
11. Allow all students to try their boats.

Discussion Prompts:
- ***What happened?*** *(The boats moved forward across the water).*

- ***Why did this happen?*** *(The hydrophilic end of the soap was trying to move toward the water, making it easier for the boat to move across the water!)*
- ***What else could you do with this experiment?***

Activity Four – Bubble Mania   Time: 20 Minutes

Supplies	#	Supplies	#
K-3 Bubble Packs (16 pipe cleaners, 2 transparency pieces 2 plastic mesh pieces, 2 folded paper towels, & 2 ½ sheets white paper)	1	Pans (9in, round, aluminum)	4
Bubble solution (8oz bottles)	1	Paper towels (large rolls)	1
Bubble solution (mini bottles)	16		

Goal: To learn about bubbles and test if they will pop when landing on different surfaces.

Source: *Chemistry Experiments* by Louise V. Loeschnig

Background:

Water has surface tension, which 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.

Whether a bubble pops when it comes in contact with a solid surface depends on many different factors, including the surface properties of the material. You probably know that different materials have different properties, some of which you can see or feel (like color or density). However, materials have some other properties that are harder to observe directly. Surfaces can be hydrophobic (repel water) or hydrophilic (attract water). You can observe this by dropping some water onto the surface and seeing whether it forms big beads (hydrophobic) or spreads out in thin sheets (hydrophilic). Whether a material is hydrophobic or hydrophilic depends strongly on its surface roughness. Some materials, like sandpaper, have macroscopic surface features, meaning you can feel the bumps and see them with your naked eye. However, other materials have microscopic surface features. Even if the material looks and feels smooth to you, it might have very tiny bumps or pores. These can actually help the material repel water, because the surface of the water, held together by surface tension, is unable to penetrate into the tiny gaps in the material. Other materials, like paper or sponges, have larger gaps that help then *absorb* water (https://bit.ly/3BloBYE).

Cool Chemistry: Fizz, pop, WOW! (Grades K-3)

Class 8: Bubbles & Goop

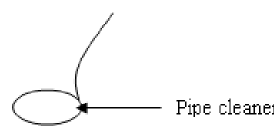
Procedure:

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 can be helpful.)

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)*
    - ***What happens when a bubble lands on something?*** *(It pops or it might stick to the surface.)*
    - ***What happens when a bubble pops?***

2. Take students outside. Have students help you carry the supplies for this activity.
3. Put students in 4 groups.
4. Give each student a pipe cleaner and each group should have one combination of testing materials:
    a. 1 transparency piece and 1 folded paper towel.
    b. 1 transparency piece and 1 ½ sheet white paper.
    c. 1 plastic mesh piece and 1 folded paper towel.
    d. 1 plastic mesh piece and 1 ½ sheet white paper.

5. Have students bend their pipe cleaners to make a bubble wand. The wand loop works best as a circle, but students are free to try any shape. Make sure to twist the short end of the pipe cleaner around the long stem of the pipe cleaner to complete the loop (see picture on left).

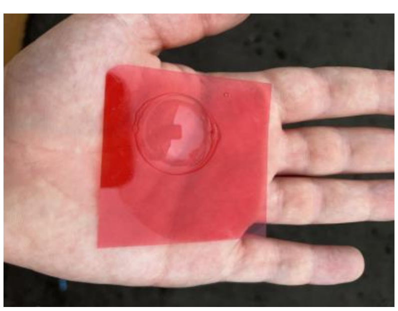


6. Divide the bubble solution among the four 9in aluminum pie pans and give one to each group.
7. Have students dip their bubble wands into the solution and blow bubbles to make sure their wands work. Now is the time to adjust the wands if they are not able to form bubbles.
8. Ask students: ***Each group has 2 pieces of material to test for catching bubbles. What do you think will happen when we try to catch bubbles with each of these materials?***

9. Have groups:
    a. Decide which student(s) will be in charge of holding the testing materials and which students will blow bubbles.
    b. Have bubble blowers blow bubbles and the materials holders try to catch the bubbles.

Discussion Prompts:

Act. 4, Bubble Mania. Make different kinds of bubble wands using the pipe cleaners. They can have any shape loop as long as the loop is closed by twisting it around the stem.



Act. 4, Bubble Mania. Try to catch the bubbles using the different surfaces provided. After trying the surfaces dry, dip them into the bubble solution then try catching again. The bubbles should stick now!

- ***What happened to the bubbles when they touched the testing materials?*** *(They popped).*
- ***Is there a way we can make the bubbles stick to the testing materials without popping?***

10. If students want to switch roles, do it now.
11. Have material testers dip the materials in the bubbles solution before trying to catch the bubbles.
12. Repeat the bubble blowing and catching process as above.

    Discussion Prompt:
    - ***Were you able to catch any bubbles this time?*** *(The plastic mesh and the transparency should have held the bubbles. The paper and paper towel may or may not have worked, depending on how much bubble liquid was soaked up).*

13. Repeat bubble blowing as desired, allowing students to change the shapes of the bubble wands. This is a time for free exploration.

    Discussion Prompt:
    - ***Why were we able to catch bubbles on the surfaces that had bubble solution on them but not on dry surfaces?*** *(Bubbles are very fragile, so they can pop when the contact anything. When a surface has bubble solution on it, the bubbles can stick to the bubble solution and not even touch the surface!)*

Activity Six – Daily Debrief & Wrap-Up! Time: 5 Minutes

Supplies	#
Lab Notebooks	16
Pencils	16

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 was your favorite part of this class?***
    - ***How can you keep exploring chemistry at home or at school?***
    - ***What is one question you have about chemistry now that you've completed this class?***

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

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!
- **Any questions?** Please reach out to the AKA Science Program Manager, Kathryn Sechrist at ksechrist@impactnw.org

THANK YOU FOR TEACHING AKA SCIENCE!!!!!!!!

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