National Chemistry Week • American Chemical Society

Your Home — It's All Built on Chemistry

Think about the rooms in your home, like the bedroom, bathroom, and kitchen. How much chemistry can be found in them? It's everywhere! In fact, your home is built out of materials made possible by chemistry. From the concrete in the foundation to the shingles on the roof, from the fiber in the carpets to the insulation in the walls, and from the counters in the kitchen to its pipes and cabinets, chemistry is essential to the structure and contents of your home.

What do wood and carpet fibers have in common, aside from being materials that are in your home? They are polymers! Polymers are 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".

Wood is an example of a natural polymer called cellulose. It is found in the lumber used to build the frame structure supporting your home, in the cabinets in your kitchen, or your hardwood floors. The furniture and some of your toys may be made from wood, too.

Polymers can also be made in laboratories by chemists. These polymers are known as synthetic polymers. One example is nylon. Nylon can be in many items around your home, but the most likely place to find it is in carpet.

Another synthetic polymer that builders are using more and more is a plastic material called polyvinyl chloride or PVC for short. You may also hear it referred to as "vinyl". PVC, or vinyl, is flexible, strong, and can be used in a number of ways around the home. For instance, you can see it as house siding, window framing, and kitchen flooring.

Another reason vinyl is becoming popular is that it can be made to look like wood, clay, concrete, bricks, and other materials. It is less expensive and is mainly used to replace the real material for decorative reasons—though sometimes people choose vinyl because it is lighter in weight or requires less maintenance than an actual tile or wood floor, for example. So next time you see window shutters or knock on a front door, investigate to see if it is wood or vinyl.

Are all materials in the home made from polymers? Even though it may seem like it, the answer is no. The glass used in windows and mirrors is a mix of silicone dioxide and limestone. From glass, manufacturers make a material called fiberglass. It can be found in insulation and shower doors and stalls.

Metals are found throughout the home too. Common examples are copper and nickel. Most builders today use PVC instead of copper for plumbing, but many older homes still have their copper, and luxury houses may use this distinctive metal on their roofs. You may also spot some copper-bottomed pots and nickel-plated faucets in your kitchen. Look at the chart below to see other metals that are in your home.

In this issue of *Celebrating Chemistry*, you will learn more about how chemistry plays a key role in the construction and building of our homes. Materials made or discovered by scientists and engineers allow homes to become more efficient for energy, heating, and cooling as well as safer and more resistant to forces of nature like earthquakes, tornadoes, and hurricanes.

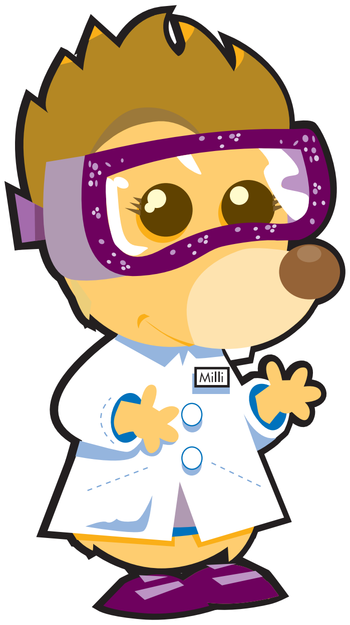
Dig into the articles that explore the materials and how chemistry is found in the home. After you have finished reading and doing the activities, ask your teacher or family members about where else chemistry can be found in homes. It is amazing how much you can learn from talking to people—and with your own new knowledge about chemistry and the home, perhaps they will be learning from you, too!

ELEMENT	WHERE YOU MIGHT FIND THE ELEMENT IN THE HOME
Al Aluminum	Foil, window frames, doorknobs, cookware, cans, refrigerators, siding
B Boron	Glass, insulation, soaps and detergents
Cu Copper	Wires, tubes, cables, pipes, stoves
Au Gold	Stereo, jewelry, telephone

ELEMENT	WHERE YOU MIGHT FIND THE ELEMENT IN THE HOME
Fe Iron	Metalwork, gates, stoves, combined with other metals and carbon to make steel
Li Lithium	Batteries, ceramics/pottery
Ni Nickel	Knives, forks, spoons, rechargeable batteries, clocks
Ag Silver	Photographic film and paper, jewelry, mirrors, wiring, silverware

ELEMENT	WHERE YOU MIGHT FIND THE ELEMENT IN THE HOME
S Sulfur	Paints, rubber products, batteries
Ti Titanium	White paints, toothpaste, enamel finishes, bicycles
W Tungsten	Light bulbs, paints, TV
Zn Zinc	Washing machines, cameras, coins, batteries, gutters

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

- **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".

Milli's Insulation Investigation

It is important to keep the temperature at home comfortable for living, no matter what the weather is like outside. When it is cold, we have to heat our homes to keep them warm. When summer comes, we turn on fans or air conditioning to keep our houses cool. Heat moves from a place where it is warmer to one where it is colder. To help keep your home comfortable inside and to save energy, insulation is placed in the walls, where it works like a jacket around your house. The most common types of insulation used in homes are made from fiberglass and cellulose. Fiberglass is extremely fine strands of glass. Cellulose insulation looks like a pulpy, puffy form of just what it is: recycled newspapers, boxes, and waste paper. In this activity you will test several different materials to find out which one is the best insulator.

Materials

- Blunt-ended scissors
- Ruler
- Pencil or pen
- Aluminum foil
- Newspaper
- Plastic wrap
- Wax paper
- 5 identical ice cubes
- Rubber bands
- Paper towels
- Baking tray
- Watch or timer
- Wire rack (optional)

NOTE: This activity can take between one and two hours to complete.

ADAPTATION *Use small see-through ice packs instead of ice cubes and wrap in a small towel, bubble wrap, aluminum foil, and wax paper or brown paper. Observe the differences in the amount of melting of the material inside over time.*

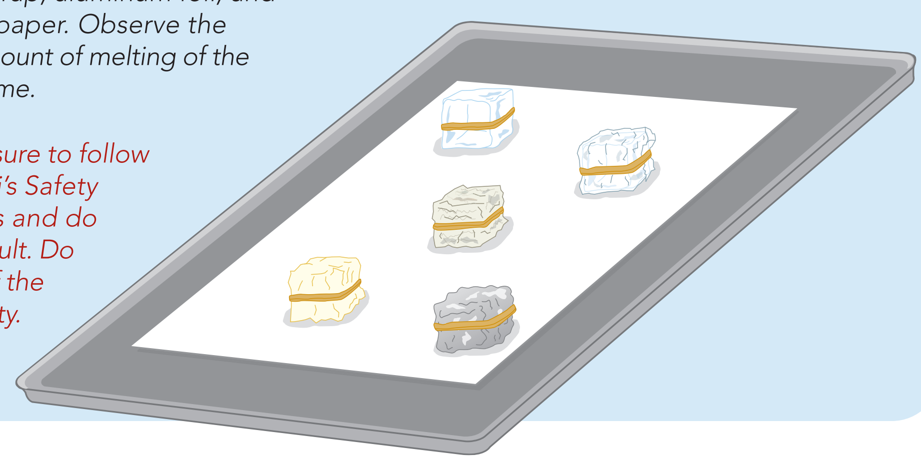
SAFETY! *Be sure to follow Milli's Safety Tips and do this activity with an adult. Do not eat or drink any of the materials in this activity.*

Procedure

1. Cut the aluminum foil, newspaper, plastic wrap, and wax paper to the same size for wrapping each ice cube.
2. Wrap one ice cube in each type of wrapper, being careful to wrap the cubes the same way each time.
3. Use a rubber band to hold each wrapper in place, and put a rubber band around the unwrapped cube as well.
4. Cover the baking tray with a paper towel as shown below. Place the cubes on the baking tray. A wire rack may be placed on the tray to observe the cubes more easily.
5. Check the cubes every fifteen minutes and record your observations in the "What Did You Observe?" section.
6. After the unwrapped cube has completely melted, or one and a half hours have passed, unwrap the cubes and observe how much ice is left inside each wrapper. Record your results in the "What Did You Observe?" section.
7. Throw away the wet wrappers and paper towels. Thoroughly clean the work area and wash your hands.

Try this...

Try using other "wrappers" like heavy-duty foil, pieces of fabric, or bubble wrap. Try putting a set of cubes in the shade and a set in the sun. Put a set of wrapped cubes in the refrigerator and observe how the melting times differ when the surrounding temperature is lower.



What Did You Observe?

Describe how the cube looks (if you can see it), or how big the damp circle on the paper towel has become.

Time in Minutes	Unwrapped Cube	Aluminum Foil	Newspaper	Plastic Wrap	Wax Paper
15					
30					
45					
60					
75					
90					

Which cube melted the fastest?

Which cube took the longest time to melt?

List the wrappers in order from worst to best insulator:

Why do you think some are better insulators than others?

Where's the Chemistry?

The wrapper that allowed more heat through to the ice and melted it fastest is the worst insulator. The wrapper that kept the heat away from the ice and melted it the slowest is the best insulator. Metal tends not to be a good insulator because it transfers, or conducts, heat—in this case, it conducted the heat from the warmer air in the room to the cold ice.

Teachers and Parents!

Visit **chemistry.org/ncw** for:

- information about the National Chemistry Week poster contest
- ideas for celebrating in your local area and classroom
- links to the online interactive games
- more activities to do and articles to read at home
- tips on conducting these activities with groups
- Spanish versions of material
- alignment with the *National Science Education Standards*

Hidden Objects

Check off each object as you find it!
Answers are on page 12.

☐ Bowl

☐ Broom

☐ Candle

☐ Flashlight

☐ Hammer

☐ Nail

☐ Paintbrush

☐ Pencil

☐ Salt shaker

☐ Toolbox

☐ Tube of toothpaste

Milli's Home Hazard Hunt

Milli's most important wish for you and your family is safety in the classroom, the laboratory, and of course, at home. Chemistry plays an important role in keeping us safe. Fire extinguishers, for example, contain special chemicals that help put out fires. Some chemists work in laboratories creating new kinds of materials (e.g. paint, carpet, drywall) that are less likely to burn in a fire. Others improve the materials in your home to make them safer and less likely to rust, leak, or break (e.g. pipes, wires, refrigerators).

Wherever you are, it is important to avoid hazards. A hazard is a source of danger. Carbon monoxide is a gas that you cannot see or smell. It can be a hazard, but chemists have designed simple detectors that you plug into the wall to let you know if there is too much carbon monoxide gas inside your house.

Some hazards may not seem too dangerous, such as not using oven mitts or potholders when handling a hot pan, or plugging many appliances into an outlet, but they could be the cause of an accident or mishap. Each year millions of people are injured at home.* Accidents happen, but there are things we can do to make them less likely and to keep us safe at home.

You already follow Milli's Safety Tips (page 2) when doing science experiments. Many of the same safety rules apply in the home. Sometimes injuries can be avoided by looking around and finding hazards before any accidents happen. Are you ready to put your planning and observation skills to good use? Are you ready to help your family stay safe?

Use your observation skills to look for five hazards in the room pictured above. Can you find all of them? Look carefully for things that might be hanging, could easily be knocked over or be a danger for small children.

Where in your home do possible hazards exist? Go with an adult from room to room in your home and look for them. When you find one, talk about why it could be a hazard, and what can be done to correct it. Never try to correct a hazard yourself; your adult partner will either help or will contact a professional to fix it.

Earthquakes, floods, lightning storms, tornadoes, and hurricanes are all natural hazards and can happen when you least expect them. Every home should have a preparedness kit that has essential items like water, food, a flashlight, and a first aid kit. Information about hazard preparedness is available from the Department of Homeland Security, the American Red Cross, and your state or local government.

Milli wants you to remember that chemistry helps us prevent hazards by coming up with better and safer materials and ways to detect trouble before it gets out of hand. However, it is up to each of us to do our own part to keep our homes safe and to be prepared.

* The Home Safety Council's 2004 "State of Home Safety in America" report estimates nearly 21 million medical visits on average from unintentional injuries in the home.

Avi's Sensational Salt Dough

Brick is made by shaping clay and then drying or baking it at high temperatures. It is so strong and durable that it can still be found in grand structures that were built over 5,000 years ago, like the ancient Egyptian temples, Roman aqueducts, Inca pyramids, and the Great Wall of China, to name a few. Builders also use brick for smaller structures such as homes, either as part of the structure or decoration. Can you think of any places where bricks could be used around your home? In this activity, you and your adult partner will mimic how bricks are made. You will shape and bake creations from a dough that is made from flour, salt, and water.

Materials

- Conventional or toaster oven
- 1/2 cup measure for dry goods
- White flour
- Salt
- Large bowl
- Large spoon
- 1/4 cup liquid measure
- Warm water
- Aluminum foil
- Cookie sheet or metal tray
- Clock or timer
- Oven mitts
- Food coloring (optional—add to the water before pouring)
- Rolling pin and cookie cutters (optional)
- Smock or apron (optional)

NOTE: Different types of flour or addition of spices can give texture or color variation to the dough. Sculptures may be painted once they have dried. Unused dough can be stored in the refrigerator, in an airtight container, or plastic wrap, for up to a week.

SAFETY! *Be sure to follow Milli's Safety Tips and do this activity with an adult. Have your adult partner operate the oven and carry out the oven-related steps. Do not eat or drink any of the materials in this activity.*

Procedure

1. Have your adult partner preheat the oven to 200° F.
2. Measure and pour 1/2 cup flour and 1/2 cup salt in the bowl, and mix together with the spoon.
3. Slowly add 1/4 cup warm water while stirring the flour and salt, and continue to mix until the ingredients blend into a dough.
4. Knead the dough with your hands until it is smooth and elastic. If dough is sticky, add more flour. If too dry, add more water.
5. Shape the dough. Use tools that your adult partner has approved to help make your creations.
6. Cover the cookie sheet or metal tray with aluminum foil and carefully place your designs on the foil.
7. Ask your adult partner to place the tray in the oven. If you have a glass oven door, you can keep an eye on the dough.
8. Have your adult partner take the tray out of the oven with the oven mitts and check to see if they have finished baking after about 15 minutes. When dry and ready, your designs will be less shiny. The thicker your creations, the more time they need to bake, just as with sturdier bricks.
9. When the creations have dried, have your adult partner remove the tray from the oven with the oven mitts and place the tray on a heat-resistant surface. Be careful. Everything from the oven will be hot!
10. Wait for your adult partner to tell you when your newly created art is cool enough to touch.
11. When it has cooled completely, remove your sensational salt dough creation from the cookie sheet.
12. In the "What Did You Observe?" section, describe what the dough felt like before and after you baked it.
13. Thoroughly clean the work area and wash your hands.

Try this...

Try changing the amounts of salt and flour used to make the dough. Use a straw to make a hole near the top of your creation. After it has baked and cooled, you may tie a string or ribbon through the hole to make an ornament.

Where's the Chemistry?

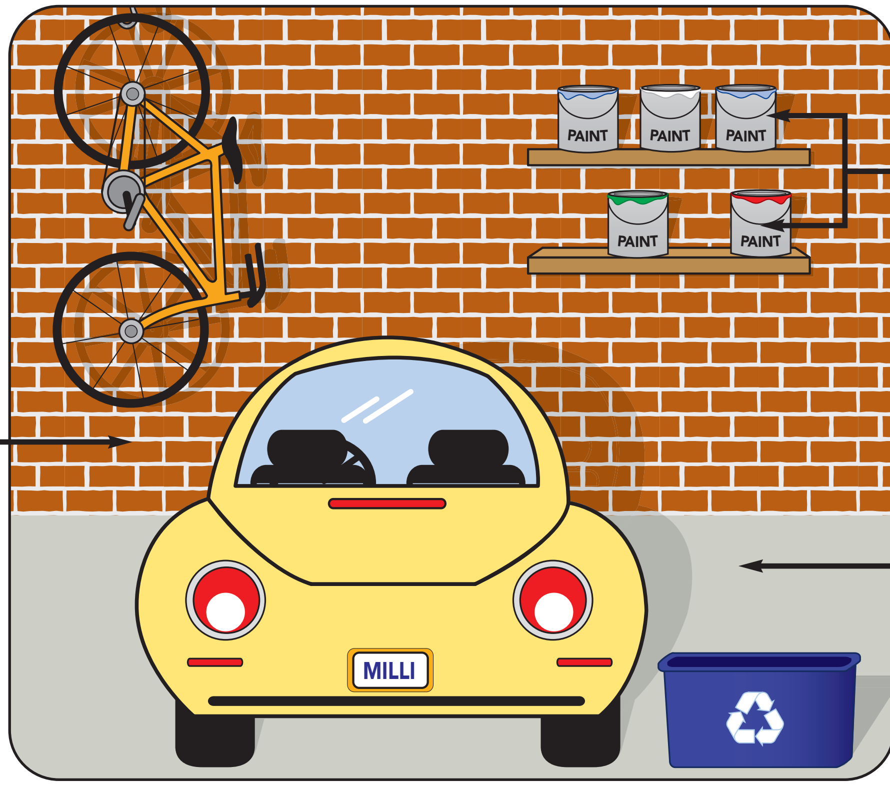
In this activity, a chemical change occurred when you baked the dough. It was soft and elastic at first and then became hard and rigid during baking. When a chemical change happens, things cannot be made to go back to what they were like originally and something new is formed. You can notice these changes by observing how it looks or how it feels. The color may be different, or it may feel solid instead of soft. In order for chemical changes to occur, heat may be required like in this activity.

What Did You Observe?

How did the dough feel as you started to shape it? After you baked it?

Your home is all built on chemistry. Think of the materials used to construct it—from rocks and minerals composed of chemicals to compounds developed in the laboratory by chemists. Several materials have been highlighted below from all the possibilities in these household rooms. Read on, and then try exploring on your own—elsewhere in the illustrations, or around your own home!

Garage



PAINT

All paints have two things in common: a pigment, like colored powder, and a binder, which holds the mix together and allows the paint to coat a surface smoothly. Other chemicals can turn paint into a water-repelling sealant or make it longer-lasting.

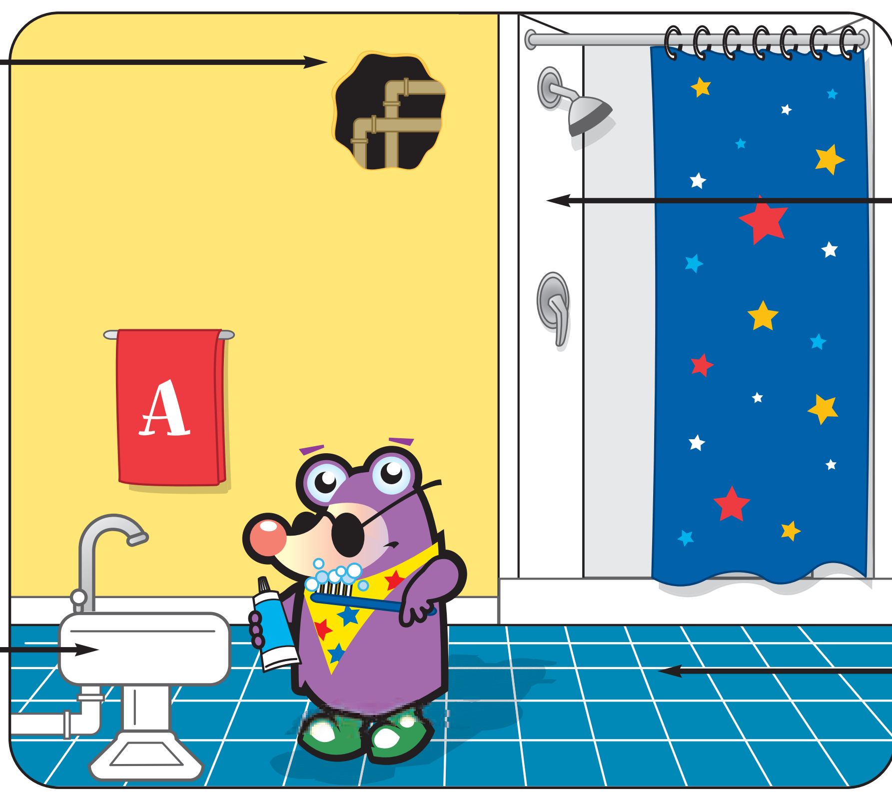
BRICKS

Bricks are made from drying or baking water and clay in an oven, or in the sun. Because they are strong and durable, they are used in places exposed to high temperatures, like a fireplace, or in rough conditions, like the outside of a home.

CONCRETE

Concrete is a mixture of cement, sand, and gravel or crushed stone. When water is added to the mix, a chemical reaction called hydration occurs. Builders pour the paste-like mixture into molds and as time passes it becomes rock-hard. A home's foundation, walkway, and front porch are a few examples of where concrete can be found.

Bathroom



PIPES

The pipes that carry water throughout most homes are made of a reddish-colored element called copper. Copper is a good choice because it is strong but flexible. It keeps hot water hot and cold water cold all the way through the house. Today, nearly all builders have switched to polyvinyl chloride, or PVC, because it is much less expensive, and just as effective.

FIBERGLASS

Fiberglass is made of extremely fine fibers of glass. The fibers are melted and held together with a chemical that allows them to be shaped into a form that can be used for many home products. Some shower stalls have walls and doors that are made of fiberglass. Certain types of home insulations are made of fiberglass, too.

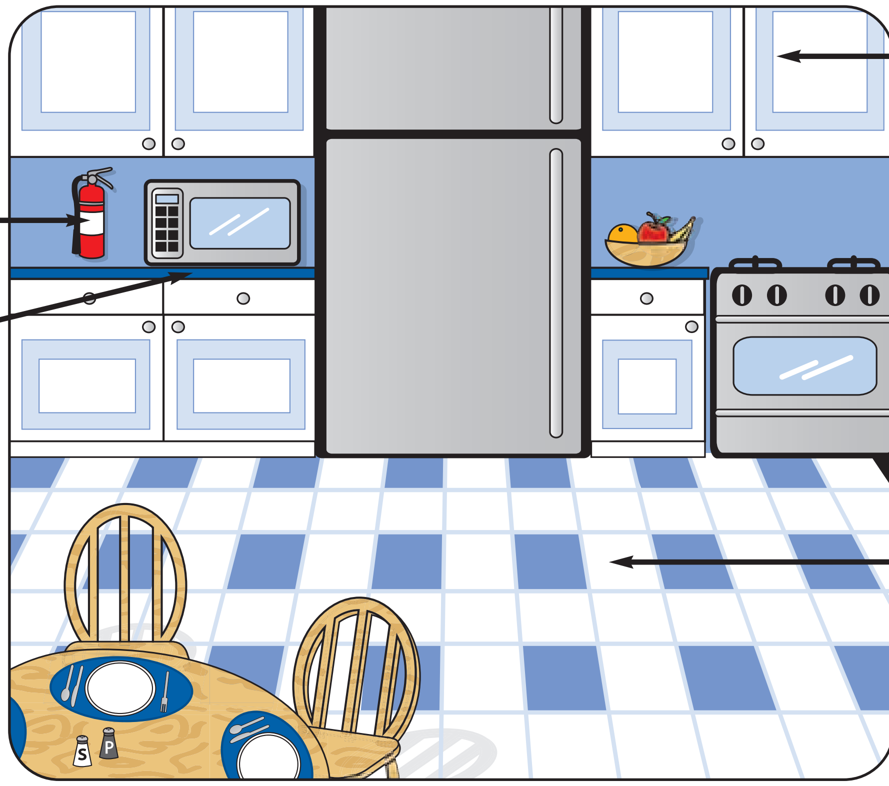
PORCELAIN

Porcelain is a hard substance made by heating materials, often including a kind of clay called kaolinite, at very high temperatures. It is also used for ceramic tiles, toilets, and countertops in the bathroom because of its strength, durability, and its resistance to high temperatures.

GROUT AND CAULK

Grout and caulk are thick liquids usually made up of a polymer, water, cement, sand, and sometimes a pigment for color. When grout hardens or dries, it makes a very hard seal. Grout and caulk are most often used in the bathroom and kitchen. Grout is found between tiles on the floor and caulk is found around sinks and tubs. This is because it does a good job of keeping water from seeping into walls, where the water can rot wood and mold can grow.

Kitchen



FIRE EXTINGUISHER

There are different types of fire extinguishers, but the "dry chemical" type is the kind that is found in most homes. Dry chemical fire extinguishers contain chemicals like sodium bicarbonate and potassium bicarbonate. Fire extinguishers are a very important part of a kitchen.

COUNTERTOPS

The most common materials used for countertops include engineered stone, natural stone, and laminate. Engineered stone is made of mixed colored pebbles, polymers, and a chemical called epoxy, which holds it all together. Granite is a natural stone found deep in the Earth's surface. Laminate has three layers (kraft paper, decorative paper layer, and a clear surface layer) fused together under high pressure and temperature. They all provide work space in the kitchen.

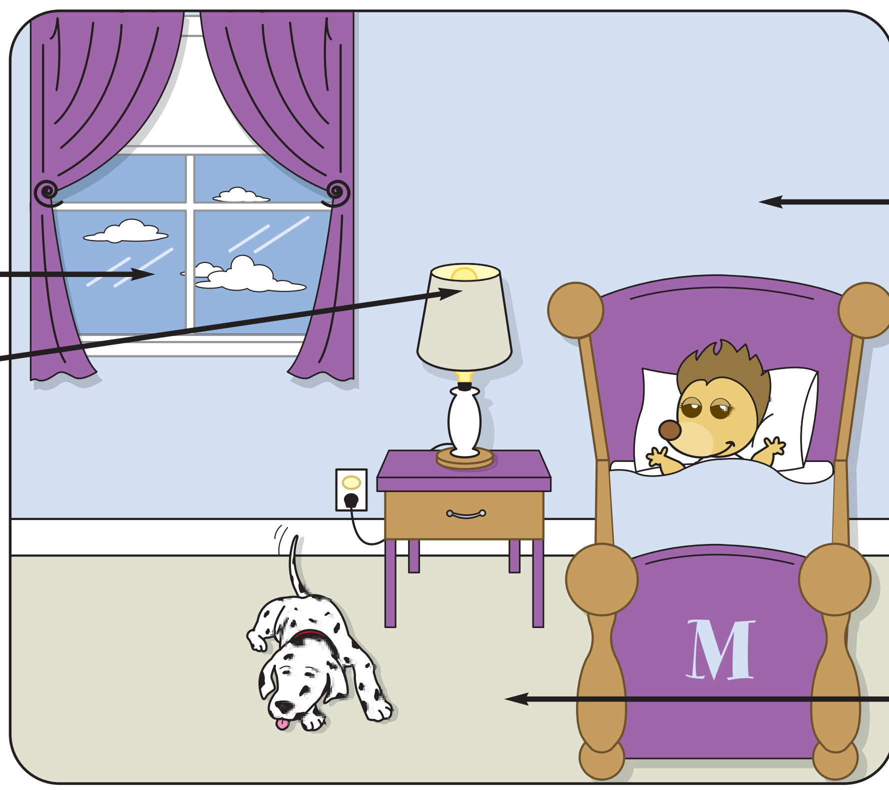
CABINETS

Most cabinets today are made of either solid wood or a type of human-made wood product. Wood is a natural polymer called cellulose. The human-made wood products consist of broken-down wood mixed with wax and another natural material called resin. These products can be as strong as wood in many cases, but are less expensive.

FLOORING

One type of kitchen flooring is linoleum. Linoleum is made from combining linseed oil (which comes from flax seeds) with wood flour, cork dust, tree resins, ground limestone, and coloring. It is used because it is water-resistant and easy to clean, which makes it a good cover for the kitchen floor. PVC flooring is commonly being used in place of linoleum.

Bedroom



WINDOWS

Newer homes usually have windows with two layers, or panes, of glass. The space in between the panes is sometimes filled with a gas or gases such as argon or krypton. These gases are nontoxic, odorless, and slow moving, which makes it even harder for heat to move through windows. This helps keep a house warm in the winter and cool in the summer.

LIGHT BULBS

There are different types of metals found in light bulbs to help the flow of electricity. There is a thin metal wire called a filament. It is usually made of a chemical element called tungsten. Tungsten will glow when excited with electricity, and does not melt like many other metals do. The bulb, which covers the filament, is often filled with a non-toxic gas like argon to keep the tungsten from burning away.

DRYWALL

Drywall is the most common material used to form the surfaces of walls and ceilings. It is made from a mineral compound called gypsum rock. The chemical name of gypsum is calcium sulfate dihydrate. The rock is ground into powder, then compressed and sandwiched between two sheets of heavy paper. It is easier to put up compared to applying layers of plaster paste, the previous method of covering wall surfaces.

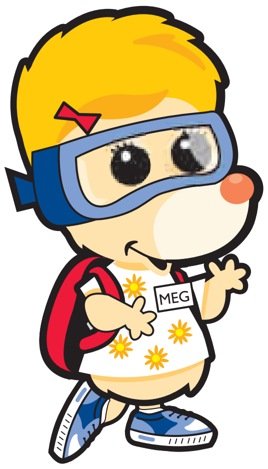
CARPET

Most carpets found in homes are made from synthetic polymers like nylon, olefin, polyester, and acrylic. They are more durable—and thus resistant to wear and tear—and are easier to clean versus carpet made from natural materials, such as wool or cotton.

The Adventures of

Meg A. Mole

Future Chemist



In honor of the National Chemistry Week theme, "Your Home—It's All Built on Chemistry," I visited a chemist who helps make our homes more colorful! I traveled to Los Angeles, California, where I met Hermenegildo "Gil" Mislang. Mr. Mislang works for Dunn-Edwards Corporation, a paint manufacturer!

Paint products are used to protect surfaces on our homes and buildings and give them color. In his job, Mr. Mislang mixes chemicals together to make paint products better and even more colorful. He also finds ways to make them with chemicals that are friendlier and safer to people and the environment.

When I arrived at the laboratory, Mr. Mislang showed me how they make a small batch of paint in the lab. My favorite part was when they used the mixer to blend the paint. I love combining colors to make new ones! Many toys today and even the paint in bedrooms of boys and girls are bright and colorful as well as safe because of research done in laboratories like Mr. Mislang's.

In the lab, most of the work is in research and development. They use a lot of instruments and equipment. For example, they have an instrument that tests for the thickness of paint after it is made. Paint has to be the right thickness to work correctly. They also have equipment that tests paint and makes thousands of colors in different shades.

Mr. Mislang told me the best part about his job is that he gets to work with creative people and is doing work to help reduce pollution and make environmentally friendly products.

To read more about my visit with Mr. Mislang, please visit my pages on the chemistry.org/kids website.

-Meg

Meg with Gil (far right) and some of the Dunn-Edwards research staff (left to right: Inna Shchors, Jose Ramirez, Olga Ivanilova, Claire Edrosa, Hai Nguyen)

Chemist Inna Shchors showing how they test paints

Personal Profile: Hermenegildo "Gil" Mislang

What is your favorite food?
Italian food

What is your favorite color?
Shades of green

What is your favorite movie?
"Star Wars"

When is your birthday?
January 7

Favorite pastime?
Cooking/gardening

About your family
My parents are from the Philippines. My father was a sailor and my mother a teacher. I have two brothers both also chemists, and four sisters: three are nurses and the fourth is an accountant. I have two sons, Jan and Chris. Jan is a graphic designer and Chris is studying to be a food chemist.

Very interesting project you were a part of?
Developing the paints used to paint the MGM Hotel & Resort in Las Vegas.

Playtime Paint

Why do we paint our homes? We paint the outside of our homes mainly to protect them from the rain, wind, and the sun. Other reasons we paint are to make our homes and the rooms inside look nice or just to brighten our lives. Modern paints are highly specialized and complex, but they all have two basic parts: pigments and binders. The pigment gives paint its color. The binder adds important chemicals that "hold" the pigment, help the paint stick to surfaces, and allow it to form a smooth film when it dries. There are different types of paints used in a home depending on what needs to be painted. For instance, the outdoor paints need to be weather resistant while indoor paints are made to have less odors as they dry. In this activity you will make your own paint using chalk as a pigment, and glue and water as binders.

Materials

- 2 freezer-style zip-closing bags
- Colored chalk (regular or sidewalk)
- Mallet or hammer
- Small cups (4 oz.)
- Measuring spoons
- Water
- Wooden craft sticks
- White craft glue
- Paintbrushes
- Paper

NOTE: Wear a smock or apron to protect clothes from paint.

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. Place one freezer bag inside of the other.
2. Place 2–3 pieces of the same colored chalk or 1 sidewalk colored chalk into the inner bag and close both bags, squeezing as much air out as possible.
3. Carefully use the mallet or hammer to break the chalk into a fine powder. Your adult partner may need to help with this step. Make the powder as smooth as possible. It will be harder to break up the small chunks once you have taken the powered chalk out of the bag. Your paint will end up lumpy if you do not break up the chalk.
4. Carefully open the bags and slowly pour the powder into a small cup.

   Note: If you want to make more than one paint color, repeat step 3 with another color of chalk. Use separate cups for each color.
5. Add 3 teaspoons of water to the powder in the cup.
6. Using a craft stick, mix the chalk powder and the water until you have a fine paste. The smoother the paste, the smoother your paint will be.
7. Add 1 tablespoon of white glue to the cup and stir everything together.
8. If your paint appears thick, you may need to add up to 3 more tablespoons of water to get the paint the consistency that you want. Add 1 tablespoon at a time and mix after each addition.
9. Paint a picture on the paper.
10. Thoroughly clean the work area and wash your hands.

Try this...

Try mixing different colored paints to see what other colors you can make.

Where's the Chemistry?

Paint is made of tiny particles of color that are suspended in a liquid instead of dissolved in it. Think about what happens when you add salt or sugar to water. It dissolves into what is called a solution. Unlike a solution, paint's particles "float" within a thick liquid such as oil or glue. The thick liquid helps the paint stick to and spread evenly across a surface, and then allows it to form a film on the surface as it dries. In the activity, the glue and water mixture suspended the chalk's colored pigments. That is, the glue acted as a binder to help spread the paint evenly across a surface to dry.

Word Scramble

Unscramble the words in the list and place each letter in its blank to the right. When you have unscrambled all the words of items that might be found in a home, the circled letters will reveal a secret message.

krisbc ___ ___ ___ ___ ___ ___

nitap ___ ___ ___ ___ ___

golfoirn ___ ___ ___ ___ ___ ___ ___ ___

nemetc ___ ___ ___ ___ ___ ___

acetuf ___ ___ ___ ___ ___ ___

oplowdy ___ ___ ___ ___ ___ ___ ___

rerafortiger ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___

woniwd ___ ___ ___ ___ ___ ___

wrldyal ___ ___ ___ ___ ___ ___ ___

tvseo ___ ___ ___ ___ ___

patecr ___ ___ ___ ___ ___ ___

___ ___ ___ ___ ___ ___

___ ___ ___ ___ ___!!

Spaghetti Strength

Can you think of an example of a polymer that is a strong building material? Yes you can! Wood is a naturally occurring polymer found in the lumber used to build the frame of a home or in the plywood placed on the outside part of the frame. One of the reasons why it is strong is because of the strength of its chemical bonds. Imagine standing side-by-side in a line with your friends. Each of your arms is hooked so that you are sturdily linked to each other. Your linked arms are like the wood's chemical bonds. Chemical bonds may be broken by a force, like someone pulling really hard on one side of the line with your friends. If the force is strong enough, the bonds will break. Strong chemical bonds are important for building materials, like lumber, because it has to be sturdy enough to hold the weight of a home or building. Scientists test how much force is required to break a sample of material to make sure that it is safe and strong enough to use for building. In this activity, you will see how scientists examine building materials by testing the strength of spaghetti and how the number of strands effects its strength.

Materials

- Small paper cup (4 oz.)
- String
- Pencil
- Raw spaghetti
- Other uncooked pasta (one thinner and one thicker than spaghetti; e.g. angel hair and fettuccini)
- Masking tape
- Metric ruler
- Pennies

NOTE: To more closely mimic the layers within a piece of plywood, it is suggested that the pasta strands be dipped in water and stuck together by running the thumb and index finger over the length of the water-dipped pasta until they stick to one another. Pasta prepared this way will need to dry overnight before conducting the activity.

If done in a large group, groups can be given one type of pasta each and may be asked to share data.

ADAPTATION *The cup can be suspended using a pipe cleaner as the handle instead of string. Larger coins or identical steel washers could be used instead of pennies.*

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!*

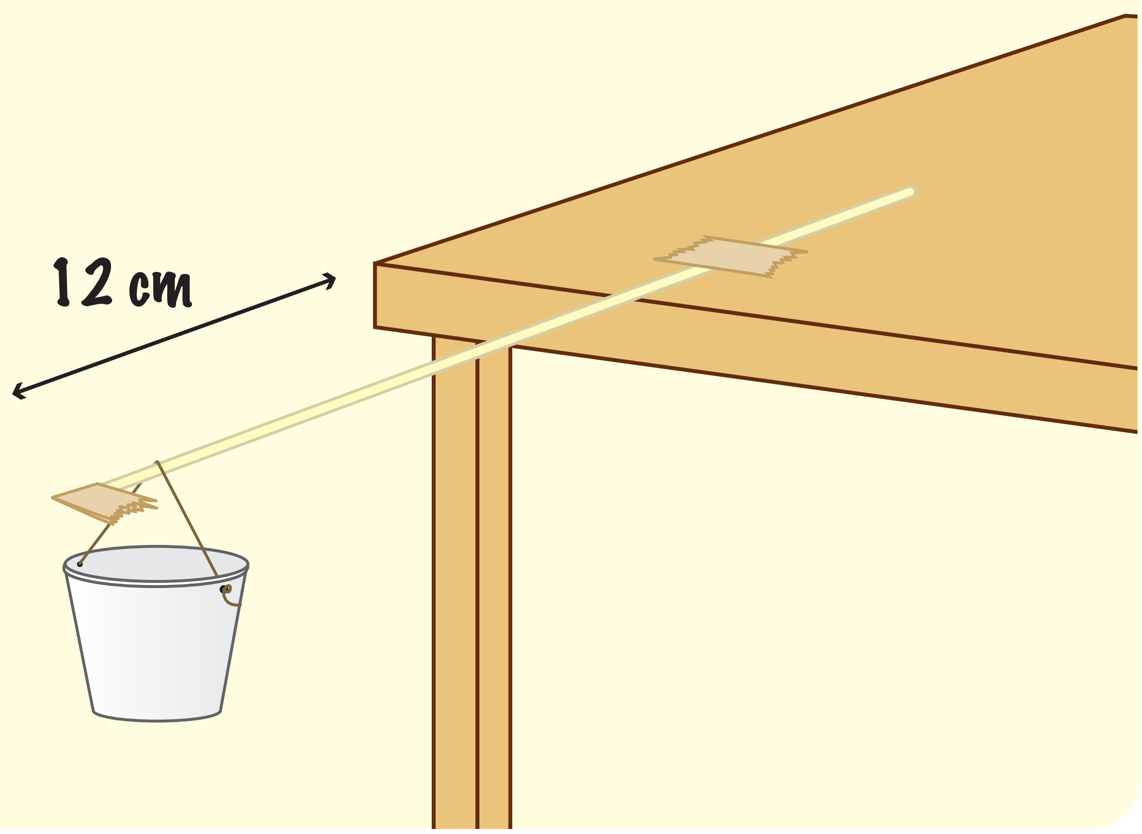
Procedure

1. Make a "penny bucket" from the paper cup and string. First use the pencil to carefully poke a hole in the side of the cup, just below the rim. Poke a second hole directly across from the first one. Your adult partner may help you make the holes.
2. Tie one end of the string to each hole to make a handle for your penny bucket as shown, and set it aside.
3. Place one piece of spaghetti on the table and use the ruler to measure so that 12 centimeters of spaghetti hang off the edge of the table.
4. Tape the spaghetti in place.
5. Place a small piece of masking tape on the end of the spaghetti that hangs off the table by folding the tape in half over the end.
6. Hang the empty penny bucket on the spaghetti up against the tape.
7. GENTLY place pennies one at a time into the penny bucket.
8. Continue to add pennies until the spaghetti breaks.
9. Record the number of pennies in the "What Did You Observe?" section.
10. Repeat steps 3 through 9 for 2, 3, and 4 strands of spaghetti. When you tape the ends, make sure the spaghetti strands are touching one another.
11. Repeat steps 3 through 10 for thinner and thicker pasta.
12. Throw away the empty penny bucket and broken spaghetti pieces. Return the pennies to their owner. Thoroughly clean the work area and wash your hands.

Try this...

Graph the data for this experiment, with the number of strands of pasta on the x-axis and the number of pennies on the y-axis.

Try putting the pasta strands at different distances from the edge of the table.



What Did You Observe?

Number of strands of pasta	Number of pennies held before breaking		
	Regular spaghetti	Thin pasta	Thick pasta
1			
2			
3			
4			

Which number of strands was the first to break? ___________ the last? ___________

Which type of pasta held the most pennies overall?

Why do you think this is so?

Where's the Chemistry?

Spaghetti is a type of polymer called a carbohydrate. Its bonds are strong; however it could only support a certain number of pennies. When there was too much strain on the spaghetti strands, it caused the chemical bonds to break. There is strength in having several strands of spaghetti stuck together. This allows more pennies to be supported.

Your Home—Getting Better with Chemistry

Thanks to the research done by chemists and engineers, homes today are built with different materials than what they were built with about 50 years ago. Although the newer materials serve the same purpose as the older products, builders like to use the newer materials because they can be less expensive, faster and easier to apply, or simply work better.

A good example is in the case of slate versus asphalt shingles for the roof. Slate is a rock whose fine grain, delicate colors, and ability to break apart in sheets made it a popular choice for shingles up to the early part of the 1900s. It is still among the most durable roofing materials available. It can last up to 100 years or more, but is quite expensive and takes a longer time and special skills to apply to a roof. Asphalt shingles, the preferred option by the 1960s, are made from fiberglass and then covered with asphalt, a sticky, black and thick liquid. The asphalt is covered with crushed rocks to give it different colors. Asphalt roofs are less expensive, easy to install, and these days can last 15–40 years.

Sometimes newer products are good to use because they are safer, like in the case of paint. Lead was added to paint both as a color and to help it dry faster and last longer. When researchers discovered that lead can be a health hazard, its use was banned in formulas for household paint. Chemists have developed safer chemicals for paint that actually allow it to dry even faster than before.

Read the chart below to find out other materials that were formerly used to build homes and what is commonly used today. The column labeled "Yesterday" lists the primary material once used. The column labeled "Today", on the right, lists what's likely to be found in newer homes, though some older material is still in use too. Ask an adult what building materials are in your home.

	YESTERDAY	TODAY
Walls	Plaster	Drywall
Plumbing	Lead or iron	Copper or PVC
Wiring	Aluminum	Copper
Windows	Single pane glass	Multi-pane glass with argon gas in between
Treated Lumber	Arsenic	Copper sulfate
Siding	Aluminum or wood	Vinyl or fiber-cement composite
Insulation	Rock wool	Fiberglass or cellulose
Paint	Oil-based	Water-based
Exterior Doors	Wood	Fiberglass, vinyl or steel
Roof	Slate	Shingles

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Hidden Objects from page 4

Word Scramble from page 9

krisbc	b r i c k s
nitap	p a i n t
golfoirn	f l o o r i n g
nemetc	c e m e n t
acetuf	f a u c e t
oplowdy	p l y w o o d
rerafortiger	r e f r i g e r a t o r
woniwd	w i n d o w
wrldyal	d r y w a l l
tvseo	s t o v e
patecr	c a r p e t

S A F E T Y F I R S T!

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. One of these programs is National Chemistry Week, held annually the fourth week in October. Another of these programs is Chemists Celebrate Earth Day, held annually April 22. ACS members celebrate 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 more information about these programs, please contact us!

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