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National Chemistry Week
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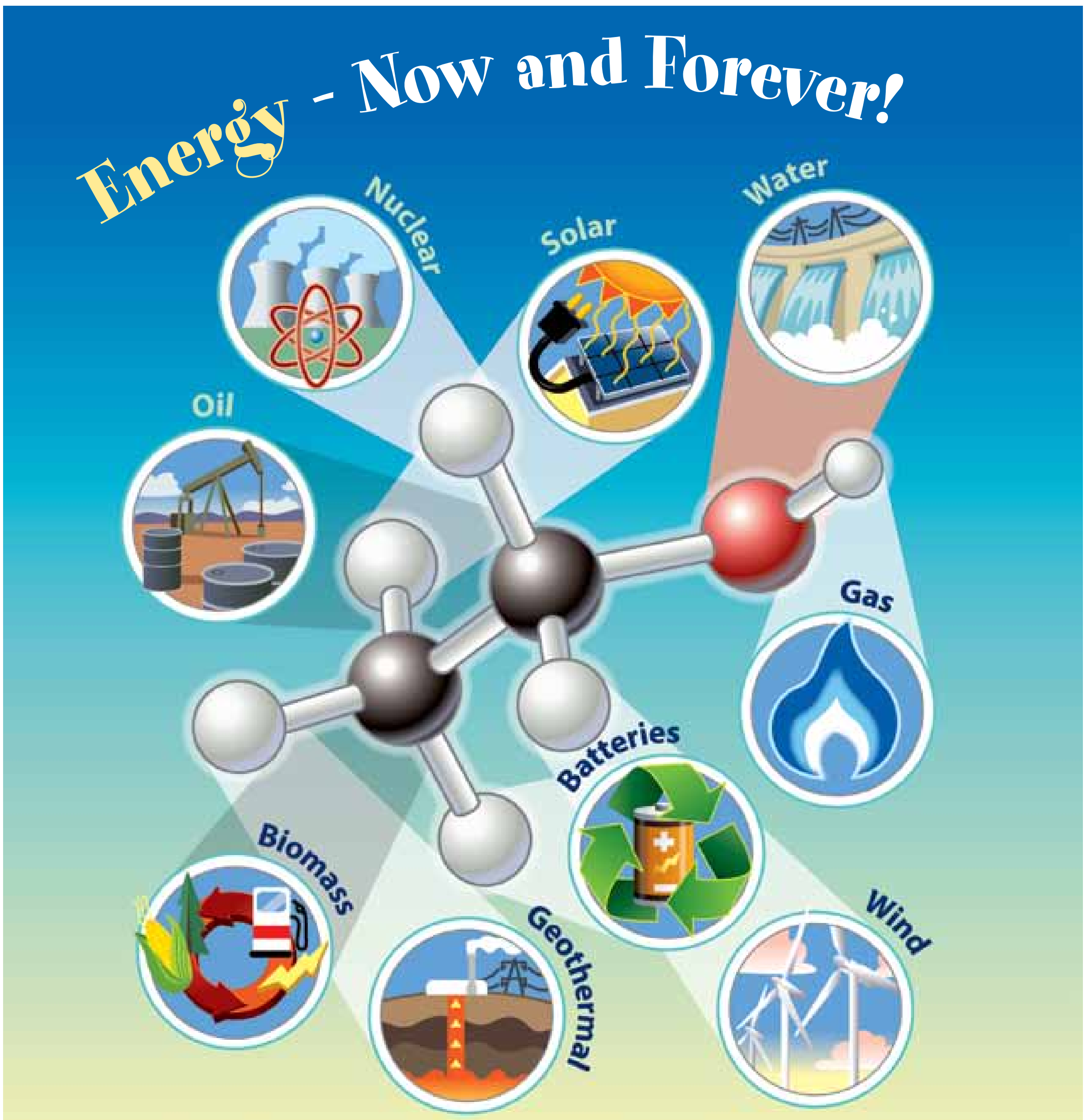
Celebrating Chemistry

National Chemistry Week
American Chemical Society



Energy–Now and Forever!

ENERGY! You're using it right now to read this. It gets you to and from school, runs your computer and phone, and cooks your dinner. Did you know that every time you use energy, the energy was produced using a chemical or nuclear process? Some energy is continuously supplied by power plants — different power plants rely on water, coal, uranium, wind, and light. These supply the power to recharge your portable games and light your house. Other types of energy must be carried with us in the form of fuel. For example, cars may run on gasoline, natural gas, ethanol, hydrogen, or a combination of these. Whatever fuel they use, it must be stored in the car's gas tank to make the engine work.

In this edition of *Celebrating Chemistry*, you will learn about some of the ways in which energy is made and what scientists and engineers are doing to supply the world's energy. Some energy sources are renewable, meaning that there can be a constant supply. Many traditional energy sources are non-renewable, meaning that we need to be careful how much we use. If you want to learn more about energy, check out "Energy – It's Everywhere!", an online edition of *Celebrating Chemistry* produced for the International Year of Chemistry in 2011 at www.acs.org/ncw.

We're always going to need energy, so spend National Chemistry Week getting to know which energy moves you and how we can have energy now ... and forever!

George L. Heard
Chair, ACS Committee on Community Activities

Turning Sand into $and

By Ressano De Souza-Machado

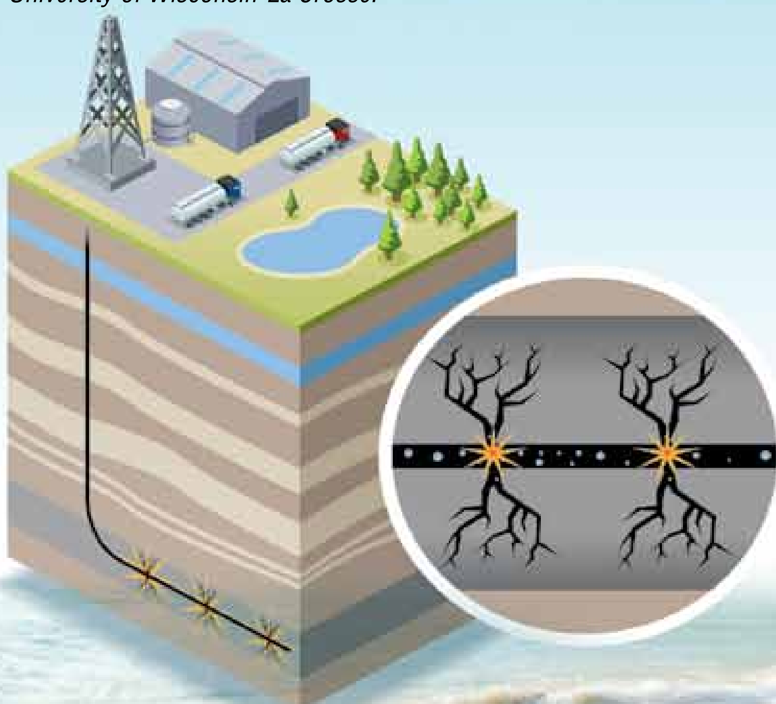
Building a sand castle at the beach in the summer and wiggling your toes in warm sand are great memories when the weather turns cold in the winter, aren't they? Now this simple and common material is being put to an amazing new use … one that might actually help keep us warm during the winter!

Sand is finely divided rock, and mostly consists of a compound called "silica" whose chemical formula is SiO_2. This means silica is made of one atom of silicon and two atoms of oxygen. Silicon and oxygen are the most common elements in the earth's crust, and if you look at an atlas, you will see vast areas of sand deserts all around the world. The sand in Minnesota, Wisconsin, and Arkansas is almost pure silica (also known as quartz or silica sand). Each tiny piece of the sand is round like a bead, and super strong.

A new use for this silica sand is "fracking sand" or "frac sand." The frac sand is sent to Texas, North Dakota, or Montana on train cars, and coated with a resin. The resin-treated sand is then mixed with water, other chemicals, and forced under pressure into long tunnels drilled into shale rock. Small explosions open up cracks at the ends of the tunnels, freeing natural gas or oil. The resin-treated sand helps keep the cracks open so the natural gas or oil can then be pumped out. About 100,000 tons of frac sand may be used in one well, depending on the size of the well. WOW — that's a big underground sand mountain, not just a small pile of sand like in a playground!

There is a lot of controversy with the mining of sand for fracking, and the fracking process itself, because the technology is so new and there are uncertainties about its impact on human health and the environment. The research on the process continues. Fracking could be used to increase our country's production of natural gas to heat our homes and oil to make gasoline. And you thought sand was just fun at the beach!

Ressano De Souza-Machado is a Senior Lecturer at the University of Wisconsin-La Crosse.



What Keeps Us Warm ... Also Gets Us Moving!

By Marilyn D. Duerst

Guess how many cars are on the streets or highways in the world during any workday. A million? A hundred million? Even more?

Experts estimate that on any weekday, over 2 billion cars are being driven on the world's streets and highways! Can you even imagine that many? Even in a single large city, an almost unbelievable number of cars are on the streets. For example, on any given day, about ten million cars are being driven on the streets of Beijing, China alone. That means there has been a big change in the number of cars being used — because just ten years ago, there were ten million *bicycles* on the streets of Beijing, and far fewer cars.

Most cars run on gasoline, a mixture of compounds called "hydrocarbons." These compounds are made of the elements hydrogen (symbol H) and carbon (C). Gasoline is made from crude oil (also called petroleum), which is a black, smelly, gooey liquid that is pumped out of deep wells in the earth. It is called a "fossil fuel," because it started out as small ocean creatures that lived and died millions of years ago.

The most important compound in gasoline is called octane. Octane molecules have eight carbon atoms (just like an octopus has eight arms) and eighteen hydrogen atoms, so its formula is C_8H_{18}.

Do you have a "natural gas" furnace in your home? This type of gas contains a compound called methane, CH_4, the simplest hydrocarbon of all. Have you ever seen someone use a gas grill to cook burgers? If so, they were burning propane (C_3H_8), a gas that is stored under high pressure in the metal tank attached to the grill.

Thousands of other hydrocarbons exist, and they all can be burned to give off heat. Tar and waxes are also made mostly of hydrocarbons. When hydrocarbons burn, oxygen from the air combines with the carbon to make carbon dioxide, and the oxygen combines with hydrogen to make water vapor. Fuels keep us warm and get us moving!

Marilyn D. Duerst is a Distinguished Lecturer in Chemistry at the University of Wisconsin-River Falls.

Get Fired Up!

Materials:

- Tea candle or votive candle
- 6″ x 6″ piece of corrugated cardboard
- 8″ x 8″ piece of aluminum foil
- One small and one large drinking glass (Both must be glass, not plastic)
- 1-quart glass bottle
- 1-gallon glass bottle
- Watch or clock with a second hand

ADULT PARTNER SUPERVISION AND HELP REQUIRED

> **SAFETY!**
> The candle flame should not touch the surface of the glasses or the bottles. The glass is not heat-safe and can crack if it gets too hot.
> Safety glasses are required.

Directions:

Work on a surface that is fire-safe. (No tablecloths or plastic covers should be on the surface.) You may want to protect the table top with a sheet of aluminum foil.

1. Cover the cardboard square with aluminum foil, folding the edges under and making it flat.
2. Place your candle in the middle of the foil-covered cardboard.
3. With the clock handy, have your adult partner light the candle and place the smaller glass upside down over the candle. Note how long it stays lit and look at the glass carefully. Record this time in your data table, as well as everything you observe inside the container.
   SAFETY TIP: The glass container will be hot at the end of your experiment. Allow it to cool before removing it for the next experiment.
4. Predict how long the candle will stay lit when you use a bigger container. Record your prediction. Repeat the experiment with the other containers. Don't forget to start by predicting the amount of time you think the candle will stay lit. Record the actual time the candle stays lit in your data table.

Data table:

Size and type of container	Predicted amount of time until flame goes out	Actual amount of time until flame goes out	Other observations

Questions

1. Make a claim as to why the candle went out.
2. Make a claim as to why the candle stayed lit a different number of seconds with the different sized glass containers. What is your evidence for your claim?
3. What other changes did you observe on the inside of the glass or bottle?

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.
- Use all materials carefully, following the directions given.
- Follow safety warnings or precautions, such as wearing gloves or tying back long hair.
- 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 away from your mouth, nose, and eyes!

NEVER experiment on your own!

Where's the chemistry?

Candle wax is a mixture of HYDROCARBONS (compounds made only from the elements hydrogen and carbon). When the wax burns, it is what chemists call a "combustion" reaction, which needs oxygen gas from the air to happen. During the combustion, the carbon in the wax combines with oxygen to form CO_2, while the hydrogen combines with oxygen to form H_2O. In the larger glass container, there is more oxygen available, so the candle stays lit longer. The water vapor made during the reaction turns back into a liquid (condenses) when the candle goes out, and the temperature inside the glass goes down. This liquid water appears on the inside of the glass. If the combustion reaction is incomplete, carbon (soot) will also form on the inside of the glass.

Powering America with Nuclear Energy

By Ronald P. D'Amelia

What would you say if I told you I could give you a magic fuel pellet about the size of a small Tootsie Roll that can provide the same energy as 149 gallons of oil, 1,780 pounds of coal, or 17,000 cubic feet of natural gas? What if I told you that when it's used to generate electricity, this magic pellet gives off no air pollutants such as carbon dioxide (CO_2) or sulfur dioxide (SO_2), and it would cost less to use (in the long run) compared to other non-renewable energy sources, such as coal, oil, or natural gas?

I bet you would say: WOW, GREAT! Well, there's nothing "magical" about this fuel pellet. I'm actually talking about nuclear fuel, which uses the energy stored in the nucleus of uranium (U) atom that is released when the nucleus is split apart. Uranium is found in small amounts in rocks and soil, and is 500 times more common than gold (Au) and about as common as tin (Sn). Today, nuclear power is fulfilling 20% of the energy needs in the United States, with 100 nuclear reactors in 31 states, located everywhere from California to Texas, Michigan, Florida, New York, and beyond. Although nuclear power has been and could be a good energy source, the nuclear waste generated has been a problem that needs to be considered.

So remember, when you turn on your lights, TV, listen to your MP3 player, or charge your cell phone, there is a good chance that the electrical energy you're using was generated by nuclear power!

Ronald P. D'Amelia, Ph.D. retired from Kraft/Nabisco as a senior Principal Scientist after 32 years of service. He is an Adjunct Professor of Chemistry at Hofstra University, Faculty Advisor to the Hofstra chapter of student members of ACS, and a Fellow of the ACS.

Putting

Materials:

- 2 large bowls
- Plastic 1-liter soda bottle
- Large balloon
- Hot water (from tap)
- Ice cubes
- Water
- Small rock

SAFETY!
☑ *Safety glasses required*
☑ *Caution: hot liquids*
☑ *Do not eat or drink any of the materials used in this activity*

Experiment Design

Thermal Energy to Work!

We all need energy to do things … whether it's to light up a room, heat your food in a microwave, mow the lawn, take a trip to the store, or even do your homework! In this issue of *Celebrating Chemistry*, you learned about many ways to produce energy. During this activity, we'll explore thermal energy and see how it can be used to make things work!

Instructions:

1. Cool the balloon and the bottle in the freezer for 5 minutes.
2. While the balloon and bottle are cooling, fill one bowl with hot tap water. Fill the other bowl with water and ice.
3. Take the balloon and bottle out of the freezer. Squeeze all the air out of the balloon and put the balloon over the mouth of the bottle.
4. Wearing safety goggles, place the bottle into the hot water. What happens? Record your observations.
5. Now, place the bottle in the bowl of ice water. What happens? Record your observations.
6. Now it's time to get creative — after all, you're a scientist! Energy is useful when it does work. Can you design a device that uses the changes you observed in this activity to lift a small rock? Draw your plan in the space below and then test it. If it doesn't work, it's okay. Make some changes and try again, just like a scientist would!

What did you see?

	Observations
Bottle in hot water	
Bottle in ice water	

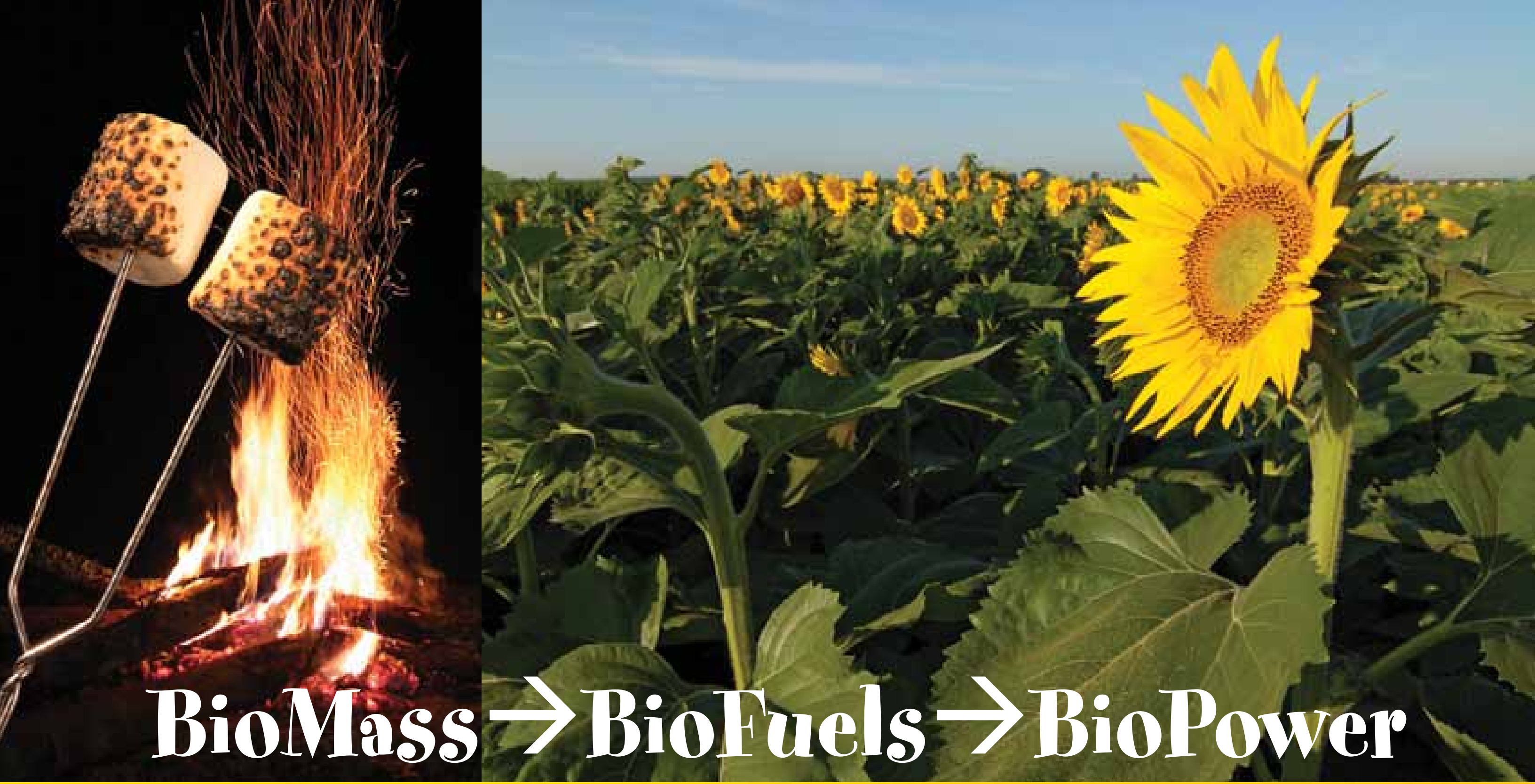
Adapted from "Thermal Energy Put to Work," an activity of The Need Project.

Where's the chemistry?

In chemistry, scientists sometimes call what they are looking at a system. In this case, the *system* is the bottle with the balloon over its mouth. Everything else (hot water, ice, etc.) around it is called the *surroundings*. Our balloon and bottle is a "closed system," because the amount of matter in the system is trapped and does not change. But energy is different — it can be exchanged with the surroundings.

When you put the bottle into the hot water, heat from the surroundings is transferred to the molecules that make up the air inside the bottle. This causes them to speed up, move farther away from each other, and hit the inside of the balloon harder.

All this causes the balloon to expand. When you put the bottle into ice water, the opposite happens. Heat goes from the system to the surroundings, the molecules slow down and get closer together, and the balloon deflates.



BioMass → BioFuels → BioPower

Turning BioMass into BioEnergy

By Ronald P. D'Amelia and Marilyn D. Duerst

Did you roast marshmallows over a wood campfire last summer? If you did, your heat source was "biomass." Biomass refers to anything that was once alive that can be used as an energy source, and includes wood, crops such as corn, peanuts, soybeans, algae, animal fats, and even some things in your garbage can. People have used biomass longer than any other energy source. For thousands of years, up until about a hundred years ago, people mostly burned wood to heat their houses and cook their food.

Nowadays, crude oil, natural gas, coal, and nuclear fuels provide most of the world's energy needs, while "biomass" produces only 4% of our energy. It is pretty obvious that paper and wood can be burned to give off heat, but what about other plants and garbage?

Garbage can be burned to generate steam and electricity in a waste-to-energy power plant. Used cooking oil and soybean oil can be changed into biodiesel by heating them with an alcohol. This biodiesel can be used to power a car or truck. A fungus called yeast is added to cane sugar or corn starch to make ethanol, a gasoline additive used to make "E-85 fuel" for cars.

One problem is that crops like corn, sugarcane, and soybeans are also used to feed farm animals. As an alternative, scientists are working on using weeds such as switchgrass to make biofuels instead. Algae, that greenish gunk you see in ponds late in the summer, has also been considered as a new source of biomass. Maybe your car someday will run on fuel from algae or weeds instead of gasoline, a fuel that is made from crude oil, a non-renewable natural resource.

Ronald P. D'Amelia, Ph.D. retired from Kraft/Nabisco as a senior Principal Scientist after 32 years of service. He is currently an Adjunct Professor of Chemistry at Hofstra University, the Faculty Advisor to the Hofstra chapter of student members of ACS, and a Fellow of the ACS.

Marilyn D. Duerst, Distinguished Lecturer in Chemistry at the University of Wisconsin-River Falls.

The Adventures of Meg A. Mole, Future Chemist

Michelle and her husband, AC Buchanan, discuss new results from AC's lab with Meg.

Dr. Michelle Buchanan

In honor of this year's focus on energy, I traveled all the way to Oak Ridge, Tennessee. There I met Dr. Michelle Buchanan, Associate Laboratory Director at Oak Ridge National Laboratory (ORNL).

Dr. Buchanan explained how she develops "new technologies for energy production and use." Her work is important because we need to make sure we have enough clean energy in the future that everyone can afford. She also told me about some of the projects that she is working on. One is about creating "new materials that can make cars both stronger and lighter." This is very important because "reducing the weight of cars can reduce the amount of gasoline they need to run."

Another project Dr. Buchanan is working on is "developing new types of electric car batteries." These batteries will help the cars drive longer distances and decrease the time needed to recharge the battery. Other projects include: developing "new chemical reactions that can help make fuels from plant materials, and technologies that will help us save energy in our homes and schools, such as new types of lighting and building materials." Dr. Buchanan and the people who work with her "develop new instruments, such as electron microscopes that let you see individual atoms in a material, and also laser tools that let you observe chemical reactions."

Dr. Buchanan told me that "many of the people at ORNL are students, who work in laboratories and wear lab coats, safety glasses, and gloves," just like I do! One thing she enjoys about her job is that she gets to work with "scientists from around the world." She also explained that she likes "working with people who are dedicated to discovering new things that will make a positive impact on energy. This is an important area for all of us because we use energy in our lives every minute of every day. It is present in almost everything we do — how we prepare our meals, how we get to school and jobs, and how we live at home."

"I was always interested in figuring out how things worked when I was young," Dr. Buchanan told me. She "liked working with her dad when he was building things and fixing the car," and also worked on many science fair projects. Her favorite subjects in school were reading, math, and science. She told me she "had great teachers in school who introduced me to how reactions, electricity, mechanical systems, and even living systems worked." Her college professors introduced her to research. Dr. Buchanan explained, "Doing research in college really made what I had learned in books and in school more exciting, and helped me decide to become a scientist."

So how does her work apply to a child's life? She asked me, "Can you imagine not having heat in your home in the winter, or lights to read by at night? Developing technologies that will allow us to have abundant, clean, affordable energy for the entire world is a big challenge and chemistry is playing a central role in meeting future energy needs."

Personal Profile

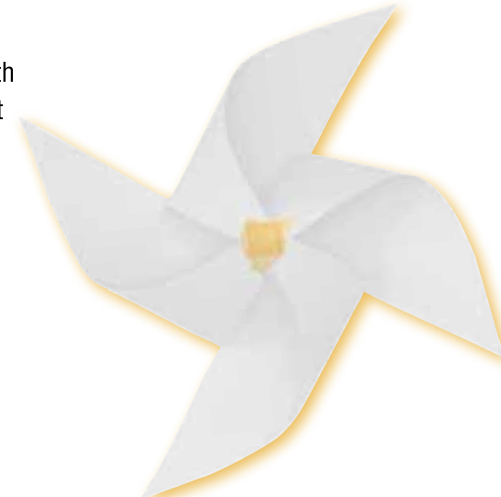
Favorite pastime/hobby: "I'm one of a very few chemists who tap dance! I also like to cook, which is a lot like being in a chemistry lab because you can change recipes and see what happens … and you can eat your experiments!"

Accomplishment you are proud of: "Helping young people get started as scientists."

Cool project you worked on: "A few years ago, I worked with police on new ways of detecting fingerprints to solve crimes."

Your family: "My husband is also a chemist, and now our daughter is training to be one too."

Make a Solar-Powered Motor!



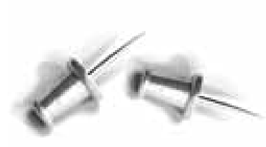
When you are playing outside in your yard or at the beach, you can feel the warmth of the sun on your skin. This is solar energy — and it comes in the form of light and heat from the sun, 93 million miles away! Maybe you've noticed that dark-colored clothes absorb the sun's heat and make you feel warmer, while light colors reflect solar energy, and keep you cool.

People use solar energy all the time, and in many ways. Greenhouses capture both light and heat to help plants grow. Some people use solar energy to dry their clothes on clotheslines. Nowadays, technologies using solar collector panels are used to trap energy from the sun and turn it into electricity to run electrical appliances in homes and businesses.

You can use stuff from your house to turn solar energy into a motor to turn a pinwheel!

Materials:

- **Can opener**
- **Masking tape**
- **Sandpaper**
- **Scissors**
- **Wire**
- **Three tin cans (note: soup cans work well, or you can use tall cylindrical containers, like two Pringles cans)**
- **Two bricks, wooden blocks, or stacks of books**
- **Thumb tacks or straight pins with heads**
- **One sheet of white paper or aluminum foil 15 cm square**



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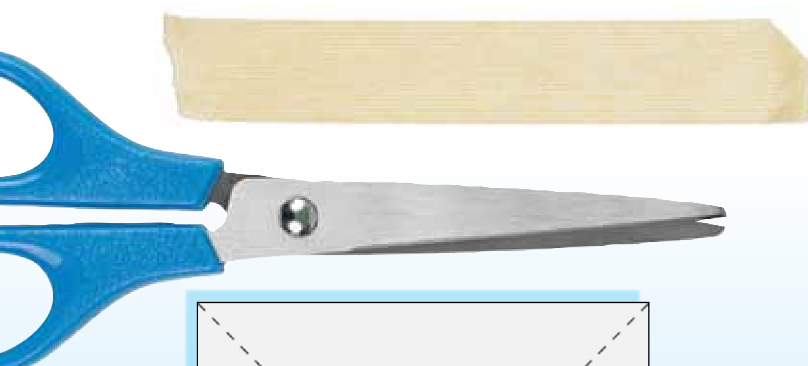

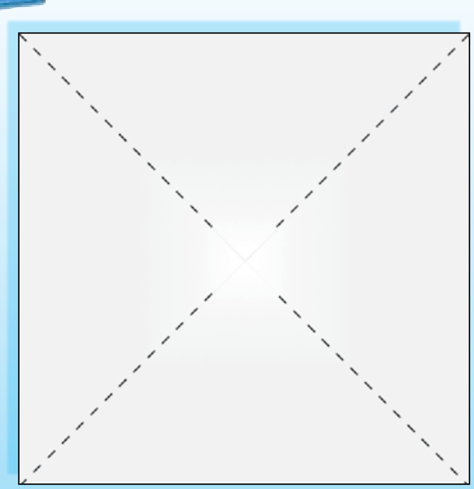

This activity was adapted from the National Research Council Canada.

Instructions

1. With the help of an adult partner, use the can opener to remove both ends from the three large cans. Be careful of sharp edges. If there are any sharp edges, use sandpaper to remove them. Tape the cans together end-to-end to form a column.
2. Make a pinwheel. Use scissors to make cuts in a 15-cm sheet of paper or aluminum foil diagonally from each corner to within 1 centimeter of the center (see picture). Bend every other point back to the center of the square. Tape the points together at the center.
3. Bend a piece of wire into an "elbow" shape and tape it, elbow up, to both sides of the top of the tin can column. Tape a thumb tack or straight pin (point up) to the piece of wire at the elbow.
4. Find a spot indoors that receives direct sunlight, such as a windowsill or table. Position the tin can column on top of two supports (such as the bricks or books).
5. Leave enough room between the bricks to ensure that there is space between the bottom of the tin can column and the surface it's resting above.
6. Balance the pinwheel on the pin in the middle of the tin can column.
7. Now, make observations!

Keep experimenting!

As a budding scientist, try different things to make the pinwheel spin faster. Think and be creative! Here are some things you might want to think about experimenting with:

- The material the pinwheel is made from
- The color of the inside or outside of the tin can column
- The height of the bricks or books the tin can column sits on
- The time of day you do the experiment

Where's the chemistry?

As the heat of the sun warms the air inside the tin can column, the air's density goes down. Things that are less dense float in things that are more dense, just like a helium balloon floats in the air. The less dense air rises in the can column, comes out its top and pushes on the pinwheel to make it spin.

Word Search

A E T C U I E R G L A C A R B O N D I O X I D E

N I N L R N S F S E F B R R D N T C S S F I L N

S B A H A U L O N A H T E W R M A M E E R B E I

A N R T N A D R U A T L S N I S C C E O A O N B

G U C L I E F E L F E E E E I A I S I W C R A R

L O O D U S A I O I F O S S I L F U E L K B P U

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A N E B H N R E I S S A M O I B I H I A E P S W

N T R A O L L M R O I E N A P O R P I B B R N B

Batteries	Crude oil	Gasoline	Nuclear reactor	Solar panel
Biodiesel	Dam	Hydrocarbons	Octane	Thermal energy
Biomass	Fossil fuel	Natural gas	Propane	Uranium
Carbon dioxide	Fracking	Non-renewable	Silica	Wind turbine

Puzzle answers are at www.acs.org/ncw.

Celebrating Chemistry

Celebrating Chemistry is a publication of the ACS Department of Volunteer Support in conjunction with the Committee on Community Activities (CCA). The Department of Volunteer Support is part of the ACS Division of Membership and Scientific Advancement. The National Chemistry Week (NCW) edition of *Celebrating Chemistry* is published annually and is available free of charge through your local NCW Coordinator. NCW is a combined effort among CCA and several ACS Technical Divisions. Please visit www.acs.org/ncw to learn more about NCW.

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 163,000 members. ACS members live in the United States and different countries around the world. Members of the ACS share ideas with each other and learn about important discoveries in chemistry during scientific meetings held around the United States several times a year, through the use of the ACS website, and through the many peer-reviewed scientific 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 Chemists Celebrate Earth Day, held annually on April 22. Another of these programs is National Chemistry Week, held annually the fourth week of October. ACS members celebrate by holding events in schools, shopping malls, science museums, libraries, and even train stations! Activities at these events include carrying out chemistry investigations and participating in contests and games. If you'd like more information about these programs, please contact us at **outreach@acs.org**.

ACS Chemistry for Life®

Words to Know

Biomass: material from living or recently living things like corn, algae, and grass. It can be burned as is or converted into another type of fuel, biodiesel.

Carbon dioxide: a molecule made of one carbon and two oxygen atoms. Along with water, it is one of the products created when you burn hydrocarbons.

Ethanol: an alcohol that can be made from the sugar in plants and can also be used as fuel.

Fossil fuel: natural fuel formed deep underground from plant and animal remains. Examples are coal, oil, and natural gas.

Non-renewable: when we use it up, it's gone. Examples include coal and oil.

Hydrocarbon: chemical compounds made up of just hydrogen and carbon atoms, like oil, wax, or natural gas.

Pollutant: a natural or man-made substance that can harm the air, water, soil, nature, and our health when these materials occur in harmful amounts.

Nuclear reactor: a device where energy is produced by splitting the nuclei (or centers) of atoms under controlled conditions.

Solar energy: power from the sun.

Silica: a compound, made of silicon and oxygen, that makes up solid, hard rock and sand.

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