

Celebrating Chemistry



Chemistry Keeps Us Clean!

National Chemistry Week • October 20-26, 2002 • American Chemical Society

Chemistry helps keep us clean in many different ways. We need chemistry to make soaps and detergents. We need chemistry to purify our water, and to protect our environment. In this issue of *Celebrating Chemistry*, you will learn about how soaps and detergents are made. You will learn how they work, and what they do. You will also learn how lake and stream water is treated to make it safe to drink.

The activities described in this paper were designed as experiments that you can perform anywhere using common materials like sand, soap and pennies. As you perform each experiment,

you will need to make careful observations, and take notes on each step of your experiments, so that you can see the chemistry involved.

Before beginning any of these activities, be sure to work with an adult and read the warning labels on all of the materials that you use. Read through the activities before you do them, and wear eye protection. We strongly recommend that chemical goggles be worn for all of these activities.

Chemistry is all around us. It is in the food we eat, the clothes we wear, the air we breathe, and the water we drink. If you can touch it, taste it, smell it or see it, then it must be chemistry. By

learning more about chemistry, you will be able to understand more about the world and how it works. We hope that you will have fun exploring the concept of “clean” in this edition of *Celebrating Chemistry*, and that you will keep your eyes open to the world around you.

National Chemistry Week is sponsored by the American Chemical Society. The purpose of National Chemistry Week is to celebrate the positive contributions of chemistry to our daily lives. This year, the theme for National Chemistry Week is Chemistry Keeps Us Clean!

Soap Stories

Bathing has been around for a long time, because people have always had a desire to get clean. Even before soap was invented, people would wash with water in streams or rivers. However, the water only washed away dirt. It could not dissolve the oily residue and grime that built up over time.

The first people to write about using soap to bathe were the Egyptians in about 1500 BC. Egyptians made soap from animal and vegetable oils that were mixed with alkaline salts such as sodium carbonate. The goopy mixture worked relatively well for cleaning, and for treating skin diseases. The Egyptians bathed regularly, and are believed to have been quite clean.

However, there is an earlier record of soap making. Researchers have found small amounts of a soap-like material in clay jars from the ruins of the ancient city of Babylon. The material was made in about 2800 BC, 1300 years before the Egyptians. Writing on the outside of the jars says that the material was made by boiling animal fats with ashes, and that it was used for hair styling.

The Greeks preferred not to use soap to clean themselves. Instead, they would scrub their skin with blocks of clay, sand, pumice and ashes to remove dirt and grime. They would then anoint themselves with oil, and scrape it away with a knife-like blade called a strigil. The Greeks did use soap, but only to wash their clothes in the stream.

Around 312 BC, soap regained popularity with the construction of the first Roman baths. The ancient Romans built huge public baths that were

filled with water from manmade canals that carried water from nearby rivers into Roman cities. The Romans invented indoor plumbing using lead pipes. In fact, the word “plumbing” comes from the Roman word for lead—plumbum.

But alas, when the Roman Empire fell in 476 AD, people in Europe stopped bathing. People were dirty, their food was unclean, and their homes were unsanitary. During the Middle Ages, many people became very sick. Because people did not clean themselves or their homes well, health plagues were common. In 1347 AD, Italian traders spread the bubonic plague from China to Europe. In just five years, the “Black Death”, as it was called, killed one-third of Europe’s population.

It wasn’t until the 17th century that cleanliness came back into style, but soap was considered a luxury item. Most people simply could not afford it. During this time, soap makers guarded their formulas carefully, and the governments of Europe placed a high tax on soap. It wasn’t until the 19th century that soap became an affordable item for most people.

Early pioneers in the United States used lye soap to clean. Lye soap was hard to make, and it was very harsh on the skin. However, it was cheap,

and materials to make it were easy to find. To make lye soap, pioneers would mix lye with oil. The lye came from ashes, and the oil that they used usually came from pig fat, or tallow. To make lye, they would pour water over ashes from a fireplace. Then they collected the water, and filtered it. The ashes would not dissolve in the water, but the lye would. To obtain oil, the pioneers would heat pig fat in a large pot until all of the oil was released. The oil was then boiled, and the scum that collected on the top was scraped off and discarded. The oil and the water containing lye were combined, and lye soap resulted. The process often took days, and the lye soap was so harsh that it burned the pioneers’ eyes and skin.

We have come a long way since the days of the Egyptians. Today, finding a bar of soap is as easy as going to the store. There is no need to make your own. Modern soaps are gentler on your skin, and they clean better than ever before. Some soaps even contain lotions and perfumes to make your skin soft and to keep you smelling fresh. We’ve got it easy these days, and it is all because of good chemistry!

2002 Edition

Look inside for exciting activities, articles and puzzles!

Visit chemistry.org/ncw for additional activities, cool facts, text in español, reading lists, related websites, and tips for presenters.

Testing Water's Skin

Water is a very important chemical! It covers about three-fourths of the Earth's surface and makes up about two-thirds of your body's weight. Every living thing needs water to survive. One of the special things about water is that it tends to stick to itself. This property is called cohesion. When water sticks to something else, it is called adhesion. Because water sticks so strongly to itself, it tends to bead up on slick surfaces like a car's hood or windshield. Water also forms a "skin" on its outer surface. This "skin" is strong enough to support a water bug, and it is flexible enough to bend around the edge of a water drop.

Materials

2 Paper towels
Penny
Small disposable paper cup (3 oz.)
Water
Dropper
Liquid dish detergent
Food coloring (optional)

ADAPTATION: To see the water's surface more clearly, you can add a drop of food coloring to the water. You may also want to use a magnifying glass and a flashlight.

SAFETY: Be sure to follow Milli's Safety Tips and do this activity with an adult! Do not drink any of the water samples in this activity.

Procedure

1. Place a clean, dry penny flat on one of the paper towels.
2. Fill the cup about halfway with water.

3. Use the dropper to carefully place water onto the surface of the penny one drop at a time, counting the drops and watching from the side as they are added. Add the drops close to the center of the penny and hold the tip of the dropper just above the penny.

How many drops of water fit onto the penny before the water runs over the edge and onto the paper towel? Write your answer in the table in the "What did you observe?" table and draw a picture of what you saw.

4. Dry the penny completely with the other paper towel and then place it onto a dry spot on your first paper towel.

5. Add five drops of liquid dish detergent to the cup containing the water and mix it slowly with the dropper.

6. Try dropping soapy water onto the top surface of the penny as before.

How many drops can you add before the water runs over the edge onto the paper towel? Write your answer in the table and draw a picture of what you saw.

7. Thoroughly clean the work area and wash your hands.

What did you observe?

Number of Drops of **Water** on a Penny _____

Number of Drops of **Soapy Water** on a Penny _____

Draw a Picture of Water on a Penny

Draw a Picture of Soapy Water on a Penny

Where's the Chemistry?

Because water sticks to itself so well, it will easily form very large drops. In a drop, all the water molecules are close together, and they can touch several other molecules at the same time. Each of the water molecules is surrounded on the top, bottom, left, and right by other water molecules. When detergent is added to the water, the drop falls apart. The detergent molecules stick to the water molecules, and they block the water molecules from sticking to each other. As more detergent is added to the water, the water molecules have a

harder time sticking to one another. Since the water molecules cannot stick to each other as well, they cannot form large drops, so soapy water forms small drops, and very soapy water will not form drops at all.

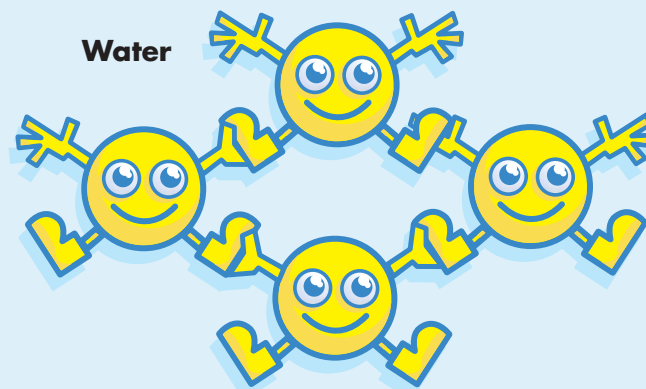
Water Molecule



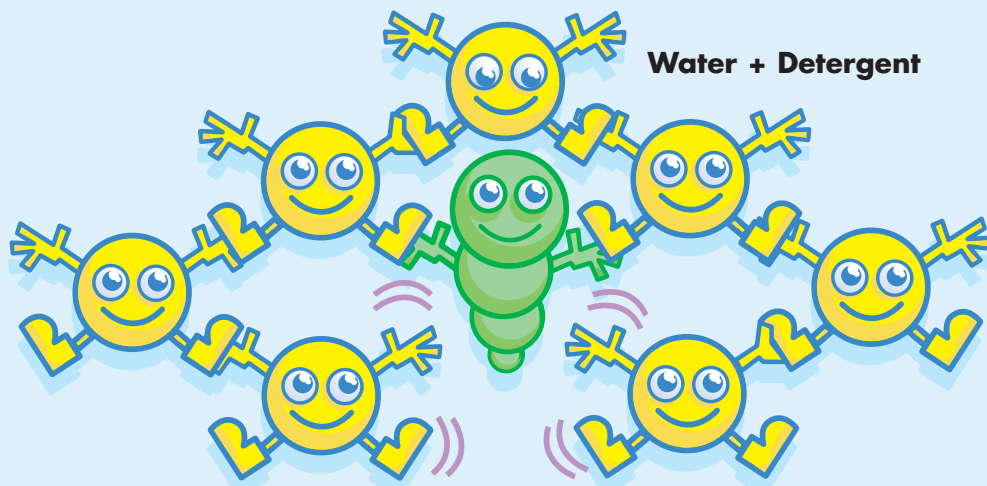
Detergent Molecule



Water



Water + Detergent



Milli's Safety Tips

Safety First!

Always:

- Work with an adult.
- Read and follow all directions for the activity.
- Read all warning labels on all materials being used.
- Wear eye protection.
- Follow safety warnings or precautions, such as wearing 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, your nose, and your eyes!

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



Water Walkers

Use what you learned about water cohesion in the “Testing Water’s Skin” activity to have some fun. Many different kinds of insects can walk on the surface of a pond without breaking the water’s “skin”. They can do this because they have many legs, and they can spread their weight out over a large surface area. If they were to stand on one foot, then all of their weight would be in one small spot, the water’s “skin” would break, and they would sink to the bottom of the pond. You may also have seen a feather or a leaf fall gently onto the surface of a pond without sinking. Like the water bugs, feathers and leaves are very light, and their weight is spread out over a large area of the surface. Based on these examples, and others that you may have seen, try making your own water walker!

Materials

- Disposable aluminum pie or cake pan
- Water
- Small paper clips
- Pop-top rings, plastic tabs
- Aluminum foil or paper
- Pencil
- Blunt scissors

SAFETY: Be sure to follow Milli’s Safety Tips and do this activity with an adult! Do not drink any of the water samples in this activity.

Procedure

1. Fill the pan with several centimeters of water. Do not overfill the pan.
2. Hold a paper clip by one end and observe what happens when it is dropped into the water.
3. Now try to put a second paper clip on the surface of the water by very carefully lowering it so that it lays flat on the water’s “skin” or surface. Keep trying until you are able to get the paper clip to float.
4. Try to float other paper clips or plastic tabs on the water’s surface. It will take a little practice and a steady hand.
5. Once you have practiced putting things on the surface of the water, you are ready to make your own “Water Walkers”. Use the pencil to lightly draw on the aluminum foil or paper to make a paper animal like the frog to the right. Be sure that you have a flat surface that will float on the water as part of your design. Big “feet” work best!
6. Use the scissors to cut out the design.
7. Set your creation carefully on the water and observe. Did it float? If not, try again, or make another “Water Walker” that you think will work better.
8. Thoroughly clean the work area and wash your hands. Pour the water down the drain, and throw away any other trash.

Try this...

When there are several objects floating on the water, try adding a squirt of liquid dishwashing detergent to the water and observe what happens.

Note: Once detergent has been added to the pan, the water’s “skin” will be broken. You will need to pour out all of the water and rinse any soapy residue out of the pan before you continue with your experiments.



Where’s the Chemistry?

As you learned in the “Testing Water’s Skin” activity, water molecules tend to stick together. This cohesion is strong enough at the surface of the water to form a “skin”. In this activity, you had to be very careful to place the paper clip and other objects gently on the water’s surface, so that you did not break the water’s “skin”. You also had to place them onto the water so that they laid down flat, so that their weight would be spread out over a large area. By spreading the objects’ weight over a large area on the surface of the water, you were able to make them float without breaking the water’s “skin”.

Hold a paper clip by one end and observe what happens when it is dropped into the water.

Set your creation carefully on the water and observe. Did it float?



Wondering about Water

What if water did not have all of its special properties? In what ways would the world be different? Think about how strange the world would be if water were different. Write a poem or a story about a world where water doesn’t work like we expect.

Think about these things:

What if water adhered strongly to many substances?

How well would windshield wipers work?
How easily could you dry off after a swim?
What would happen when it rained?

What if water was not very cohesive, and did not stick to itself easily?

Could you pour a glass of water?
How big would puddles be?
Could plants survive?

What if water did not dissolve things?

Could you make a glass of sweetened tea?
Could you wash with soap?
Would ocean water be salty?

What if ice sank in water?

Could aquatic plants and animals live through a cold winter?
How long would you have to wait to go ice-skating in the winter?
Would there be liquid water to drink in a cold winter?

What if water did not have cohesion and adhesion?

Would water bugs sink?
Could we drip drops from an eyedropper?
Would we need to use detergent to make bubbles in water?

Bubble Trouble

An important quality of soap is how well it suds or bubbles and how long the suds last. Suds help spread out the soap so it can work to clean greasy dirt. Sometimes other chemicals can keep soap from being its sudsiest. In this activity, you will measure the amount of bubbles that you can make with a detergent.

Materials

- 3 Disposable, clear, plastic bottles with caps (0.5 L or 20 oz.)
(The bottles should be the same size and shape.)
- Metric ruler
- Permanent marker
- Distilled water
- Food coloring (optional)
- Measuring spoons
- Liquid dishwashing detergent
- Epsom salt
- Clock or timer with second hand

ADAPTATION: Food coloring can be added to the water to make it easier to see. You can also use a magnifying glass to see things more clearly, and you can use a funnel to help you pour the water into the bottles.

SAFETY: Be sure to follow Milli's Safety Tips and do this activity with an adult! Do not drink any of the water samples in this activity.

Procedure

1. Use the ruler to measure 2 cm (1 inch) up from the bottom of one of the bottles, and make a mark with the permanent marker.
2. Using the mark as your guide, draw a line all the way around the bottle that is 2 cm (1 inch) from the bottom. You may need to make a few more guide marks with the ruler to make the line straight. This line will be your water line.
3. Using the ruler again, measure up from the water line that you just made, and mark every centimeter (1/2 inch) until you get to the top of the bottle. Number the marks as you make them starting with 1 for the first mark above the water line.
4. Repeat steps 1-3 for the other two bottles.
5. Using the marker, label the side of one of the bottles "water", the side of another one "water + detergent", and the side of the last one "water + detergent + salt".

6. Carefully add water to each of the bottles, stopping at the water line. If you add too much water, just pour some out and try again.
7. Add one-quarter (1/4) teaspoon of dishwashing detergent to the bottles labeled "water + detergent", and "water + detergent + salt".
8. Add one-quarter (1/4) teaspoon of Epsom salt to the bottle labeled "water + detergent + salt".
9. Tightly cap each of the bottles, and shake each one for 5 seconds.
10. Write down how many centimeters (or inches) of bubbles you observed in each of the bottles in the "What did you observe?" table below.
11. Wash your hands and thoroughly clean the work area. Pour the liquids down the drain, and throw the bottles in the trash.

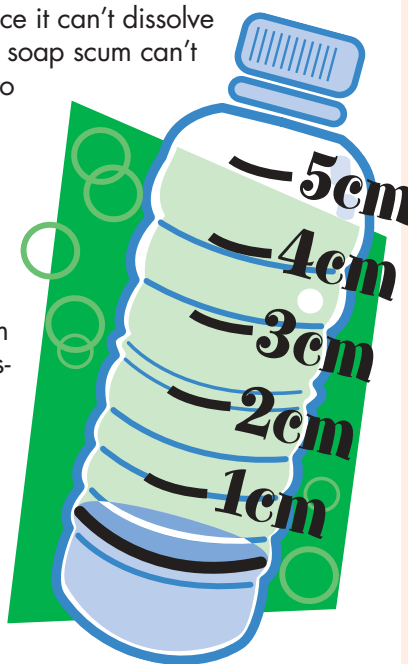
Try this...

You probably saw that water with Epsom salt dissolved in it doesn't do a very good job of making bubbles. What if you add a different type of salt? Try the experiment again using table salt in place of the Epsom salt to see what happens!

Where's the Chemistry?

Epsom salt is a chemical called *magnesium sulfate*. When magnesium sulfate is added to soapy water, the magnesium combines with the soap. This combination is actually a new substance that doesn't dissolve well in water. The common name for this substance is soap scum. Since it can't dissolve in water, the soap in the soap scum can't get back into the water to make bubbles.

When people complain about "hard" water reducing the bubbling and sudsiness of their soap, it is often magnesium and calcium in the water that is causing the problem. Detergent works better than soap in hard water because magnesium and calcium do not bond to detergent in the same way as with soap.



Hooray for Hand-washing!

Do you ever think about germs? Did you ever wonder where they come from, or more importantly, how to get rid of them?

Germs are everywhere. They are on our hands. They are on our toys. They are on our pets, and they are on doorknobs and other objects that we touch. We pick up germs when we touch all sorts of things, and we transfer them to our faces by scratching or touching. Once on our face, germs can enter our bodies through our mouths, our noses, or our eyes to make us sick.

An important way to get rid of germs is to wash our hands. Do you know the right way to wash your hands? It seems like a very simple thing, but most people do not wash their hands correctly.

Soaps and detergents need about 15 seconds to do their job. If you rub soap on your hands, and then rinse the soap off immediately, you will not wash germs away. Germs are incredibly small and sticky. To wash them away, you must lather your hands with soap, and scrub for at least 15 seconds before washing the soap away. Most people only scrub their hands for two or three seconds before they rinse them off. Here is a quick list of steps that show the right way to wash.

1. Turn on the water faucet and wet your hands.
2. Put soap on your hands and rub them together. Rub your hands front and back, and wash under your fingernails too. You will need to do this for 15 seconds before you rinse away the soap to give it time to do its job.
(Try counting to fifteen, saying "one thousand" after each number, to see how long 15 seconds last.)
3. Rinse the soap off by rubbing your hands under running water.
4. Dry your hands with a clean towel, and use the towel to turn off the faucet.

You should wash your hands after you play outside, after you cough or sneeze, after you play with pets, and after you use the toilet. You should also wash your hands before you eat.

Very few people wash their hands every time that they should, and even fewer wash them the right way. By washing your hands correctly, you can prevent the spread of disease and make the world a healthier place.

What did you observe?

	Water	Water + Detergent	Water + Detergent + Salt
Height of bubbles			

Word Find

Instructions: Find the pink words in the laundry detergent bottle. Circle the words as you find them. The words may be read forward, backward, up, down, or diagonally. Letters may be used in more than one word. Answers are on page 12.

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

Just washing with **water** does not get us **clean**. Although some dirt does dissolve in water, other dirt is made from **oil** and grease, which do not dissolve in water. Oil and water do not even **mix** (see If Mixing is Urgent-Try Detergent! on page 6). In order to remove oil it is necessary to use a chemical such as **soap** to hook the oil and water together (see Release the Grease! on page 7). In pioneer days, the soap was made from **animal fat**, wood ashes, and table **salt**. Unfortunately, soap does not work well in water that contains calcium, **magnesium**, or **iron** compounds (see Bubble Trouble on page 4). This type of water is called **hard** water. These compounds **react** with soap to form a new compound that does not dissolve in water. This compound is called soap **scum** and causes a **ring** around the bathtub.

In order to get soap to work in hard water, chemists have made a new type of soap called **detergent**. Detergents are made for

different purposes. One type of detergent is the **laundry** detergent that we use to wash our clothes. These often contain **bleach** or an optical brightener that make our clothes look better. There are also dishwashing detergents for either washing dishes by hand or in an automatic **dishwasher**. The special detergent that we use for our hair is called **shampoo**. It usually contains a chemical to **soften** the hard water and keep it from forming soap scum in our hair. Also, most shampoos contain lanolin to keep our scalps from getting too dry. Another special detergent that we use every day is **toothpaste**. It contains a detergent and an **abrasive** material, like very fine **sand**, to clean the **plaque** off of our teeth. Since these ingredients do not taste good, a flavoring or sweetener is added. Most toothpaste contains a **fluoride** compound to make the teeth's enamel stronger to resist tooth decay.

bubblology (bŭb'əl-ŏlə-jē) n. The study of bubbles.

There is a lot to be learned from a bubble! Bubbles can teach us about life, light and strength.

The wall of a bubble has three parts. There is an outer wall made of soap or detergent, a center wall made of water, and an inner wall that is also made of soap or detergent. The inside of the bubble is filled with air. This structure of the bubble's wall is very similar to that of membranes found in living creatures like us.

Did you ever wonder how the food you eat gets from inside your stomach to inside your muscles? To get to your muscles, the food must first be digested. Then it must pass through a set of membranes into your blood. The nutrients then circulate through your arteries to your muscles, where they pass through another set of membranes into your muscles.

The next time that you blow bubbles, look for a cluster of them, and watch closely. If they don't pop too quickly, you will see that the air from the smaller bubbles will pass through the bubble wall into a larger bubble on the other side. This is very similar to the way that oxygen passes from your lungs through a membrane and into your blood stream. The larger bubbles are sturdier, because their walls are not curved as much as the walls of smaller bubbles.

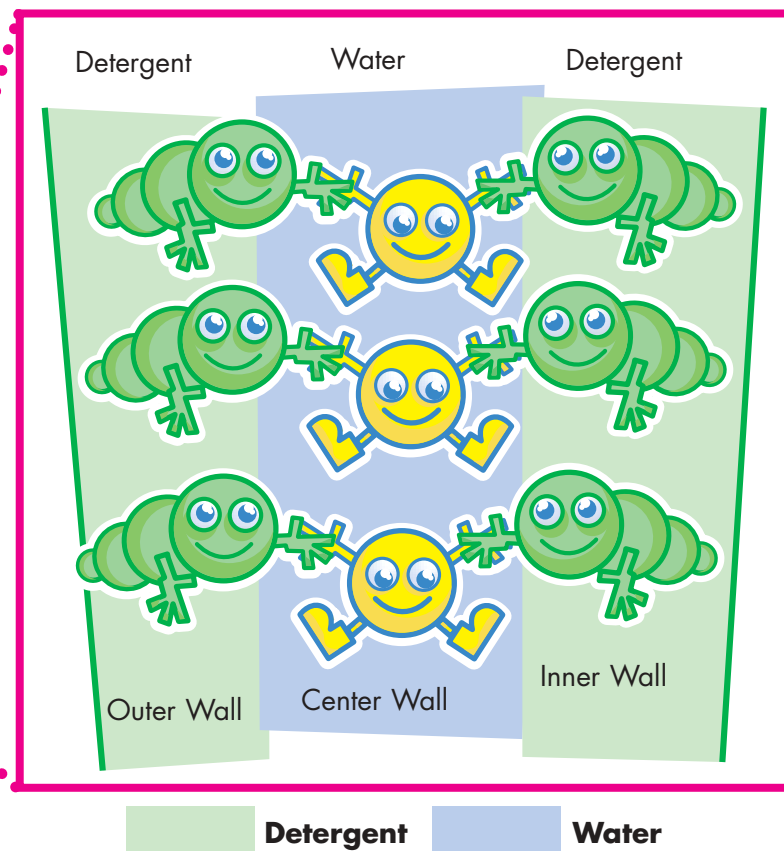
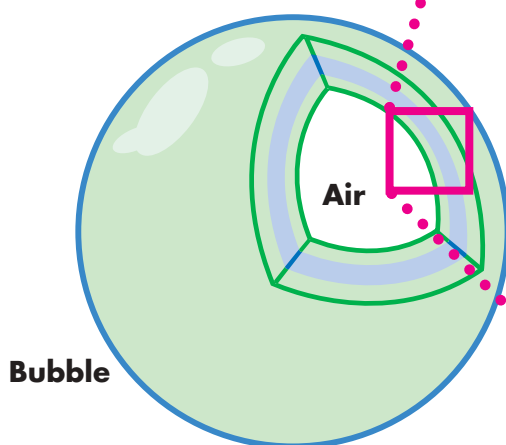
Bubbles can also teach us about light. The light from the sun is made up of many different colors. Mixed together, they look white. However, it is possible to separate the different colors of light from each other with a prism. Small drops of water or ice crystals can work like a prism. You have seen this for yourself, if you have ever seen a rainbow.

The wall of a bubble can work the same way. That is why bubbles are iridescent. When light hits a bubble, it may look blue, or it may look red. The colors seem to dance around on the surface. The colors that we see depend upon the thickness of the wall of the bubble and how much it is bent. As water evaporates from the bubble, the bubble's wall becomes thinner, and the colors change. Also, as the wind blows a bubble around, its wall bends, changing the color.

Bubbles can also teach us how to make things stronger. Bubbles are usually very fragile. They can easily pop. But if we add sugar to the bubble solution, the bubbles are much sturdier. They will last for two or three times as long. This is because the sugar strengthens the wall of the bubble. The sugar dissolves in the water layer of the bubble's wall and takes the place of some of the water. Since the sugar does not evaporate as quickly as the

water, the bubbles last longer. In addition, the sugar molecules are very large and stiff compared to water molecules. Like a large board nailed to the wall of a house, the sugar molecules brace the wall of the bubble to make it stronger.

Bubbles are pretty incredible, but who knew? The observations that people have made about them have led to many questions and interesting answers that help explain the world around us.



If Mixing Is Urgent—Try Detergent!

Normally, oil and water do not mix together very well. This fact makes it hard for water to wash away oily dirt. Detergent can help water and oil mix together. This mixing helps the water wash the oil away. You can try the following activity to see how much detergent really helps oil and water to mix!

Materials

White index card
1 Zip-closing plastic bag
Masking tape
Marker or ballpoint pen
Measuring spoons
3 Small disposable paper or plastic cups (3 oz.)
Water
Food coloring (blue, green, or red)
Vegetable oil
Liquid dish detergent
Dropper
Toothpicks

ADAPTATION: To see this experiment better, try using a magnifying lens and a flashlight.

SAFETY: Be sure to follow Milli's Safety Tips! Do not drink any of the water samples in this activity.

Procedure

1. Place the index card inside the plastic bag and close the bag.
2. Use the masking tape and pen to label one of the cups "vegetable oil", another "water" and the third "detergent".
3. Place about 1 tablespoon of water into the "water" cup. Add 1 drop of food coloring to the water and swirl to mix.
4. Place about 1 teaspoon of vegetable oil in the cup labeled "vegetable oil", and about 1 teaspoon of dish detergent in the cup labeled "detergent".
5. Use your dropper to place about six drops of colored water on the plastic bag.

6. Do the same thing on another spot on the bag so that you have two large drops of colored water on the bag in separate places.
7. You can use the same dropper to add a few drops of oil to the water in each area. Does the oil mix with the water or does it stay separate?
8. Use a toothpick to stir the water and oil in one of the areas. Does the oil stay mixed with the water, or does it separate when you stop mixing?
9. Dip a clean toothpick in the liquid dish detergent. Use this toothpick to stir the other area of oil and water. Does it look like the oil and water are mixing any better than they did without the detergent? Keep stirring to see how well the oil and water can be mixed. Does the oil mix with the water now? If the oil and the water are not mixing completely, you may want to dip the toothpick in the detergent again, and then stir the oil and water some more.
10. Describe what you saw in the table found in the "What did you observe?" table.
11. Thoroughly clean the work area and wash your hands.

A Matter of Mixing

Water is great for cleaning. It can wash away almost anything, but when it comes to oil or grease, it doesn't have a chance. That is because oil and grease are very different from water in the way they behave.

Water is able to wash things away because it dissolves them. An example of this is when salt is added to water. The salt seems to disappear, because it separates into smaller and smaller pieces until we can't see it any more. These small pieces of salt dissolve in the water. They are still there, but we just can't see them. Sugar does the same thing. It dissolves into water. There are a couple of ways that we can prove to ourselves that the sugar or the salt is still there. For one, we can taste them. Salt water tastes salty, and sugar water tastes sweet. Also, if we take salt water, or sugar water, and let it sit on a counter or a windowsill for a while, the water will evaporate and leave a white powder behind. In the case of salt water, the powder is salt, and for sugar water, the powder is sugar.

Chemists use the term hydrophobic (hi-dro-FO-bic) meaning "water-fearing" to describe things like oil and grease, because they never mix with water. Other materials like sugar that quickly dissolve in water are

called hydrophilic (hi-dro-FIL-ic) meaning "water-loving".

As a rule, we can say that things with similar properties can dissolve in each other. That is, hydrophilic materials will dissolve in other hydrophilic materials, and hydrophobic materials will dissolve in other hydrophobic materials. For example, salt and water are both hydrophilic, so salt will easily dissolve in water. However, things with very different properties will not dissolve in each other. For example, salt will not dissolve in oil, because salt is hydrophilic, and oil is hydrophobic.

Soaps and detergents are exceptions to this rule, because they can dissolve in hydrophobic or hydrophilic materials. In some cases they will act more like water, and in others they will act more like oil.

Soaps and detergents show both hydrophilic and hydrophobic properties. If a detergent is added to a container with oil and water, the detergent will stick to both the water and the oil, causing them to mix. This is how detergents help to clean your clothes. The detergent mixes with oily stains, and lifts them into the water so that they can be washed away. So, the next time that you need to wash your jeans, think about whether water will work by itself, or whether you need to add some detergent to help mix things up!

Hydrophilic Materials

Water
Salt
Sugar
Rubbing alcohol
Vinegar

Hydrophobic Materials

Olive oil
Butter
Axle grease
Beeswax
Lipstick

What did you observe?

Mixing Oil with Water

Mixing Oil, Water, and Detergent

Try this...

Detergent is used to get the oil and grease off pots, pans, and dishes. Shampoo and soap are used to get oils off your hair and skin. If detergent helps grease and water to mix, what do you think would happen if you tried the same activity with shampoo or soap? Try it and see! Be certain to follow all safety precautions.

Where's the Chemistry?

Water and oil do not mix with each other, because they are very different kinds of materials. They feel different when you touch them, and they act differently when you drop them on to a plastic sheet. Detergents are special kinds of materials that can dissolve in both water and oil (see "A Matter of Mixing"). Because the detergent can mix with both the oil and the water, it allows these two very different materials to mix together.

Release the Grease!

In this activity you can test whether water or laundry detergent is better at cleaning a colorful greasy substance like lipstick. Next time, you won't be stuck when you need to un-stick lipstick!

Materials

- White index card
- Lipstick
- Masking tape
- Pen
- 2 Small disposable cups (3 oz.)
- Measuring spoons
- Water
- Liquid dishwashing detergent
- 2 Cotton swabs

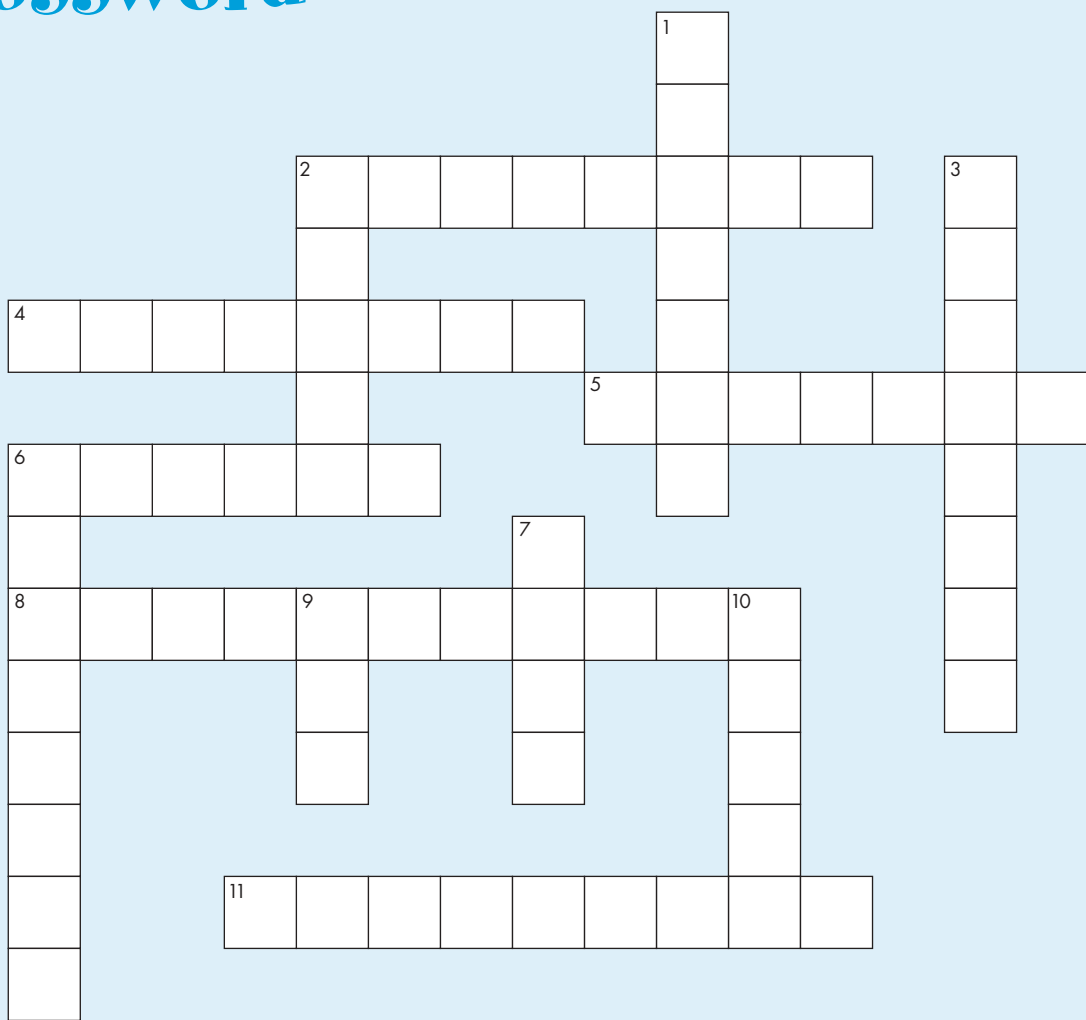
SAFETY: Be sure to follow Milli's Safety Tips and do this activity with an adult! Do not drink any of the water samples in this activity.

Procedure

1. Place the white index card flat on the work surface.
2. Use the lipstick to make two separate circles of color on the index card that are about the size of a quarter.
3. Use masking tape and a pen to label one cup "water" and the other cup "detergent".

4. Place about 1 tablespoon of water in the cup labeled "water", and about 1 tablespoon of dishwashing detergent in the cup labeled "detergent".
5. Dip one end of a cotton swab in the water and lay that end on top of one of the lipstick circles.
6. Dip one end of the other cotton swab in the laundry detergent and lay that end on the other lipstick circle.
7. Without lifting either end into the air or pressing down hard, hold one swab by the dry end and move it in a circular motion about 20 times over the lipstick circle. Move the other swab in the same way over the other lipstick circle.
8. Look closely at the way both liquids have moved with the lipstick and observe the water and detergent-dipped ends of the cotton swabs. Write down any differences between the water and the detergent washes in the "What did you observe?" Table.
9. Thoroughly clean the work area and wash your hands. Dispose of the solutions down the drain, and place the swabs and rinsed cups in the trash.

Crossword



ACROSS

- 2 Insect that makes use of a property of water to "skate" along its surface.
- 4 The grease in "Release the Grease" came from this.
- 5 These may be polished with vinegar, apple juice, or even soda!
- 6 A bubble, like a prism, separates different _____ of light.
- 8 This means "water fearing".
- 11 This helps get clothes clean!

DOWN

- 1 Can be formed with detergent, water, a bit of sugar, a plastic strawberry basket and some air from you!
- 2 Makes up 2/3 of your body's weight.
- 3 Property of water sticking to other surfaces.
- 6 Property of water where water molecules stick to each other.
- 7 To get clean, you must wash with _____.
- 9 This is an example of something that by itself does not mix well with water.
- 10 Chemistry Keeps Us _____!

Answers on page 12.

What did you observe?

Washing with Water

Washing with Detergent

Where's the Chemistry?

Lipstick is a greasy substance. Water alone does not mix well with grease and cannot wash it away. Detergent can mix with the lipstick and can also mix with the water. This allows the water and detergent together to wash the lipstick away.

Remember how soap helps water to mix with other things the next time you are washing your hands.

Cleaning Water With Dirt

When we get a drink of water from the water faucets in our homes, we do not have to worry about getting sick. That is because our water has been cleaned and treated at a water treatment plant. Most water treatment plants use sand and charcoal filters to clean the water. In this activity, you will make your own water treatment system and see how it works.

Materials

Water
 Measuring cup
 2 Medium disposable paper cups (8 oz.)
 Food coloring (red, green, or blue)
 Measuring spoons
 Dirt and grass
 Wooden craft stick
 Fragrant oil (optional - orange or lemon works best)
 5 Small disposable paper cups (3 oz.)
 Ballpoint pen
 2 Cotton balls
 Sand (available at a hardware store)
 Quarter (25 cent coin)
 Metric ruler (15 cm)
 Activated charcoal (available at a pet store with the aquarium supplies)
 Scissors

SAFETY: Be sure to follow Milli's Safety Tips and do this activity with an adult! Do not drink any of the water samples in this activity.

Procedure

Dirty Water

1. Add three quarters (3/4) of a cup of water to one of the medium size paper cups.
2. Add one drop of food coloring (red, green or blue works best) to the water.
3. Add a tablespoon of dirt and grass to the water, and carefully mix everything together using the wooden craft stick.

You will use this "Dirty water" to test how well your filters work.

ADAPTATION: As an option, you can ask an adult to add a drop of fragrant oil to your dirty water to imitate smelly things that are sometimes found in pond or lake water. Be careful—fragrant oils are usually very concentrated and can burn your eyes!



Sand Filter

1. To make a sand filter, ask your adult partner to push the tip of a ballpoint pen through the bottom of one of the small paper cups. *They must be careful to push the pen away from them, so that they don't poke themselves in the hand!*
2. Stuff a cotton ball into the hole that was just made for you, using the ballpoint pen to help. The cotton ball should plug the hole completely, so that the sand that you put in next will not fall out.
3. Put 5 tablespoons of clean sand into the cup.

Filter Stand

1. Make a stand for your filter from a medium paper cup.
2. Start by turning the cup upside-down. Place a quarter in the middle of the bottom of the upside-down cup, and trace its outline using the ballpoint pen.
3. Ask your adult partner to cut along the line with scissors to make a hole in the bottom of the cup that is about 1-inch wide. You must not try to do this yourself! Don't worry if the hole is not perfectly round.
4. Holding the cup right side up, measure up from the bottom of the cup 1 centimeter and mark a line all the way around the outside of the cup using the ballpoint pen.
5. Flip the cup upside-down and have your adult partner cut straight down the side of the cup. Your adult partner should cut from the rim of the cup to the line that you just drew. Your adult partner should be careful not to cut completely through to the bottom of the cup, but to stop where you drew the line.
6. For the next cut, measure 3 centimeters over from the cut that was just made and have your adult partner make a second cut straight down the cup from the rim to the line.
7. Fold the entire flap out, and cut it off.
8. Turn the cup upside-down and place it on the table. You now have a filter stand.

Test #1 - The Sand Filter

1. Place a small empty paper cup on the table. Write "Test #1" on the side of the cup using the ballpoint pen.
2. Put your filter stand over the top of the smaller cup. The small cup should fit inside of the filter stand. The small cup should be right side up, and the filter stand cup should be upside-down.
3. Place your sand filter on top of the filter stand. The hole with the cotton in it should be centered over the hole in the top of your filter stand.

4. Write "Sample" on the side of a new, clean small paper cup.
5. Stir your dirty water with the wooden craft stick.
6. Fill the small paper cup labeled "Sample" half full with the dirty water.
7. Pour the dirty water from the small cup labeled "Sample" slowly onto the sand filter.
8. Watch through the side of the filter stand to see what happens to the water. *If you added a fragrant oil, wave your hand over the top of the cup to bring any odors to your nose. Do not place your nose or face directly over the top of the cup. Can you smell the fragrant oil, or was it removed from the filtered water?*
9. Write down your observations in the "What did you observe?" table.

Charcoal and Sand Filter

1. To make a charcoal and sand filter, ask your adult partner to push the tip of a ballpoint pen through the bottom of one of the small paper cups. *They must be careful to push the pen away from them, so that they don't poke themselves in the hand!*
2. Stuff a cotton ball into the hole using the ballpoint pen to help. The cotton ball should plug the hole completely.
3. Add 2 tablespoons of clean sand to the cup.
4. Add 2 tablespoons of activated charcoal to the cup. It should form a layer on top of the sand.
5. Carefully add another tablespoon of clean sand on top of the charcoal.

Test #2 - The Charcoal and Sand Filter

1. Place a small empty paper cup on the table. Write "Test #2" on the side of the cup using the ballpoint pen.
2. Put your filter stand over the top of the smaller cup. The small cup should fit inside. The small cup should be right side up, and the filter stand cup should be upside-down.
3. Place your charcoal and sand filter on top of the filter stand, so that the hole with the cotton in it is centered over the hole in the top of your filter stand.
4. Stir your dirty water with the wooden craft stick.
5. Fill the small paper cup labeled "Sample" half full with the dirty water.
6. Pour the dirty water from the small cup labeled "Sample" slowly onto the charcoal and sand filter.
7. Watch through the side of the filter stand to see what happens to the water. Observe the water after the filtration process is complete. *If you added a fragrant oil, wave your hand over the top of the cup to bring any odors to your nose. Do not place your nose or face*

directly over the top of the cup. Can you smell the fragrant oil, or was it removed from the filtered water?

8. Record your observations in the "What did you observe?" table.
9. Thoroughly clean your work area and wash your hands. Dispose of all liquids down the drain. All solids and cups must be placed in the trash.

Try this...

Try using dirt in the place of the sand in the filter. What is the difference between dirt and sand? Which one works better? Try using a coffee filter. Does it work more like the sand filter, or more like the charcoal filter?

Where's the Chemistry?

Sand is a very good filter for solids like dirt, grass, and trash. It works because the pieces of sand pack very tightly together with only small channels or holes in-between. There just isn't enough room for the pieces of dirt and grass to get through the layer of sand. So in this experiment, the sand was able to keep the dirt and grass from getting through, but the food coloring passed straight through.

Activated charcoal is actually burnt wood that has been dried in an oven. Many different types of chemicals will stick to the surface of activated charcoal. Some people use charcoal filters to clean the water in aquariums. Other people use it to clean the water in their kitchen sinks. If you

have a filter on your water faucet at home, it probably has activated charcoal in it.

In the second experiment, the activated charcoal removed the food coloring and the fragrant oil from the water. However, if the same filter were used for more water samples, the food coloring would eventually start to come through. That is

because the charcoal can only hold so much food coloring. Once all of the binding sites on the surface of the charcoal are full, the charcoal filter no longer works—there are no places left that can hold any more food coloring or oil. That is why you should replace the filter in your aquarium once a month.

What did you observe?

	Test #1 Using the Sand Filter	Test #2 Using the Sand and Charcoal Filter
Water color before filter		
Water color after filter		

Was there any difference in the results of the two tests?

What did the sand do to the dirty water?

What did the charcoal do to the dirty water?

Hidden Objects



Check off each object as you find it!

- Toothbrush
- Bar of Soap
- Lipstick
- Cotton Swab
- Bucket
- Mop
- Toothpaste
- Scrub Brush
- Glass of Water

Answers on page 12.

Washing Water

Have you ever looked closely at the water in a lake or stream? What about water from a spring? Was it clean? Would you drink it? Do you think it would make you sick if you did?

The water that we find in a lake or stream is usually too dirty to drink without cleaning it first. Sometimes we can tell that water is dirty, because it looks muddy, or smells bad. But other times, although it may look and smell clean, it would make us sick if we drank it. To be safe, you should never drink water unless it has been treated properly.

Water for our towns and cities is cleaned in water treatment plants before it comes to our homes and schools. Water treatment plants use four basic steps to clean water: coagulation, sedimentation, filtration, and disinfection. These steps are described in detail below.

Coagulation

To coagulate something means to make it stick together in clumps. Our blood does this naturally when we get a cut. Blood clumps together to form a scab over a wound. In water treatment plants, chemicals are added to dirty water to make the very small particles coagulate or clump together. These larger clumps are much easier to remove from the water. The most common chemical used for coagulation is alum. You have probably come across alum before without even knowing it. Alum is what makes your mouth pucker when you eat a dill pickle.

Sedimentation

Sedimentation means settling to the bottom. In a fast-moving stream, soil and other materials are stirred up into the water, making it look cloudy. When a stream runs into a lake, the water slows down, letting the soil and other solid materials fall to the bottom of the lake. In a water treatment plant, water is

pumped into a large tank called a sedimentation tank. The sedimentation tank usually has several walls rising up from the bottom of the tank. These walls are short enough to let the water flow over their tops, but tall enough to slow the water down. The solid materials settle to the bottom of the tank just like in a big lake. The cleaner water at the top of the tank is then pumped out into a filter.

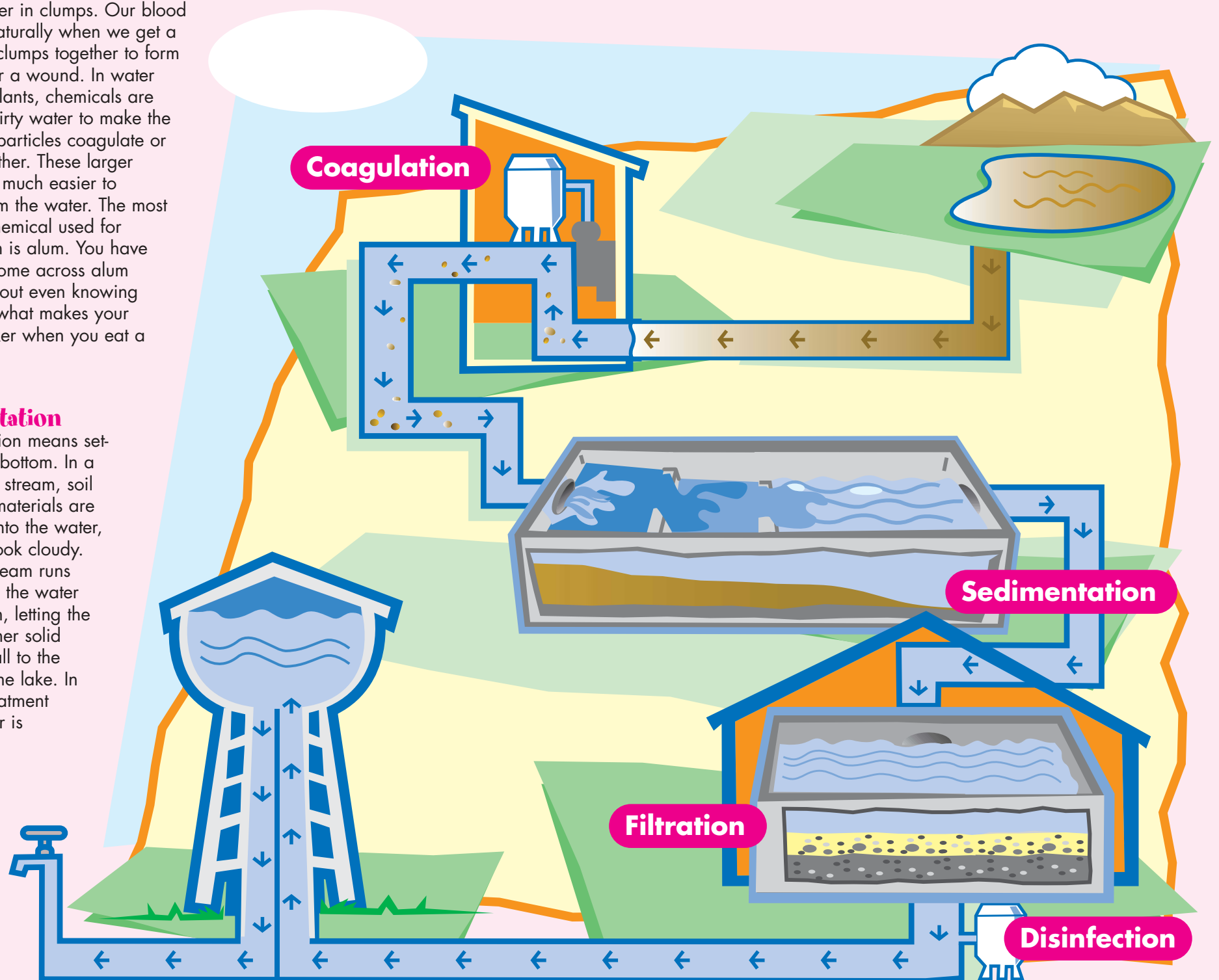
Filtration

The filters used to treat water in water treatment plants are very similar to the ones you made in the "Cleaning Water with Dirt" activity. They are usually made of sand, but they may also have gravel, coal, or activated charcoal. These filters remove the solid materials not taken out by the sedimentation process. The water is now crystal clear, and it would taste good to drink, but it could still make you sick.

Disinfection

Many times, water from streams or lakes contains harmful germs that can make us sick, but are too small for us to see or filter out. These germs are removed in the final treatment step called disinfection. During disinfection, a chemical like bleach is added to the water to kill the germs and make it safe to drink.

Water treatment makes all the difference with respect to our health. Before water treatment plants were common, many children died each year because of diarrhea and dehydration. Many others became ill. But because of water treatment plants, we no longer have to worry about getting sick from drinking dirty water.



Polishing Pennies

Pennies are made from bright, shiny copper, but they don't stay bright forever, because the copper reacts slowly with oxygen from the air to create a coating of copper oxides. The copper oxides are dull and dark. What is the best way to make pennies shine like new again?

Materials

- Masking tape
- Pen
- 6 Small disposable plastic cups (3 oz.)
- 5 Old, dull pennies
- Water
- Dilute liquid dishwashing detergent (1/4 teaspoon detergent in 1 cup of water)
- Disposable plastic spoon
- Lemon juice
- Cola
- Vinegar
- Paper towels
- Clock or timer

SAFETY: Be sure to follow Milli's Safety Tips and do this activity with an adult! Do not drink any of the liquid samples in this activity.

Procedure

- Use the masking tape and pen to label the cups: "lemon juice", "cola", "detergent", "vinegar", and "water".
- Place a penny in each of the cups, and describe each in the "What did you observe?" table.
- Pour enough water, lemon juice, cola, vinegar, and detergent into the labeled cups so that each penny is completely covered.
- Wait 3 to 5 minutes.
- Use a plastic spoon to remove the penny from the "lemon juice" cup and observe how it looks. Write your observations in the "What did you observe?" table in the box under "lemon juice".
- Polish the penny with a paper towel. Observe what happens and write your observation in the table. Look at the paper towel. What color is the material that you rubbed off?
- Place the penny on the work surface in front of the cup from which it was removed.
- Repeat steps 6-8 for each of the pennies in the other liquids, and record your observations in the table.
- Wait about 5 minutes after all pennies are out of their solutions and observe them again. Write down your observations in the table.
- Thoroughly clean the work area and wash your hands. Rinse the pennies with water, and dry them. Pour all liquids down the drain, and place the other materials in the trash.

Try This..

Conduct your experiment again, using vinegar mixed with a few shakes of table salt. Also, try

What did you observe?

Penny	Lemon Juice	Cola	Detergent	Vinegar	Water
Before putting into liquid					
When removed from liquid					
After rubbing on paper towel					
After 5 minutes					

vinegar with a pinch of cream of tartar, a pinch of table salt, and a drop of dishwashing detergent. See if tomato ketchup or a water solution of baking soda is a good penny cleaner.

As you try these different cleaners, be certain that you continue to follow the safety guidelines, and that your adult partner approves.

Where's the Chemistry?

Not all liquids are the same. In this case, the liquids that were acidic were better cleaners

than the ones that were not. Lemon juice contains citric acid, cola contains phosphoric acid, and vinegar contains acetic acid. The detergent and the water are not acidic at all.

The acids in the lemon juice, the cola, and the vinegar react with the copper underneath the oxides on the outside of the penny to form new materials. These newly formed materials dissolve in the liquid and are washed away. So, what is left behind is a very thin coating of copper oxides that you can easily rub away. Did you notice whether any of the solutions changed colors?

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 nonliving 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 artificial sweeteners, Teflon, Nylon, new medicines, the adhesive used on Post-it notes, and many different kinds of plastics. Some chemists are teachers. They help students learn about the world around them. Some chemists work in art museums restoring and preserving works of art. 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 such 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 the American Chemical Society website, chemistry.org.



Celebrating Chemistry is a publication of the American Chemical Society's (ACS) Office of Community Activities in conjunction with the National Chemistry Week Task Force. The Office of Community Activities is part of the ACS Membership Division. *Celebrating Chemistry* is published annually and is available free of charge through your local National Chemistry Week Coordinator. You can go to chemistry.org/ncw to locate your National Chemistry Week Coordinator, or to find out more about National Chemistry Week.

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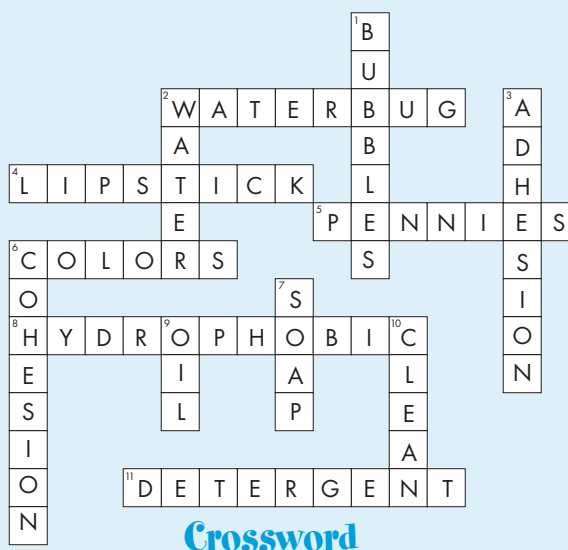
Many of the activities described in this publication were modified from WonderNet (chemistry.org/wondernet), a publication of the ACS Education Division. Other contributors include Jeanne Russell of the University of Texas of the Permian Basin for the word find "Come Clean with Chemistry", and Charles Knobler of the University of California for insights into "bubblology". Additionally, the support of the Soap and Detergent Association as well as the American Chemistry Council is appreciated.

The activities described in this newspaper are intended for elementary and middle 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.

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Answer Keys

Hidden Objects



Crossword

Word Find



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. ACS has more than 163,500 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 and through the use of the ACS website and the journals it 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 the fall. ACS members celebrate NCW by holding events in schools,

shopping malls, libraries, science museums, and even train stations! The activities at these events include, among other things, 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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