Celebrating Chemistry

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Do you think children who lived a thousand years ago had toys? Believe it or not, they did! Their toys were very simple compared to the toys that you play with every day. Their toys were mostly handmade from things that were found in nature, like animal bones, stones, wood, or clay. The ancient Greeks and Romans played with rattles and dolls made from clay. They also played with wooden tops, barrel hoops, and horses carved from wood. The Egyptians played with marbles made from stone. Kites flown in Asia were once made with wood and cloth. Can you imagine playing with a stone yo-yo? Children in Greece and Egypt did.

Children played with the same types of toys through the 1600s. During the 1700s when George Washington became president of the United States, scientists began to discover and invent more materials to make toys. Not only could they use rocks, wood and clay, but they could also use cotton, leather and paper. Children began to play with picture alphabet cards, puzzles and board games.

Hand-carved wooden toys like rocking horses, toy soldiers and dolls were popular with children through the early part of the 1800s. Since it took time to hand-make wooden toys, only a small number could be sold at a time and they were expensive. Toy makers looked for ways to make toys affordable for all children to enjoy.

The invention of machines changed how things were made in the 1800s, especially toys. They helped make toys faster than by hand and in larger numbers, so toys could be more affordable. Machines also helped to make toys and some of their parts from metals like aluminum, tin and iron. For example, toy trains and trolleys had wind-up tools made from tin to make them move. Cast-iron toys were made to look like bank buildings and horse-drawn fire engines. Machine-made toys became were very popular among toy makers and children because they could be shaped and cut to look like real-life things.

Another type of material used to make toys is plastic. The first type of plastic, celluloid, was invented around 1870. It was cheap and could be easily molded. The first plastic baby rattle was made out of this material. The plastic that most toys are made from today is called polystyrene and it was invented in the late 1920s. It is strong and can be stretched and shaped into different things. More toys were made with this type of plastic after 1945. Some of the toys that were introduced at this time were Lego blocks, Mr. Potato Head, and Cootie. Have you ever played with these toys? Ask your parents and grandparents if they had these toys as children.

Thanks to discoveries by inventors, scientists and engineers, toys today are made from stronger and safer types of materials. Although many toys are still made with wood, metals and plastics, there are strict rules on how they can be used in toys. Before you start playing with any new toys, be sure you and your adult partner read all the directions and instructions carefully.

Chemistry plays an important part in the inventing and making of toys. In this issue of *Celebrating Chemistry*, you will learn more about the chemistry of toys and make a few toys from items that may be found in your home or school. Read the articles about the materials and the chemistry used to make toys. After you have finished reading and doing the activities, ask your teacher or family members about the toys they played with as children. Share your knowledge of the chemistry in toys.

Hidden Objects

Check off each object as you find it!

Answers are on page 12.

- ☐ Artist's brush
- ☐ Balloon
- ☐ Baseball
- ☐ Boomerang
- ☐ Bowling pin
- ☐ Crayon
- ☐ Magnet
- ☐ Magnifying glass
- ☐ Yo-yo

Milli's Safety Tips!

Safety First!

Always:

- Perform the activities with adult supervision.
- Read and follow all directions for the activity.
- Read all warning labels on all materials being used.
- Wear eye protection, specifically splash and impact-resistant goggles.
- Follow safety warnings or precautions, such as wearing aprons and gloves, or tying back long hair.
- Use all materials carefully, following the directions given.
- Be sure to clean up and dispose of materials properly when you are finished with an activity.
- Wash your hands well after every activity.

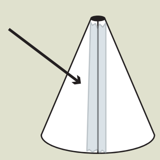
- **Never** eat or drink while conducting an experiment, and be careful to keep all of the materials used away from your mouth, nose, and eyes!
- **Never** experiment on your own!

For more information on safety go to chemistry.org/ncw and click on "Safety Guidelines".

Avogadro's Air Rockets

Even though you cannot see air, you know it is there. Air is a mixture of gases that we breathe every day even when we are sleeping. Have you ever had a toy that used air to make it work? Maybe you had a kite that caught the air and flew high in the sky. Perhaps you had a boomerang or flying disc that zoomed through the air. Some toys have special air pumps to create air pressure inside of them. In this activity, you will use air pressure to make Avogadro's Air Rockets go.

Materials



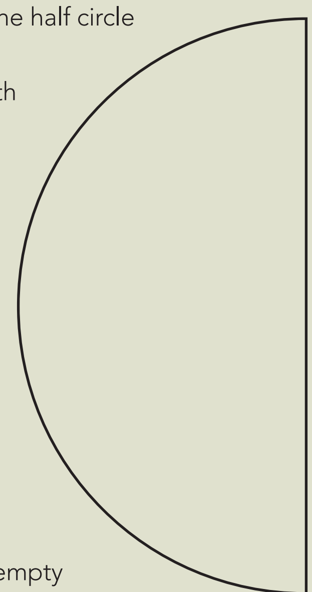
- Pencil
- Paper
- Blunt-ended scissors
- Tape (clear cellophane)
- Thin plastic coffee stirrer
- Straw
- Empty dish detergent squeeze bottle (remove cap, rinse out and shake dry)
- Colored pencil, crayon or water-based marker (optional)

ADAPTATION *Leave the top on the bottle, make a closed cone without the straw or coffee stirrer and blast the air rocket from the top of the bottle.*

SAFETY! *Be sure to follow Milli's Safety Tips and do this activity with an adult!*

Procedure

1. Use a pencil to draw a half circle on a piece of paper or trace the half circle shown here.
2. Cut out the half circle with the scissors. You may decorate your half circle with colored pencil, crayon or water-based marker.
3. Leave a small opening at the tip and tape it to make a cone.
4. Stick one end of the stirrer through the tip and tape it in place to the inside of the cone.
5. Place the straw into the empty bottle and hold it in place with your hand. Try to cover the opening around the straw as much as possible with your hand.
6. Place your air rocket onto the straw.
7. Point your air rocket away from yourself and from others. Give the bottle a hard squeeze and watch your air rocket go.
8. What happened to your air rocket? Write your answer in the "What Did You Observe?" section.
9. Launch your rocket several more times. Try to hold the bottle the same way and squeeze with the same amount of pressure each time.
10. Thoroughly clean the work area and wash your hands.

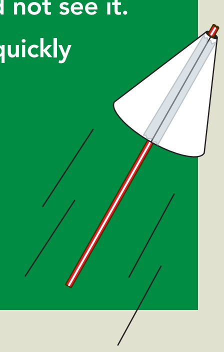


Try this...

Try making some air rockets with bigger and smaller half circles or different materials like aluminum foil, tissue paper, card stock or newspaper. Which ones go further? How might the materials make a difference? Consider the weight and the durability of the materials. What would make some better to use than others? Try using a plastic drink bottle instead of a dish detergent bottle.

Where's the Chemistry?

When you held the straw in place at the neck of the bottle and covered the rest of the opening, the straw was the only way for any air in the bottle to get out. When you squeezed the bottle, more pressure was put on the air inside. This shows that air was in the bottle even though you could not see it. You launched your air rocket by quickly changing the pressure on the air inside the bottle, forcing it out through the straw.



What Did You Observe?

What happened when you gave the bottle a hard squeeze?

Were you able to get similar results by holding the bottle and squeezing it the same way each time?

Describe how high the rocket went into the air.

Gases to Go

Air is all around us. The air on earth is made of different gases—we breathe them every day. The gases in the air move as wind. Strong winds can take a kite high into the sky or move a sailboat through the water. When air or any gas pushes against something else, a force or pressure is created.

To feel gas pressure, try blowing into an empty plastic bottle. What happens? The harder you blow into the bottle, the more gas pressure you create. You feel this pressure in how the air "pushes back" and keeps you from adding more.

Stretch a balloon over the mouth of the plastic bottle to seal it. Squeeze the bottle and see what happens to the balloon. The harder you push on the sides of the bottle, the larger the balloon becomes. The balloon inflates because you increased the gas pressure in the bottle as you pressed on its sides. As you press the sides of the bottle, you are pushing the gases in the bottle into the balloon where the gas pressure is less. When you let go of the bottle, there is less pressure on the bottle, and the air moves back into the bottle.

In the "Avogadro's Air Rockets" activity, air in the bottle is forced into a straw when you squeeze the bottle's sides. Air pressure is created, which pushes the rocket out of the bottle. This is similar to a rocket that is launched into space. Fuel is burned to make gases. The gases build up in a small area near the base of the rocket increasing the gas pressure inside. As the gases escape to the outside of the rocket where the gas pressure is lower, they push the rocket along.

Some toys need gas pressure to make them work. To make a Super Soaker work, you pump one of its chambers full of air. The more you pump it, the greater the air pressure becomes. When you pull the Super Soaker's trigger with your finger, the gas pressure pushes the water out of the nozzle, drenching the people around you.

Gas pressure is what makes some toy rockets and Super Soakers do what they're supposed to do. Can you think of other toys or objects that need gas pressure to make them go?

Zippy Zappy Boats

Did you ever wonder how a water bug stays afloat on water? The bug can stay afloat because of the surface tension of the water. Surface tension is the result of the water molecules sticking to one another. This packs the molecules together and forms a smooth surface, giving the bug a "floor" upon which to walk. In this experiment you will see what happens when you change the surface tension of water.

Materials

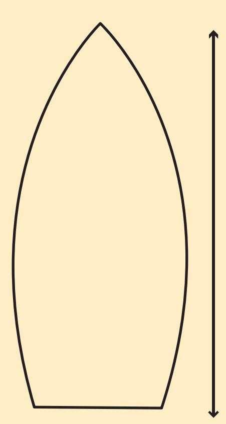
- Pencil or ballpoint pen
- Thin Styrofoam tray or plate
- Blunt-ended scissors
- Liquid detergent (any liquid soap or dish detergent)
- Cookie sheet or flat tray
- Water

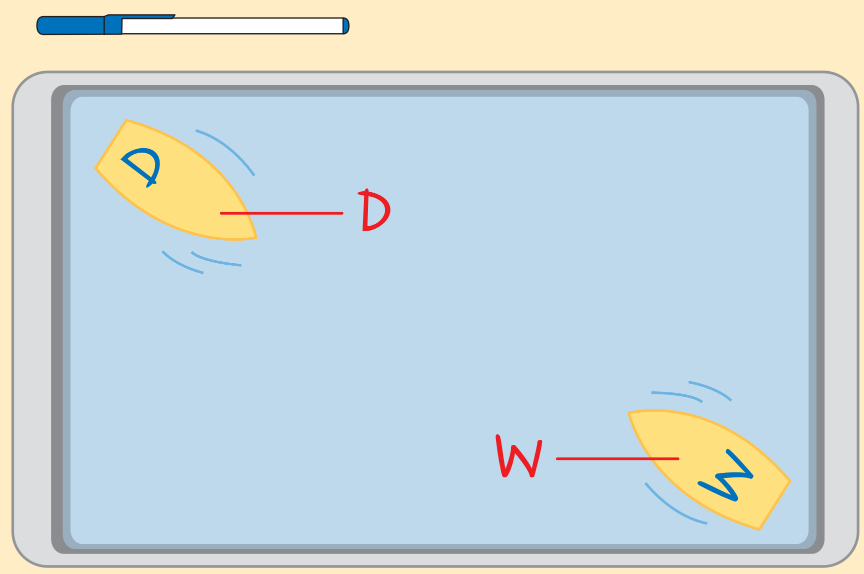
ADAPTATION *To help young participants keep the two boats separated, use two different colors of Styrofoam. The experiment may be done by placing two cut pieces of Styrofoam in opposite corners of the tray and touching a cotton swab dipped in liquid detergent to the surface of the water behind the boat. A notch may be cut into the flat edge of the boat to give participants a place to put their cotton swabs.*

SAFETY! *Be sure to follow Milli's Safety Tips and do this activity with an adult! Do not eat or drink any of the materials in this activity!*

Procedure

1. Use the pen or pencil to draw a boat about 5 cm (2 inches) long on the Styrofoam tray.
2. Cut out the boat with the scissors.
3. Trace around the boat at another location on the Styrofoam tray and cut out the second boat to create two identical boats.
4. Write a "W" on one boat and a "D" on the other one.





5. Place the boat labeled "D" letter-side down and put a drop of liquid detergent near the straight edge opposite of the point.
6. Allow the detergent to dry a few minutes. While the detergent dries out, pour water into the cookie sheet or tray until the water is about halfway up the sides.
7. Hold one boat in each hand with the letters facing up or have your adult partner help you. Place them flat on the surface of the water at the same time in opposite corners with their pointy ends heading toward the center of the tray. Observe what happens.
8. Record your observations in the "What Did You Observe?" section.
9. Recycle your boats and remaining tray or plate scraps. Carefully pour the water down the sink and wash out the cookie sheet or tray. Thoroughly clean the work area and wash your hands.

Try this...

Put fresh water in the tray and try repeating this experiment using vegetable oil instead of detergent. Make more boats and see if the size of the drop of detergent makes a big difference. Is the difference more notable when the drop has dried overnight? See if you can make a boat with a shape that moves more quickly through the water.

Where's the Chemistry?

Your "D" boat should have zipped across the water. Water sticks to itself very well, especially near the surface. A water molecule on the top of a puddle of water is pulled downward by the molecules beneath it. This special property of water is called cohesion. The cohesion of water creates a strong, flexible "skin" on the water's surface. Adding soap disrupts the arrangement of the water, and the water molecules near the boat have a harder time sticking to one another, making it possible for the boat to go forward.

What Did You Observe?

"W" boat	*"D" boat*

Reaction Action

Pfsst…sizzle…phwoosh! You could be hearing a chemical reaction. A chemical reaction can happen when chemicals are mixed together. When a chemical reaction takes place, you might see a color change or bubbles form. Other signs of chemical reactions are when you see light or feel heat after the chemicals are mixed together.

Chemical reactions occur all around us! If you leave your bicycle out in the rain, the chain could rust. The rainwater reacts with the iron in your chain and oxygen from the air to make orange rust spots. When you cut an apple in half and leave it sitting on the table for a few minutes, a chemical reaction will occur. The apple turns brown because it is also reacting with the oxygen in the air.

Many toys use batteries to make them work. There is a chemical reaction inside the battery. You can't see that reaction, but you know it happens because when the batteries are there, your toy works when you turn it on. Sometimes you have to put a new battery into your toy because the chemicals have reacted completely and can no longer power the toy.

What toys use chemical reactions? Snap a light stick. Chemicals combine and give off light. Some toys contain chemicals that turn colors. For example, there are rubber ducks that change color if the water is too hot. There are markers with special inks that change colors when you write or completely disappear because of chemical reactions.

Toy makers use chemical reactions in developing new materials for toys. They make materials like plastics that can hold any sort of shape. They can be completely round like a ball, or detailed like a truck. Toy makers experiment with different chemicals to find the brightest colors to use in toys. They have tried many different chemical reactions to make slime slimier and balls bouncier. Read about a toy chemist's work to make new toys in Meg A. Mole's interview on page 5.

Chemical reactions occur in many ways and they occur all around us. See what chemical reactions you can observe today!

It's a Gas!

Chemical reactions happen when some substances are mixed together. There are toys that use chemical reactions to make them go—like toy rockets that blast into the air and the Hot Wheels "Formula Fuelers" cars. Chemical reactions sometimes make products that we cannot see. If we cannot see them we can still find ways to show that they are there. When an effervescent antacid tablet is dropped into water, a gas is produced, but we do not see the gas in the air. Instead, we see the gas in the form of bubbles in the water. In this activity you will use a balloon to help you show that gas is made when an antacid tablet is put into water.

Materials

- Empty 4 oz. plastic bottle, clean
- Water
- Effervescent antacid tablet
- Paper towel
- Latex balloon (about 30 cm or 12 inches inflated diameter)
- Clock or timer

NOTE: It is helpful to blow the balloon up and let the air out a few times before using the balloon in the activity. This will allow the walls of the balloon to more easily expand to show the presence of the gas. It is also helpful to practice putting the balloon over the top of the empty bottle before conducting the activity.

ADAPTATION *The activity can be conducted by placing some small pieces of antacid tablet directly into the balloon before pulling the balloon over top of the bottle. When the balloon is securely on top, the balloon can be moved so that the antacid falls into the liquid. Balloons should be disposed of immediately after use.*

SAFETY! *Be sure to follow Milli's Safety Tips and do this activity with an adult! Do not eat or drink any of the materials in this activity.*

Procedure

1. Fill the plastic bottle half way with water.
2. Break one effervescent antacid tablet into several pieces over a paper towel. Carefully place the pieces of the tablet into the water.
3. Hold the bottle steady while your adult partner quickly pulls the opening of the balloon over the mouth of the bottle.
4. Look at the balloon once it is on the bottle so you can later draw a picture of it in the "What Did You Observe?" section.
5. Use the clock or timer and watch the balloon to see what happens in one minute's time (your adult partner may help with the timing so that you can watch the balloon).
6. After one minute has passed, remove the balloon from the bottle by pinching the neck of the balloon and gently pulling it off the mouth of the bottle. Slowly release the air from the balloon. Note: If at any time, you or your adult partner notices the balloon has gotten too big, remove it from the bottle.
7. Draw a picture of the balloon just after you put it in the bottle and one after a minute has passed in the "What Did You Observe?" section.
8. Pour the liquids down the drain and throw away the balloon and other materials. Thoroughly clean the work area and wash your hands.

Try this…

See what happens if you use more or less water to conduct the experiment. Also compare to see if there is a difference when warm water is used versus room temperature or cold water.

What Did You Observe?

Draw a picture of the balloon right after being placed on the bottle:	*Draw a picture of the balloon after one minute has elapsed:*

Where's the Chemistry?

Effervescent antacid tablets contain an acid, similar to vinegar or lemon juice, and a base, similar to baking soda. When the acid and base are dry like they are in the tablet, they do not react. When they dissolve in the water, they react to produce carbon dioxide gas. You cannot see this gas, but you can show that it is there by collecting it in the balloon.

The Adventures of Meg A. Mole, Future Chemist

This trip was to visit my new friend, Mr. Abimael "Maelo" Cordova, in the chemistry lab at Mattel, Inc. in California. Mr. Cordova is a toy chemist! He mixes chemicals together to create new elastic and rubbery materials that can be used in toys! He also experiments with ways of making them to see what works best. It's almost like cooking!

Mr. Cordova also makes plastics, inks, "gooey" compounds (like slime), gels, glues and paints. He makes sure the products work well and that they are safe for children.

Before I went to work with Mr. Cordova, I asked him about how he became interested in chemistry. He told me he has "always been curious about how things work". When he was in elementary school he did experiments around the house. He decided to be a chemist in high school after winning first place in a National Chemistry Fair in Puerto Rico.

Then Mr. Cordova took me to his laboratory at Mattel, Inc. where I met other chemists. Right now, they are working on a new kind of material that can be part of a toy in a movie! I was so excited to see that Mr. Cordova and his friends wear protective safety glasses like I do when they are in the lab!

While in the lab, Mr. Cordova showed me a type of blender that is used to mix chemicals together to make ink for markers. The special markers are called "dry erase" markers. They are used to write on white boards and the writing wipes right off! It is very important to mix the chemicals correctly so the ink won't damage the boards. We made inks in blue, orange, yellow and green!

Here I am pictured with Mr. Cordova, a toy chemist! Mr. Cordova thinks the best thing about being a scientist is that you learn how things work and you also get paid for doing what you enjoy!

Mr. Cordova also does research in his office using his computer. He reads to learn more things that can help him create new products and make other toys better!

If you have any questions about my visit, you can write to me at meg@acs.org.

Personal Profile: Mr. Maelo Cordova

What is your favorite food? Puerto Rican food

What is your favorite color? Blue, red, white and beige

What is you favorite movie? *The Nutty Professor* and science fiction movies

Favorite pastime? Music, baseball, basketball and reading

Your birthday? September 30th—born in San Juan, Puerto Rico.

What is an accomplishment that makes you proud? Two major accomplishments in school: First Place Award at the National Chemistry Fair in Puerto Rico and First Place award as a National Science Foundation Researcher in Chemistry in California, representing the University of California, Los Angeles.

Can you tell me a little about your family? I am the oldest of three children. I have a younger brother and sister. Both of my parents are retired after working for the government for over 40 years.

Cartesian Diver

The Cartesian Diver toy has been known to scientists for hundreds of years. It was first described in writing in 1648 by Raffaelo Maggiotti, a student of Galileo. Cartesian is a term that is thought to be from the last name of René Descartes, a French scientist, mathematician, and philosopher. Descartes is famous for saying, "I think, therefore I am". This is a toy that will make you think. In this activity you will make a science toy and use a change in pressure to make an object move.

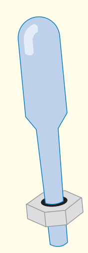
Materials

- Disposable plastic transfer pipettes
- Blunt-ended scissors
- Squid fishing lures (plastic lures for decoration—no hooks)
- Grease or soap (to lubricate fishing lures)
- Steel nuts to fit pipette stem
- Plastic soda bottle with lid (1–2 Liter)

NOTE: This activity may be done as a demonstration using an eyedropper, top half of a matchstick or a condiment pack instead of a pipette and squid fishing lure.

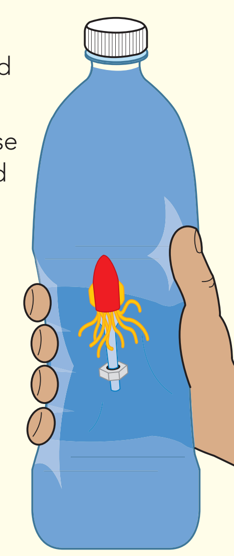
SAFETY!

Be sure to follow Milli's Safety Tips and do this activity with an adult! Do not drink the water used in this activity!



Procedure

1. Cut off the stem of the pipette about ½ inch (1–1.5 cm) below the end of the bulb and discard the cut portion of the stem.
2. To decorate the pipette, grease the squid fishing lure and stretch it over the pipette bulb.
3. Thread a nut onto the stem of the pipette. It should be a tight fit.
4. Fill the plastic bottle almost to the top with water.
5. Carefully transfer the diver to the bottle. The diver should just barely float. If necessary, add another nut to the pipette stem and/or take up some water into the pipette.
6. Add water to the bottle until it is filled completely and screw the lid on tightly.
7. Squeezing the bottle should cause the diver to move downward, and the release of pressure should cause it to float back up again. If the diver will not submerge, remove the diver and add more water to the pipette or another nut to the pipette stem.
8. Draw a picture of your Cartesian diver in the "What Did You Observe?" section.
9. Thoroughly clean the work area and wash your hands.



What Did You Observe?

Draw a picture of your Cartesian Diver:

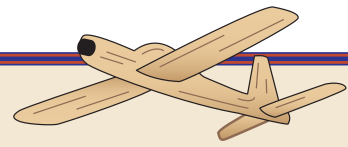
What happened when you squeezed the outside of the bottle?

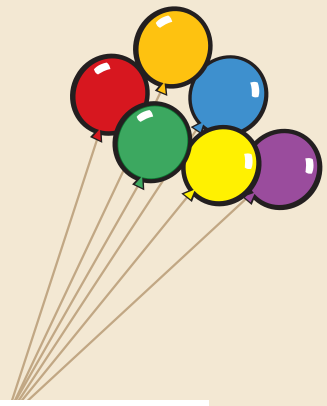
What happened when you released pressure on the bottle?

Where's the Chemistry?

This experiment shows what happens when the pressure on a gas increases and decreases. When you squeeze the bottle, the air bubble inside of the diver is forced into a smaller space making it more dense. The more dense the air becomes the further the diver sinks. When you release the bottle, the air expands and the diver rises to the top.

History of TOYS





Have you ever played with Tinker Toys or Lincoln Logs? Do you have a Raggedy Ann doll? Just think about the toys that your great-grandparents, grandparents, or your parents may have played with when they were your age. Here are just a few of the popular toys in history that may still be around today. Check out from what, how, and when these toys were invented and the chemistry that was involved in discovering or creating each of them.

About 3,000 years ago

Kites

What is it? A light-weight frame covered with material that can be flown in the wind.

History: People in China discovered kites. Because they were invented so long ago, no one knows exactly by whom or how they were developed.

Where's the Chemistry? Chemists have used kites to collect air in the atmosphere. They can study the air to measure certain types of chemicals, like carbon dioxide and oxygen.

Interesting fact: Kites have been used in many different ways: to fish, to help build a bridge and to deliver messages.

1903

Crayola Crayons

What is it? A small stick of wax that comes in different colors made for drawing.

History: Edwin Binney and C. Harold Smith saw a need for a more affordable and better quality crayon.

Where's the Chemistry? Crayons are made from two types of materials. The first is called a wax. Wax can be a solid or a liquid that comes from petroleum, a natural material found deep in the earth. The second material is a pigment. It is a substance used to give color.

Interesting fact: The first known crayons were made in Europe from recipes used by the ancient Greeks and Romans.

Photo Credit: Binney & Smith, Inc. Records. Archives Center, National Museum of American History, Behring Center, Smithsonian Institution.

1931

Latex Balloons

What is it? A flexible bag normally filled with air or other gas.

History: Neil Tillotson drew a picture of a cat's head on cardboard, cut it out, and dipped it into sap from a rubber tree. When it dried, he peeled it off and blew it into a "cat balloon".

Where's the Chemistry? Latex is a naturally occurring milky sap that comes from rubber trees. Latex balloons can be filled with helium, air, or water.

Interesting fact: Latex balloons are biodegradable. Biodegradable means the balloons will begin to break down, like the leaves in your yard.

1943

Silly Putty

What is it? A soft plastic that can bend, bounce and stretch.

History: James E. Wright was an engineer at General Electric. During World War II, there was a shortage of natural rubber. Another form of rubber was needed to produce boots and tires. Silly Putty was accidentally discovered during the process.

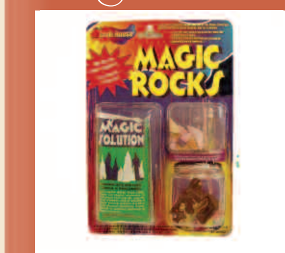
Where's the Chemistry? Silly Putty is a combination of boric acid and silicone oil.

Interesting fact: Zookeepers use it to make casts of animal footprints for identification.

Photo Credit: Binney & Smith, Inc. Records. Archives Center, National Museum of American History, Behring Center, Smithsonian Institution.

1945

Magic Rocks

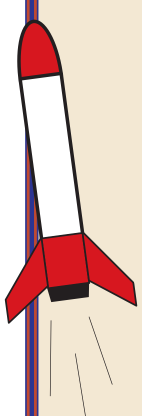


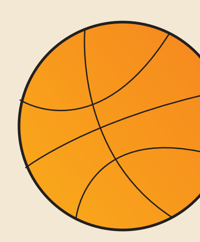
What is it? Special rocks that grow into magical-looking colored crystals.

History: Jim and Arthur Ingoldsby were in a small store in California when they first saw a "Magic Underwater Garden". It was a garden with white mountain-like rock formations. They wanted more colorful rocks instead of white.

Where's the Chemistry? Magic Rocks use a chemical reaction between Epsom salt and sodium silicate.

Interesting fact: Magic Rocks grow two to four inches in height. They will not grow any higher no matter how many rocks you add to the mix.





1945
Slinky

What is it? Coiled steel wire or plastic.

History: As an engineer in the navy, Richard James was trying to develop a meter with springs. When one of his test springs fell on to the ground, it kept "walking". His wife Betty thought of the name "Slinky".

Where's the Chemistry? Slinkys can be made out of steel or a type of plastic called styrene. Steel is a type of metal. It is a mixture of iron and carbon.

Interesting fact: When stretched all the way, a standard-sized Slinky is 24 meters (80 feet) long.

1949
Lego

What is it? Plastic interlocking building blocks.

History: Ole Kirk Christiansen's company had already been in business for years making wooden toys. Mr. Christiansen wanted to make interlocking building blocks, but knew making them out of wood would be too expensive.

Where's the Chemistry? Lego blocks are made out of a type of plastic called acrylonitrile butadiene styrene (ABS). The plastic is heated to very high temperatures and molded into blocks.

Interesting fact: There are replicated Lego structures of Mount Rushmore, the Empire State Building, the Statue of Liberty, and the White House.

1956
Play-Doh

What is it? A non-toxic moldable plastic modeling clay.

History: Young Joe McVicker invented this putty-like substance to clean the smudges off of wallpaper.

Where's the Chemistry? The putty-like substance is a type of polymer that can be molded into different shapes.

Interesting facts: Vanilla gives Play-Doh its special scent. At first it was available only in a 1½ pound can in an off-white color.

1958
Etch-A-Sketch

What is it? A box-shaped drawing device controlled by two knobs.

History: Arthur Granjean liked to put things together.

Where's the Chemistry? Aluminum powder and plastic beads coat the inside of the screen. When you turn a knob, the aluminum dust coating is scratched off the screen to create a line.

Interesting fact: The Etch-A-Sketch's original name was "Magic Screen".

1965
Super Ball

What is it? A ball that bounces with six times the bounce of regular rubber balls.

History: Norman Stingley was a chemical engineer who accidentally discovered the rubbery product, which he called Zectron.

Where's the Chemistry? Rubber is a type of polymer used in many toys. The ingredient that increases the Super Ball's bounce is a secret to this day.

Interesting fact: The name of the NFL championship game "Super Bowl", was inspired by the toy's name, Super Ball.

1974
Magna Doodle

What is it? A "dustless chalkboard".

History: Four engineers from Pilot Pen Corporation wanted to make a toy for writing or drawing.

Where's the Chemistry? Iron and other metal filings are hidden at the bottom of chambers below a thick liquid. The magnet pulls the dark filings to the top of the liquid where they can be seen.

Interesting fact: A coach of the Cleveland Browns football team once used the Magna Doodle to draw plays for the game.

Meg A. Mole's Bouncing Ball

Balls have been around for thousands of years. The earliest balls were made out of stone and wood and were used to play games that involved kicking and carrying. The discovery of natural rubber changed what people could do with a ball. They could bounce it! These days, not all bouncing balls are made out of rubber. They can also be made out of leather or plastic and be hollow or solid. Think about the last ball that you bounced. What materials were used to make it? In this activity, you will make a bouncy ball from glue, borax, and cornstarch.

Materials

- Marking pen
- 2 small plastic cups (4 oz.)
- Measuring spoons
- Warm water
- Borax
- Wooden craft stick
- White craft glue
- Cornstarch
- Watch with second hand
- Metric ruler
- Zip-closing bag

SAFETY! *Be sure to follow Milli's Safety Tips and do this activity with an adult! Do not eat or drink any of the materials in this activity.*

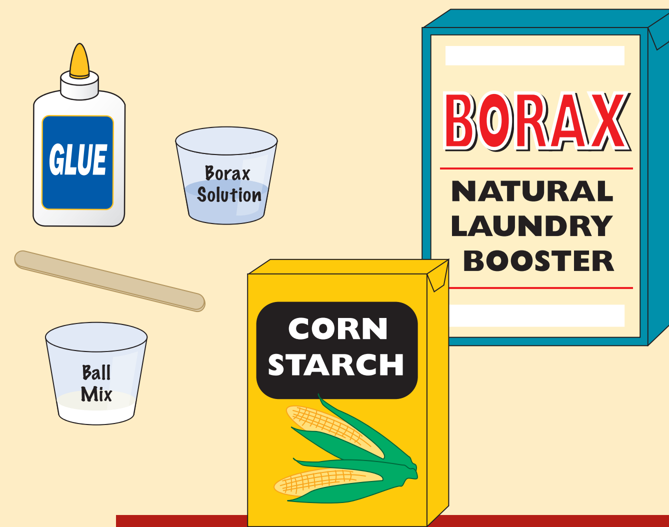
Procedure

1. Using a marking pen, label one of the cups "Borax Solution". Ask your adult partner to help you pour 2 tablespoons of warm water into the plastic cup. Measure ½ teaspoon of borax powder and place it in the same cup. Gently stir with a wooden craft stick until the powder is complete dissolved in the water.
2. Use a marking pen to label the second cup, "Ball Mix". Pour one tablespoon of glue into this plastic cup.
3. Add ½ teaspoon of the borax solution to the cup labeled, "Ball Mix". Do not stir the mix yet!
4. Add 1 tablespoon of cornstarch and wait about 10–15 seconds before you mix it all together with a wooden craft stick.
5. Stir everything together until you can no longer stir the mix with the wooden stick.
6. Take the mixture out of the cup and place it in your hands. The mixture will be sticky and messy!
7. Knead the mix to form a ball. (The more you knead, the less sticky it will become.)
8. Once the mix has been shaped into a ball, bounce it and play with it!
9. Measure the width of your ball and write it down in the "What Did You Observe?" section. Describe what the mix felt like before and after you shaped it.
10. Store your bouncy ball in a zip-closing plastic bag once you are finished playing with it.
11. Thoroughly clean the work area and wash your hands.

Try this...

See what happens if you add more cornstarch. Are you still able to make a ball that bounces?

Try making different colored balls by adding food coloring to the glue. Combine one drop of two different colors to see what you get.



What Did You Observe?

How did the mix feel as you started to shape it?... After you shaped it?

Width of your ball: _______*cm*

How high did it bounce? _______*cm*

Where's the Chemistry?

A polymer is a very long chemical made up of repeating little chemical units all hooked together in a very long chain. Glue contains a polymer called polyvinyl acetate (PVA). When you add borax solution to polymers like PVA, it cross-links or connects the two polymers together like a net or a spider's web. Depending on how much of each ingredient that you mix together, you can make something that is "goopy", slimy, or stretchy. For instance if you add more cornstarch, you will be able to bend and stretch the mix. Add less borax and you will get a "goopy" mixture. To make a slimy substance, add more glue.

In-The-Know About Glow

You see glow-in-the-dark items in all kinds of places. Some of your favorite toys, like stickers, Silly Putty, slime, and bouncing balls may glow in the dark. Have you ever seen glowing signs marking exits and other safety routes? If there is an emergency and the power goes out, these signs could save lives. How do these signs and glow-in-the-dark toys work?

Glow-in-the-dark items contain materials that can give off light. Chemists have created thousands of chemicals that glow in the dark, and toy makers commonly use two of them. The first is called zinc sulfide. It has been used for many years. The second and newer substance is called strontium aluminate and it glows much longer.

Many glow-in-the-dark materials first store energy from the sun or a household light bulb. Then they release that energy in the form of light slowly over time. When things get energy from an outside source of light and then release it slowly over time, we say they are "phosphorescent". Toys with zinc sulfide glow for several minutes after being "charged" by light. Toys with strontium aluminate can glow for several hours.

You may have seen another type of glow-in-the-dark object called a light stick. Or you may have gone to a fair or an amusement park where lighted plastic ropes were sold. These items do not need to be charged by light to work. Instead, the glowing light they make comes from a chemical reaction. The chemicals are kept separate in the light stick or rope. One of them is in a very thin tube. The thin tube is inside a thick, flexible plastic outer tube. The chemicals mix together when you break the inside tube by snapping or shaking. Once the inside seal is broken, the chemicals react and you see a glowing light. When things glow because of a chemical reaction, we call them "chemiluminescent". Phosphorescent materials get their glow energy from light, but chemiluminescent materials get their glow energy from a chemical reaction!

So the next time you look up at the plastic glow-in-the-dark stars in your bedroom or wear a glow-in-the-dark necklace, you will know a little more about what makes them glow.

Polymers – The Joy in Toys

Did you know that many toys are made from polymers? Polymers are made of tiny chemical units that are hooked together to form very long chains. "Poly" means many and "mer" means part. Together, the word polymer means "many parts."

Imagine a long line of blue beads connected together. This chain of blue beads is like a polymer. It has many parts hooked together. If you place a white bead between two blue beads, you make a new pattern. You can string blue and white beads in many ways, making many different patterns. Each pattern is like a different polymer. These polymers can be used in toys. They can be rubbery like a bouncy ball, oozy like glue, or as hard as skateboard wheels!

People have been making toys from polymers for hundreds of years. Wood is made of a natural polymer called cellulose. Before plastic was invented, people sometimes carved or made wood into toys. Other natural polymers, called proteins, can be found in feathers, beaks and fur. They were used as toy decorations or for toys like drums. One of the first balloons was made from the sap of a rubber tree. Your great-grandparents probably played with toys like spinning tops, dolls, and kites. They were made from silk, wood, cotton or rubber—all naturally occurring polymers!

Some of the toys you have today may still be made out of these natural polymers. But most toys are made from materials called synthetic polymers which were created by chemists. Examples of these are plastics and artificial versions of rubber. To make these synthetic polymers, chemicals are mixed together in factories. Since plastics and other synthetic polymers are light, strong, flexible, and stretchy, they are good materials to make toys.

Plastic toys are lighter than toys made from metal. They can be made with curved edges and molded into any shape. Some toys made from plastics are Lego blocks and Mr. Potato Head. Big Wheels bikes are also made out of special polymers. The polymers are heated and formed into their special shapes. In the "Super Shrinkers" activity, you will cut out bits and shapes of a certain type of plastic, color them, and heat them to make art.

Look around your room or the place where you keep your toys. Are the toys you see made out of polymers?

Word Find

Find each of the following words related to "The Joy of Toys". They can be forward, backward, up, down, diagonal or straight. ***Answers are on page 12.***

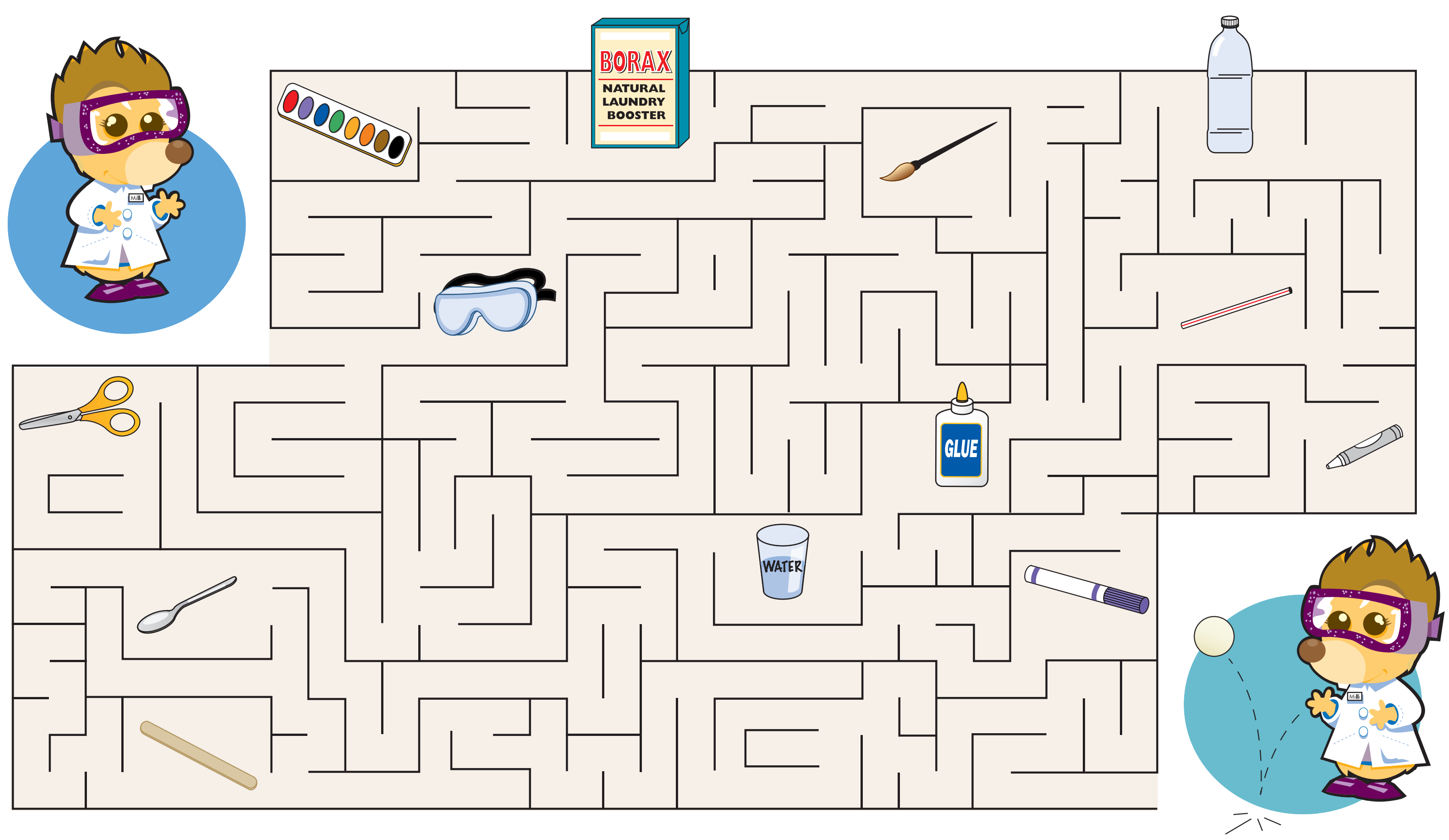
AIR PRESSURE	LEGO
BALLOONS	LINCOLN LOGS
BUBBLES	MAGIC ROCKS
CHEMICAL REACTION	PLASTIC
COHESION	POLYMER
CRAYONS	SLINKY
DOLLS	STONES
GAS	SUPER BALL
GLYCERIN	TRAINS
KITES	WATER

C	W	I	T	N	V	U	H	F	S	W	S	V	E	B	X	S	C	G	A
A	O	E	S	U	P	E	R	B	A	L	L	U	U	L	N	G	K	G	H
H	G	H	R	A	F	C	K	T	G	D	L	B	F	O	V	O	R	T	C
V	I	D	E	U	S	C	E	D	T	C	B	O	Y	G	P	L	R	B	S
R	H	F	Q	S	S	R	I	M	P	L	V	A	D	E	U	N	D	T	T
C	S	K	T	T	I	S	Z	T	E	J	R	S	K	L	S	L	U	S	O
K	T	Y	I	E	E	O	E	S	S	C	C	H	H	K	Q	O	G	N	N
R	E	M	Y	L	O	P	N	R	Z	A	E	Y	C	Y	K	C	L	O	E
J	I	H	T	I	B	D	K	I	P	D	L	O	A	R	H	N	Y	O	S
L	S	R	S	R	A	U	V	J	H	R	R	P	K	Y	N	I	C	L	D
N	O	I	T	C	A	E	R	L	A	C	I	M	E	H	C	L	E	L	H
S	L	I	N	K	Y	I	G	Y	I	A	S	A	G	J	Y	L	R	A	M
M	G	V	S	I	C	H	N	G	Q	N	A	J	F	B	S	M	I	B	R
P	B	W	C	R	R	N	A	S	J	K	F	G	D	A	J	T	N	J	T
E	C	G	I	X	I	M	U	S	E	T	I	K	G	E	S	J	D	N	A

Make a Bouncy Ball Maze

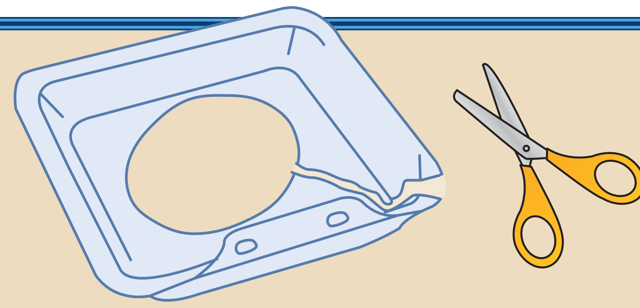
Help Milli gather supplies she needs to make a Meg A. Mole Bouncing Ball.

Answer is on page 12.



Super Shrinkers

The word plastic comes from the Greek word meaning "able to be molded". Plastics are popular materials because they can be molded or shaped in many different ways. For instance your pencil box and the desk you write on at school are most likely made out of plastic. At home, the handle of your toothbrush and the one gallon container of milk are almost certain to be made out of it. What about your games and toys? Their parts and pieces may contain plastic too. Plastic is all around us! In this activity, you will turn a piece of plastic into a piece of art.



Materials

- Conventional or toaster oven
- Clear polystyrene (PS) containers (#6 recycle code)
- Blunt-ended scissors
- Colored permanent markers
- Metric ruler
- Cookie sheet or metal tray
- Aluminum foil
- Oven mitts

NOTE: Make sure your container is a "number 6" recyclable plastic. Look for the number on the bottom of the container. Other types of plastics will not work. Good places to look for "number 6" containers are at your local deli or grocery store salad bar. If the edges of your final product are rough, your adult partner can help you to smooth them with sandpaper.

SAFETY! *Be sure to follow Milli's Safety Tips and do this activity with an adult! Do not eat or drink with any of the materials used in this activity.*

Procedure

1. Have your adult partner preheat the oven to 325° F.
2. Make sure the piece of plastic is clean and free of dust.
3. Carefully cut a design of your choice from the plastic.
4. Use permanent markers to draw or write something on your piece of plastic. The more color you use, the more intense your final piece will be. If you write something, make your letters big and thick.
5. Measure and record the length and width of the plastic with the ruler at the longest and widest parts. Write your measurements in the "What Did You Observe?" section.
6. Cover a cookie sheet or metal tray with aluminum foil and place your design on the foil.
7. Ask your adult partner to place the tray in the oven. If you have a glass oven door, you will see the plastic curl at the edges and then flatten again. When this happens, the plastic is finished shrinking. This should take less than two minutes.
8. Have your adult partner take the tray out of the oven using the oven mitts. Be careful. It will be hot! Place the hot tray on a heat-resistant surface.
9. Do not touch your newly created piece of art until it has completely cooled. Your adult partner will tell you when it is ready to be touched.
10. When it has cooled, take your design off the cookie sheet and measure the length and width as you did in Step 5. Record your measurements in the "What Did You Observe?" section.
11. Thoroughly clean the work area and wash your hands.

Try this...

You can also create designs using colored pencils. Use sandpaper to scratch the surface of plastic where you would like to draw. After you heat the plastic, does the surface still appear scratched?

Make a charm or necklace by punching a hole(s) in the plastic before you place it in the oven. After the plastic shrinks and cools, thread a string through the hole.

What Did You Observe?

	Length (cm)	*Width (cm)*
Plastic Before Shrinking		
Plastic After Shrinking		

Where's the Chemistry?

Plastic is a lightweight material that can be shaped, stretched, or bent into many different things. The material that you used to make your design is recyclable plastic called polystyrene. It is a polymer, a chemical made out of repeating chemical units. Polystyrene can be stretched or shrunk when heated. Not all plastics behave this way. Different types of plastic may melt into liquid or stay just the way they are even after you heat it.

You Can Be a Chemist!

Chemistry is the science that helps us learn about the world around us. Everything is made of chemicals—our bodies, our pets, our houses, the toys we play with, the medicines we take, the food we eat, and the books we read. Chemicals are the ingredients that make up all living and non-living things.

Chemists are scientists. Many of them work in laboratories to solve problems and make new materials. Laboratory chemists are often inventors. They combine chemicals in ways that no one else has done before. Chemists have discovered the adhesive used on Post-it notes, artificial sweeteners, Teflon, Nylon, new medicines, and many different kinds of plastics. Some chemists are teachers. They help students learn about the world around them. Some chemists work for toy companies looking for more ways to keep children around the world entertained. Other chemists are lawyers or writers for newspapers and magazines. Because chemistry is part of everything, chemists work in many different fields and have a wide variety of jobs.

If you want to learn more about chemistry, watch your newspaper for notices about programs for K–12 students. Local colleges frequently sponsor programs for students with an interest in science. Your school guidance counselor or science teacher can also talk to you about these programs as well as some possible careers in chemistry.

The work of chemists will never be over. As long as we need new products, better ways to protect the environment, and more information about the world and the way it works, there will be a need for chemists. For articles and other information about chemistry, check out the website, chemistry.org/kids.

Milli's Magnificent Bubble Solution

Soap bubbles are marvelous because there is so much to be learned from them. People of all ages are fascinated with them. Although bubbles have been a favorite among children for hundreds of years, it was not until the early 1900s that bubble solution was actually sold as a toy for children. Before that, it was just soapy dishwater. In this activity, you will test several bubble solutions and see which one makes the most magnificent bubbles.

Materials

- Marking pen
- 4 plastic or foam cups (8 oz.)
- 4 pipe cleaners or bubble wands
- Liquid measuring cup
- Water (distilled or purified is best)
- Measuring spoons
- Liquid dishwashing detergent (Joy and Dawn brands work well)
- Granulated sugar or corn syrup
- Dropper or pipette
- Glycerin (available at most drug stores)
- Watch with second hand
- Cookie sheet or other flat tray (optional)

NOTE: It is recommended to cover surfaces with newspaper or to do this activity outside.

SAFETY! *Avoid getting soap in your eyes! If soap gets in your eyes flush with water immediately. Do not blow bubbles directly at anyone! Be sure to follow Milli's Safety Tips and do this activity with an adult! Do not drink any of the materials in this activity!*

Procedure

1. Use the marking pen to label the four cups "A", "B", "C" and "D".
2. Make bubble wands out of the four pipe cleaners by forming a loop about the size of a quarter at one end.
3. Carefully measure and put ¼ cup of water into each cup.
4. Add 1 teaspoon liquid dishwashing detergent to cups "B", "C" and "D".
5. Add ¼ teaspoon sugar to cup "C" and use the dropper to add 10 drops of glycerin to cup "D".
6. Put one bubble wand into each cup and stir very slowly.
7. Try blowing bubbles using the solution and bubble wand in cup "A".
8. Record your results in the "What Did You Observe?" section. Watch the bubbles as you blow them to see how long they last. Look for colors in the bubbles and note how they look before they pop. Also observe their size.
9. Repeat steps 7 and 8 for the other three containers.
10. If you have trouble timing how long the bubbles last, you may put water in a pan or tray and blow a bubble onto the surface of the water in order to more easily observe and time it.
11. Which solution made the longest-lasting bubbles?
12. Thoroughly clean the work area and wash your hands.

Try this...

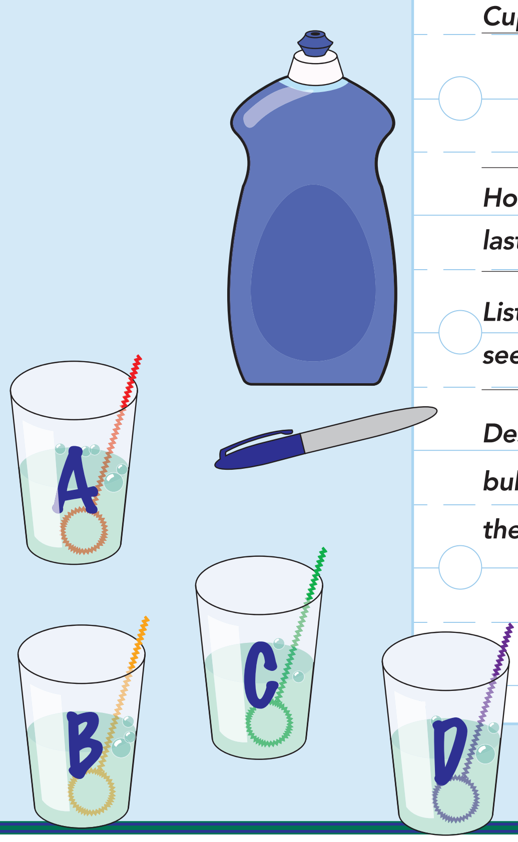
Try making bubble solutions with more glycerin, by adding salt instead of sugar, or a little salt and sugar. Check with your adult partner before mixing any other bubble solutions.

Where's the Chemistry?

It was not possible to blow bubbles with plain water because of water's surface tension. The water molecules stick together and you cannot form a big air space in the middle. The detergent does not let the water stick together as well, so it is possible to form a bubble. Glycerin is a thick liquid which attracts moisture. Adding glycerin to the water and dish detergent helps make the bubbles last by slowing down how quickly the bubbles dry out. Sugar also makes the bubbles last longer by not letting them dry out as quickly. Bubbles reflect light from the outside wall and the inside wall, which results in the shimmery colors. The colors of a soap bubble come from white light, which contains all the colors of the rainbow. When white light reflects from a soap film, some of the colors get brighter, and others disappear. As bubbles lose water to drying, the thickness of the wall changes, which in turn, allows new colors to appear. Just before a bubble pops, the wall is so thin that the bubble appears to be colorless. This lets you predict when the bubble will pop.

What Did You Observe?

Cup	A	B	C	D
	Water	*Water + Detergent*	*Water + Detergent + Sugar*	*Water + Detergent + Glycerin*
How long did bubbles last? (in seconds)				
List the colors you see in the bubbles.				
Describe how the bubbles look just before they pop.				



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The activities described in this publication are intended for elementary school children under the direct supervision of adults. The American Chemical Society cannot be responsible for any accidents or injuries that may result from conducting the activities without proper supervision, from not specifically following directions, or from ignoring the cautions contained in the text.

Word Find from page 9

C	W	I	T	N	V	U	H	F	S	W	S	V	E	B	X	S	C	G	A
A	O	E	S	U	P	E	R	B	A	L	L	U	U	L	N	G	K	G	H
H	G	H	R	A	F	C	K	T	G	D	L	B	F	O	V	O	R	T	C
V	I	D	E	U	S	C	E	D	T	C	B	O	Y	G	P	L	R	B	S
R	H	F	Q	S	S	R	I	M	P	L	V	A	D	E	U	N	D	T	T
C	S	K	T	T	I	S	Z	T	E	J	R	S	K	L	S	L	U	S	O
K	T	Y	I	E	E	O	E	S	S	C	C	H	H	K	Q	O	G	N	N
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J	I	H	T	I	B	D	K	I	P	D	L	O	A	R	H	N	Y	O	S
L	S	R	S	R	A	U	V	J	H	R	R	P	K	Y	N	I	C	L	D
N	O	I	T	C	A	E	R	L	A	C	I	M	E	H	C	L	E	L	H
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M	G	V	S	I	C	H	N	G	Q	N	A	J	F	B	S	M	I	B	R
P	B	W	C	R	R	N	A	S	J	K	F	G	D	A	J	T	N	J	T
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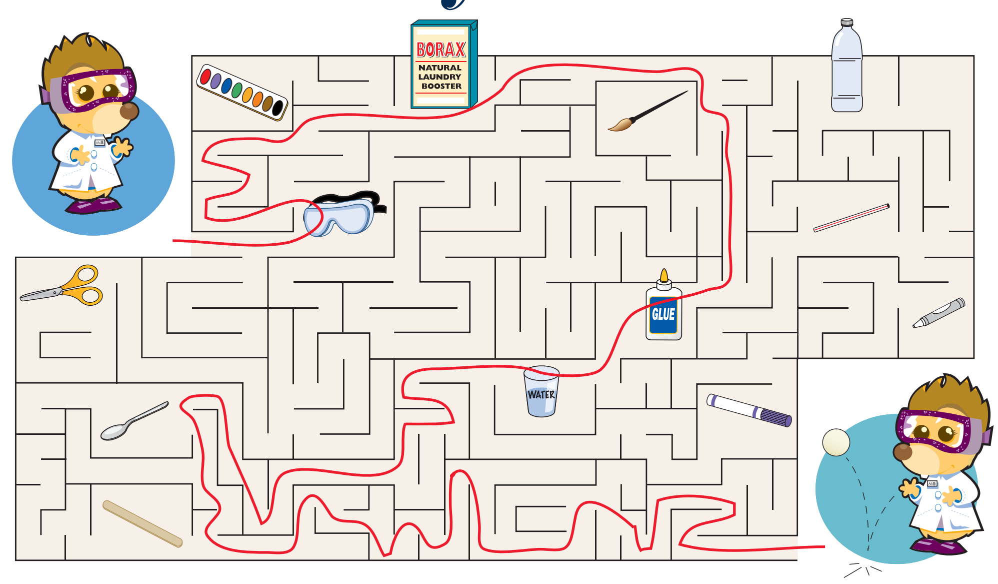
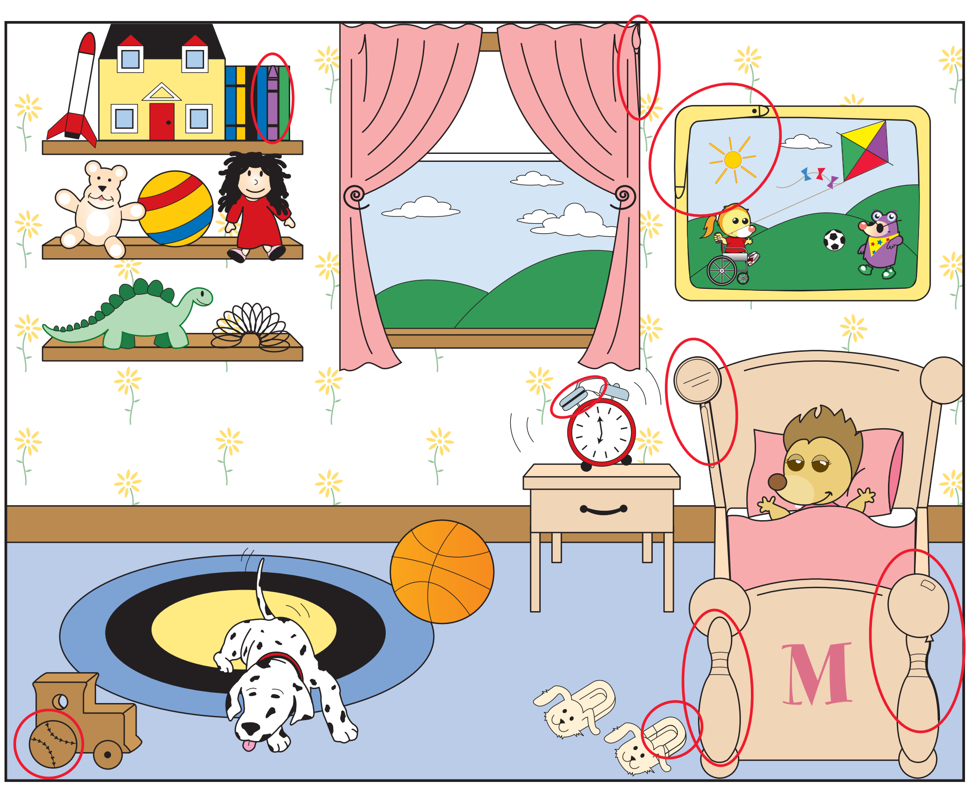
Make a Bouncy Ball Maze from page 9



Hidden Objects from page 1



What is the American Chemical Society?

The American Chemical Society (ACS) is the largest scientific organization in the world. ACS members are mostly chemists, chemical engineers, and other professionals who work in chemistry or chemistry-related jobs. The ACS has more than 158,000 members. The majority of ACS members live in the United States, but others live in different countries around the world. Members of the ACS share ideas with each other and learn about important discoveries in chemistry during meetings that the ACS holds around the United States several times a year, through the use of the ACS website, and through the journals the ACS publishes.

The members of the ACS carry out many programs that help the public learn about chemistry. The largest of these outreach programs is National Chemistry Week (NCW). NCW is held every year in October. ACS members celebrate NCW by holding events in schools, shopping malls, libraries, science museums, and even train stations!

Activities at these events include carrying out chemistry investigations and participating in contests and games. If you would like to know more about how you can participate in National Chemistry Week, please contact us!

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