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Celebrating Chemistry

CHEMISTS CELEBRATE EARTH DAY APRIL 22
AMERICAN CHEMICAL SOCIETY

Energy—It's Everywhere!

Energy: It Starts with the Sun!

By Clinton Harris, Jeff Trent, and Robert Yokley

OOOH, that feels good! Feel the warmth of the Sun's energy on your shoulders on a warm summer day. The Sun's energy is transferred from one form into another. For example, plants use the light from the Sun (during photosynthesis) to help them to grow. The Sun's heat energy warms the Earth, causing its temperature to change. This helps ice to melt, and the difference in temperature also causes the wind to blow. This heat and light energy from the Sun launches the entire energy process on Earth!

Plants extract energy from the Sun through photosynthesis and convert it into chemical energy for it to grow. Plant-eating animals, or herbivores, eat various leaves, fruits, and vegetables to grow, using the energy gained from plants. Some meat-eating animals, called carnivores, get their energy from eating herbivores. Most humans are herbivores and carnivores, getting their energy by eating plants and meat.

As plants and animals die, they transfer their chemical energy gained from the Sun back to the Earth. Over millions of years, heat and pressure cause dead plant and animal matter to change into fossil fuels. Coal and crude oil are two types of fossil fuels that come from fossilized plants and animals. Fossil fuels are called non-renewable energy sources, because once they are used up, it takes millions of years to produce them again.

We are able to use the chemical energy in coal by burning it to make electricity for our homes. Crude oil is made up of many different types of chemicals such as gasoline and diesel fuels. We are able to convert the chemical energy in the fuels into energy that runs cars and trucks. But all this started with the energy from the Sun!

The Sun also provides us with solar energy. This solar energy can be used as either thermal (or heat) energy or light energy, but we can also use this energy for more than just warmth when we are cold and light when we cannot see. Solar energy can be captured by solar panels that convert light energy into electrical energy for use right away in our homes or this electrical energy can be stored as chemical energy in batteries for use later. Because the Sun is always shining on the Earth, solar power is a renewable energy source.

What about wind energy? Wind energy comes indirectly from sunlight as well. As the Sun heats the Earth's surface, the air is heated, too. This hot air rises, and cooler air rushes in to fill the space left by the hot air. This movement of air is called wind. The energy from wind can be harvested with windmills (or large, tall, spinning fans) and machines called generators, which produce electricity. Wind power is also a renewable energy source from the Sun.

What about water energy? The Sun and the position of the Earth rotating on its axis keep the waters of the Earth warm enough so that most of the water is not frozen. Mostly in the wintertime, you can find water locked in the form of ice on the peaks of mountains, and at the North and South Pole. Heat from the Sun melts ice and snow in the mountains. As the water flows downhill, the force of the water spins a water wheel, which is connected to a generator that creates electricity for homes and cities or even an electric car. The electrical energy drawn from the flowing water is called hydroelectric power, another renewable energy source.

How about plant energy? The Sun provides energy for plants to grow, producing sugars and cellulose that can be converted to biofuels like ethanol for car engines. Plant material that can be converted into useful fuels is called biomass, which is a renewable energy source as well.

There is also nuclear energy! The Sun (just like all stars in the universe) is nuclear-powered. The Sun creates this type of energy by a process called fusion. During fusion, two tiny hydrogen atoms are slammed together to make a bigger helium atom, and a large amount of energy is released. This nuclear energy is in the form of light and heat that radiate from the Sun. Humans have discovered another type of nuclear reaction called fission. Fission also generates a huge amount of energy by breaking apart large atoms into smaller ones. The element uranium is used to generate nuclear energy through fission. The Sun, however, is the champion of nuclear power, because its energy allows all life to exist on Earth. Energy, it starts with the Sun!

Clinton Harris, Former ACS Staff; Jeff Trent, Analytical Chemist, Boehringer Ingelheim Roxane Laboratories, Inc., Columbus, OH, Adjunct Faculty, Columbus State Community College; and Robert Yokley, IYC Energy Theme

Clean Energy from Sunlight

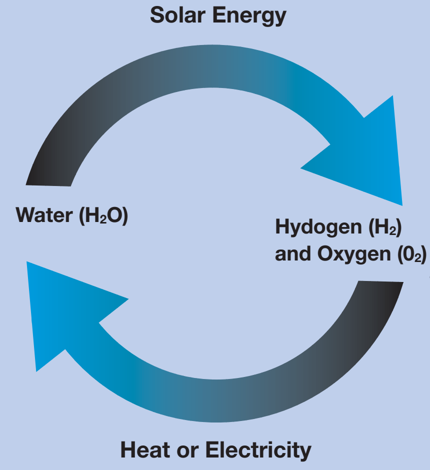
GREEN CHEMISTRY'S QUEST FOR SOLAR FUELS

By Scott Cummings

How would you like to be able to make your own fuel, using sunlight and water? This has been the dream of chemists around the world. These chemists have been working for many years to make solar fuels that might someday be able to replace some of the fossil fuels (oil, coal, and natural gas) that we use so much of. One idea for a solar fuel is hydrogen gas, which many chemists hope could be made without harming the environment and by using abundant elements. But first we need to learn how to make hydrogen gas using energy from the sun.

The idea is simple: use solar energy provided by the sun to break apart water into hydrogen gas and oxygen gas. Then, use this hydrogen gas as a clean fuel to produce either heat (when burned) or electricity (using a fuel cell). But understanding the chemistry to run this clean energy cycle (see picture) has been very challenging. It may take many more years to figure out how to use sunlight to produce hydrogen gas efficiently. The good news is that we can look to trees for inspiration. One way to make solar fuels can be found in the chemistry of plants. Many chemists are trying to unlock the secrets of the leaf.

The sun powers nearly all life on our planet. Plants, of course, grow by using sunlight. The leaves of an apple tree capture solar energy and use it to produce carbohydrates (a delicious fuel made of sugars) and oxygen from carbon dioxide and water. In order to absorb sunlight, plants use a molecule called chlorophyll, which give leaves their green color. This amazing chemical reaction, called photosynthesis, provides us with both the food and oxygen needed to power our bodies. Because the food we eat is a product of photosynthesis, we are solar-powered!



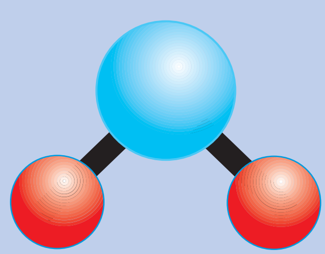
Clean-energy cycle. Solar energy is used to produce hydrogen gas and oxygen gas from water (top). Hydrogen gas reacts with oxygen gas to produce water and release energy as either heat or electricity

Chemists have been trying to mimic the chemistry of plants to build an "artificial leaf" that would use solar energy to "split water" to make hydrogen gas (H_2). Splitting water requires breaking the chemical bonds that hold together the atoms of a water molecule (H_2O) (see picture). To make an artificial leaf, we must find ways to capture solar energy. Chemists are looking beyond chlorophyll and designing a wide range of colorful molecules called dyes to capture solar energy. Some of these dyes contain the elements zinc (Zn) or ruthenium (Ru).

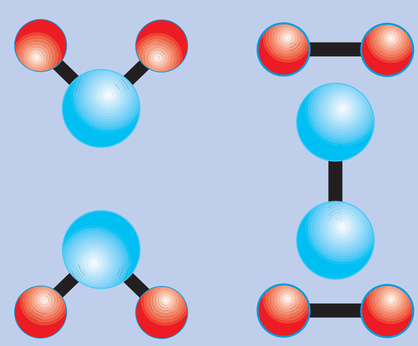
Another approach is to convert solar energy into electricity and then use the electricity to split water and make hydrogen gas. Inside rooftop solar panels are solar cells, usually made from silicon (Si), that convert solar energy into electrical energy. A costly element needed to split water by this approach is platinum (Pt). Because solar cells are very expensive, some chemists are trying to find ways to use other elements and molecules to make electricity from sunlight. Chemists are on the hunt for how to use more affordable metals and molecules.

Hydrogen gas is just one idea for a clean fuel to replace fossil fuels. If you are interested in colorful molecules, doing chemistry with sunlight, and helping to develop clean fuels and green energy, then learn more about the chemistry of artificial photosynthesis.

Scott Cummings is a Professor of Chemistry, Kenyon College. Scott teaches courses on solar energy and hydrogen energy at Kenyon College in Ohio. Students in his laboratory investigate photochemistry—what happens after a molecule absorbs light.



Water molecule. One molecule of water has two hydrogen atoms (shown in red) and one oxygen atom (shown in blue), held together by chemical bonds (shown as black lines).



Water splitting. Via solar energy, two water molecules (shown on the left) are split to make two molecules of hydrogen (in red) and one molecule of oxygen (in blue), shown on the right.

Hooray for Batteries

By Amber Hinkle

Just look around and you can find batteries in most of your favorite gadgets: in flashlights, MP3 players, cell phones, computers, cars, and others. We can describe a battery as a container full of chemicals that produce electrons. Chemical reactions that produce electrons are called electrochemical reactions. In electrochemical reactions, chemical energy is converted to electrical energy, using two electrodes—an anode and cathode—separated by an electrolyte. This energy powers our favorite toys and more, but how does the chemistry work?

Common alkaline batteries, like the D batteries used in a flashlight, contain two different metals surrounded by a thick paste made of special chemicals (the electrolyte). The metals, like all substances, are made up of atoms. Atoms are made of protons, neutrons, and electrons. One of the metals in the battery gives up lots of its electrons, and the other metal is ready to accept them. If the electrons were free to go from one metal to the other, they would zoom across as fast as they could. When we need energy from a battery, we connect it to our toy or gadget, like our flashlight, and the chemical reaction happens more quickly. This faster chemical reaction gives us electrical energy or electricity. One rule about electricity is that it will only flow through a complete circuit. That's where the wires and bulb from a flashlight come in. Connecting the bulb and wires to the ends of the battery gives the electrons a path to travel, from one metal to the other. And those traveling electrons are electricity! The key to a battery is that the two metals are separated in such a way that the electrons can't easily travel from one metal to the other. The design of the battery is clever because when the battery is not being used because the circuit is not complete, the chemical reaction happens very, very slowly and the energy is stored in the battery until needed.

There are two types of batteries. Disposable batteries are designed to be used once and thrown away when the chemicals inside will no longer react to form energy. Rechargeable batteries are designed to be recharged and used multiple times. These batteries are recharged by reversing the chemical reaction inside the battery to create stored energy again.

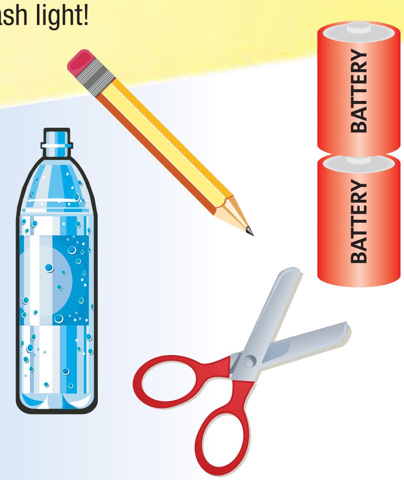
Batteries are pretty amazing! They come in all shapes and sizes; from tiny batteries that fit inside a hearing aid to batteries bigger than a car. The chemical reactions inside batteries transform chemical energy into electrical energy to power a lot of different things. Aren't you glad you don't have to drag an extension cord around when you play your handheld video games?

Another Bright Idea!

Introduction

You can use a lot of what you have learned about batteries to make your own flash light!

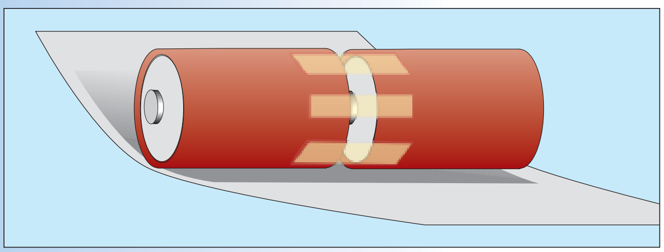
Materials



- Flashlight
- 2 D-cell batteries
- Aluminum foil
- Paper
- Pencil
- Tape
- Plastic bottle
- Blunt-end scissors
- Metric ruler

SAFETY

Be sure to follow Milli's Safety Tips on page 10 and do this activity with an adult!



Procedure

1. Take the batteries and bulb from a flashlight. Tape the two batteries together with the plus and minus ends touching as shown. Lay the batteries on a piece of paper and roll them up in the paper to form a paper tube around the batteries. Tape the tube closed. Trim off the extra paper so that the paper tube is the same length as the batteries.
2. Cut a rectangle of paper that is about 10 centimeters (cm) long and 5 cm wide. Cut off a strip of aluminum foil that is about 5 cm wide and about 30 cm long. Wrap the aluminum foil around the center of the paper until the whole strip of aluminum foil is used up and both sides of the paper are covered with several layers of aluminum foil.
3. Place the paper and aluminum foil on the open end of an empty bottle. Ask an adult helper to use a sharpened pencil to poke a hole all the way through the aluminum foil and paper. The hole should be the same diameter as the pencil.
4. Push the glass part of the flashlight bulb up through the hole until the aluminum foil is firmly pressed against the metal collar of the bulb base. Hold the bulb so that the bottom tip of the bulb is on the bump on the top of the battery. Tape the paper and aluminum foil to the sides of the paper tube to hold the bulb in place.
5. Tear off a strip of aluminum foil about 5 cm wide and about 20 cm long. Keep folding it in half lengthwise until you have a long, thick wire. Tape one end of the wire firmly to the end of the bottom battery.
6. Test your homemade flashlight by touching the free end of your aluminum foil wire to the aluminum around the bulb. The bulb should light! If it does not, check to make sure that the aluminum foil is touching the metal part of the bulb, that the bottom of the bulb is touching the top of the battery, and that the aluminum foil wire is firmly attached to the end of the bottom battery.

Ask Yourself...

What is the difference between a metal and a nonmetal?
Is aluminum a metal or nonmetal?
Can another metal or nonmetal be used to light the bulb? Why or why not?
Try another metal and see if your hypothesis is correct.

Solar Energy

Almost all of the energy we use on Earth comes from the Sun. The Sun gives us energy as light and heat called solar energy.

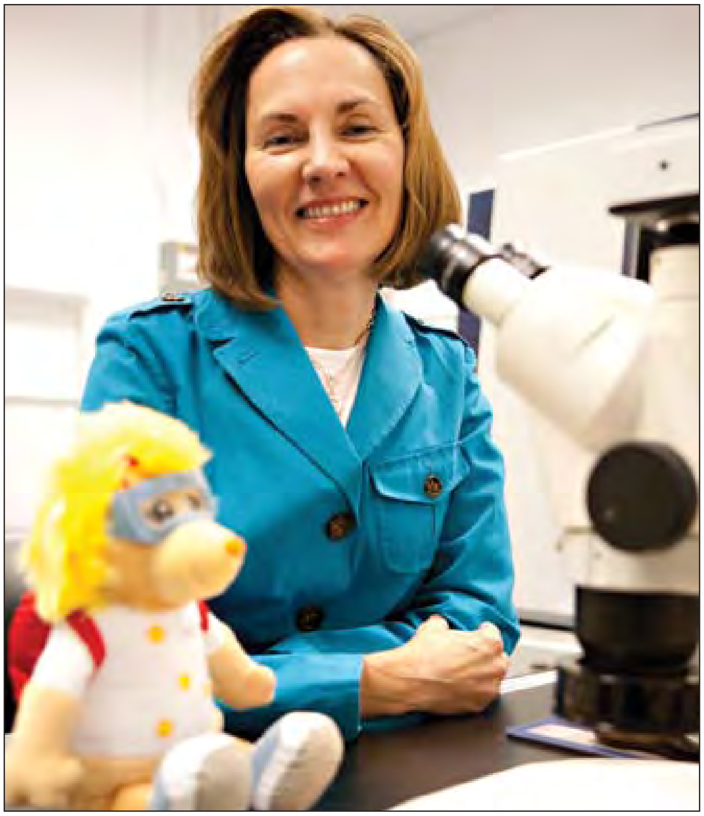
Solar energy can be changed directly to heat like in a solar house. A solar house has a solar collector that absorbs the Sun's heat. This heat is transferred to air or water, which circulates throughout the house in pipes and can be saved in a storage tank.

Solar energy can be collected using a solar cell, which absorbs energy from the Sun and changes it to electricity. Solar cells are used to power many things, including calculators and the Hubble Space Telescope.

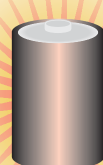
Large amounts of electricity are produced using a process called solar thermal energy conversion (STEC). Huge mirrors reflect the Sun's light onto a central receiver. The central receiver collects the concentrated solar energy and converts it to electricity.

Green plants use solar energy to make food in a process called photosynthesis. People and other animals then eat the plants to obtain the energy that they need. Some big farms grow plants that are used as a source of energy. We get energy from the plants either by burning them as we do with wood, or by changing them into a chemical to substitute for gasoline!

The Adventures of Meg A. Mole, Future Chemist



When you think of energy, one of the first things that comes to mind is batteries. From cars to smoke detectors to all those games and electronics, batteries are necessary to power many things! My latest trip was to New York. There I met Professor Esther S. Takeuchi at the State University of New York at Buffalo.



Dr. Takeuchi says her work in chemistry is about "finding ways to make batteries last longer, be smaller and more powerful." One neat thing that I learned is that when she and her group are doing their work, the batteries they are studying must be assembled with no water around, so they get to work in big, sealed plexiglass boxes with long rubber gloves attached to the front. Also, a lot of the batteries that they are testing are used for medical applications. Because of that, she says they test many of their experimental batteries at body temperature. They get to do most of their work in a laboratory. Like me, they know how important it is to wear their lab coats and safety glasses at all times!

When Dr. Takeuchi is not in the laboratory, you can also find her working in her office. This is where she writes articles, compiles her data, and prepares for class. When she is not working on her research, she is teaching students. I asked her what she liked the most about her work. She told me, "The best thing for me is the ability to be creative. I find that I get many ideas that spring into my head. I like to be able to investigate the ideas by running the experiments in the laboratory."

As a child, Dr. Takeuchi said she was very curious. She says she "wanted to understand how things worked and what they looked like inside." At her home, they had a driveway made out of pebbles rather than concrete. She decided to experiment with the pebbles! She found out that some of the pebbles had rings of color on the inside when she broke them open, so she used to take a hammer and smash the pebbles to see the inside.

The neatest thing I learned on my trip to visit Dr. Takeuchi was that she was able to develop a new battery that is used for medical devices that stop one kind of heart attack. She explained, "Many people have this device that uses the battery that we developed." She said that she is "very proud that those people benefit from the device, and that in some cases the device has saved their lives." Last year, President Obama presented her with the National Medal of Technology and Innovation for the development of the medical battery. This year Dr. Takeuchi is being inducted into the Inventors Hall of Fame. I am so glad I got to meet Dr. Takeuchi—she is an amazing chemist!

To read more about my visit with Prof. Takeuchi, please visit my web pages at www.acs.org/kids.

Personal Profile

FAVORITE HOBBY: We have a Shetland Sheepdog (sometimes called a Sheltie) named Ryan. He looks like a small version of Lassie and is very smart. He likes to play and make up games. He tries to show us the rules by acting out the game. Ryan is really fun and we have a good time walking him and playing with him. I take care of him by feeding him and brushing his teeth every day.

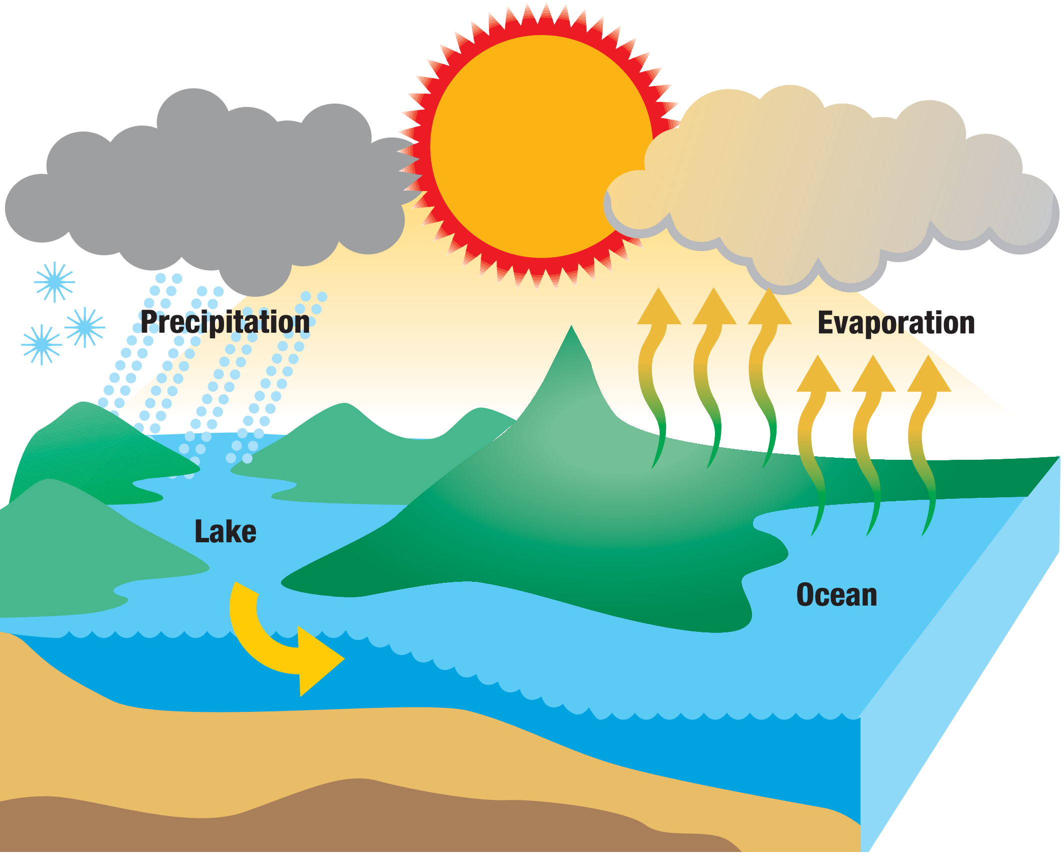
TELL ME ABOUT YOUR FAMILY: My parents were strong believers in education. They always encouraged me and my brother and sister to study and try to do well.

Quench Your Energy Thirst with Water Energy

By Robert Yokley

Almost all of the energy on Earth comes from the Sun, either directly or indirectly. Solar energy is also responsible for the water cycle. The Sun warms the liquid water on the surface of the Earth, which causes it to change into a gas. This change is called evaporation. The water in the air condenses to a liquid and falls back to Earth in the form of rain, snow, and sleet. The water then flows in streams and rivers and finally into the oceans. The cycle repeats continually.

There are a number of ways we can use the water on Earth to create electricity. One method is to build a dam on a river that produces hydroelectric power. Dams hold back lots of water. Water near the bottom of the dam flows through a pipe. At the end of the pipe is a turbine propeller that is turned by the moving water flowing into the river below the dam. This allows the turbine to generate electricity that is carried by power lines to be used by you and your neighbors.



The first use of hydropower to generate electricity in the United States occurred at Niagara Falls in 1879. The first helpful use of hydroelectric power took place in Wisconsin in 1882 when the ability to send electricity over long distances was developed.

Now over half the hydroelectricity generated in the United States is in the states of Washington, California, and Oregon. In addition, the Tennessee Valley Authority runs 29 hydroelectric plants and generates power for 9 million people living in seven states.

The benefits of dams to produce hydroelectricity include cheap electrical power and the ability to generate power during times of high use. Another advantage of hydroelectricity is the fact that fuel such as coal is not needed to generate the power. This makes it clean and does not add to climate change.

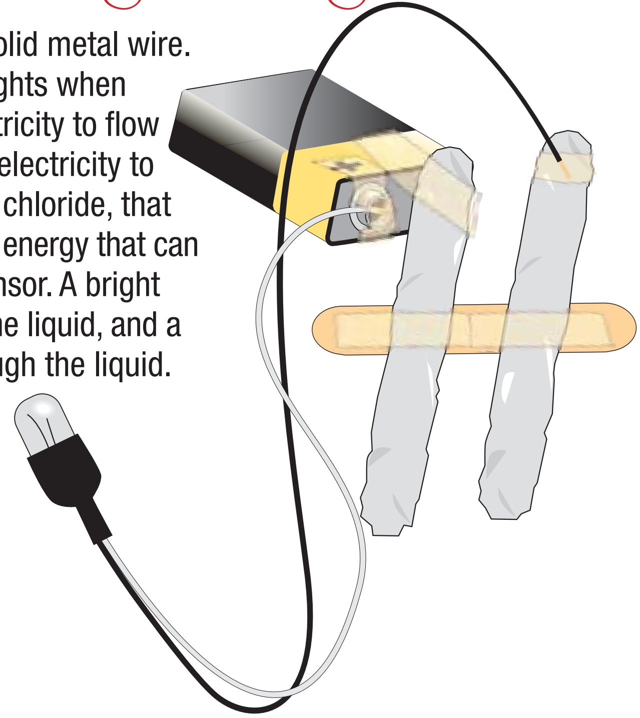
Water from the ocean can be used to generate electricity using tidal power. Tides are caused by the gravitational pull of the Moon and the Sun and the rotation of the Earth. Near the shore, water levels can change as much as 40 feet.

To use tidal power, a dam is built at the place where the ocean moves into another body of water (such as a river). When the water goes toward the land from the ocean (high tide) and out (low tide), the flowing water turns tidal turbines to produce electricity. Tidal power is available 24 hours a day, 365 days a year and is a renewable source of energy.

Article and images adapted from the U.S. Energy Information System website: www.eia.doe.gov/kids/energy.cfm?page=hydropower_home-basics.

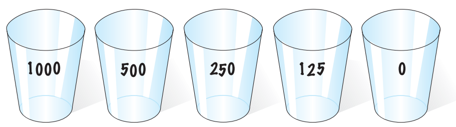
Water Wire: Electricity Flowing through Water

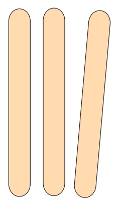
Water is a liquid, but it can be made to behave like a solid metal wire. Copper wires in your home carry electricity to your lights when you turn on the switch. Pure water will not allow electricity to flow through it. But when you add an electrolyte to water, it can carry electricity to a light like a copper wire. An electrolyte is a salt, such as sodium chloride, that is dissolved in water. In this activity, you will detect the amount of energy that can flow through a sodium chloride electrolyte solution with a light sensor. A bright light means you have a large amount of energy flowing through the liquid, and a dim light means you have a small amount of energy flowing through the liquid.

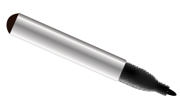


Materials

- 3 mini-craft sticks
- Aluminum foil
- Light
  (mini-lamp 1.5w volt—25 milliamps)
- 9-volt battery
- Transparent tape
- Permanent marking pen
- 5 disposable plastic cups (9-ounce)
- 1 paper towel sheet
- Tap water
- Epsom salt







SAFETY

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

Part 1. Procedure Experiment

1. Write on 5 plastic containers: *Salt Water-1000, Salt Water-500, Salt Water-250, Salt Water-125,* and *Tap Water-000*
2. To the *Salt Water-1000* container add 1 tbsp Epsom salt and 1 cup tap water. Mix with craft stick until all the salt dissolves.
3. To the *Salt Water-500* container add ½ cup of the *Salt Water-1000* solution and ½ cup tap water.
4. To the *Salt Water-250* container add ½ cup of the *Salt Water-500* solution and ½ cup tap water.
5. To the *Salt Water-125* container add ½ cup of the *Salt Water-250* solution and 1 cup tap water.
6. To the *Tap Water-000* container add ½ cup tap water.
   (Now you should have 5 plastic containers with at least a ½ cup of solution in each cup.)

Part 2. Making Your Electrolyte Sensor

1. Completely cover two of the craft sticks with aluminum foil. Do not cover the third stick with foil, leave this bare wood.
2. Next, grab your test light. Use the transparent tape to attach the white wire to the positive terminal on the battery. It will have a "+" sign. If necessary, cut some of the plastic coating away to expose more copper wire. Have an adult help with cutting.

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, specifically goggles.
- 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!

NEVER experiment on your own!

For more detailed information on safety, go to www.acs.org/earthday and click on "Safety Guidelines."

3. Use the transparent tape to attach the black wire to a craft stick covered with aluminum foil.
4. Tape the other craft stick covered with aluminum to the negative terminal of the battery. It may have a "–" sign or be unmarked.
5. Take the aluminum foil-covered craft sticks and place them about an inch apart from each other and lock them in place with the bare craft stick with transparent tape. Your electrolyte light sensor should now be ready.

Part 3. Testing Your Solutions

1. Dip the light sensor's two aluminum sticks in the cup labeled *Tap Water-000*. Record your observations and note how bright the light is.
2. Rinse the craft sticks with water and wipe them dry with a paper towel, making sure there is no liquid left on the sticks.
3. Repeat Steps 1 and 2 with the *Salt Water-125*, the *Salt Water-250, Salt Water-500,* and *Salt Water-1000* solutions.

Part 4. Challenge Experiment

1. Ask an adult to hide the labels on all 5 cups and mix up the order of the cups.
2. Use your observations from Part 3 to place the cups in order from lowest amount of salt (electrolyte) to highest.
3. Reveal the labels and see how you did.
4. Thoroughly clean the work area and wash your hands. If possible, place the plastic cups and foil from the craft sticks in a recycling bin.

Where's the Chemistry?

Although electrical energy is invisible, and dissolved electrolytes are also invisible to our eyes, you detected electricity flowing through water and how much electrolyte was present when you saw the light sensor glow. In this experiment, the electricity from the battery was passed through the aluminum foil on the first craft stick. The electrolyte solution acted like a wire by letting the electricity flow from the battery through the aluminum foil on the first craft stick, through water to the foil-covered second craft stick, through the light, and back to the battery. The light got brighter when more salt (electrolyte) was dissolved in the water. The more electrolyte, the more electrical energy could flow through the water! In this experiment, *Tap Water-000* had no electrolyte, so the light could not shine, and *Salt Water-1000* had the most electrolyte, so the light was the brightest.

Try This...

Test whether other liquids such as milk, soda, or lemonade can light your sensor. What must be present in the test liquids that lights the sensor?

Hint: Epsom salt is not the only electrolyte.

Alternative Energy

As you have read though the articles, you have learned much about alternative energy. This puzzle uses only terms from these articles, but you are only given the ALTERNATE letters of these ENERGY-related words and phrases. Once you fill in the missing letters to recreate all the terms, read the letters in the red boxes to get the final answer to the puzzle, which is a two-word term for what we are trying to prevent by adopting alternative energies. Find the solution on www.acs.org/earthday.

A__K □ L__N__ B__T__E__Y

U__A □ I__M

F__S □ I__ F__E__S

T__D__L __O □ E__

T__R__I__E __R__P □ L__E__

H__D □ O__L__C__R__C

S__S__A □ N__B__E

M__C__O__R__A__I □ M

S__L__R □ E__L

C__L__R__P__Y □ L

W □ N__M__L__S

F__R □ E__T__T__O__

N__C__E □ R __N__R__Y

E__A__O__A □ I__N

R__N □ W__B__E

E__E □ T__O__H__M__C__L

P □ O__O__Y__T__E__I__

G__N__R □ T__R

C__R__O □ F__O__P__I__T

H__D__O □ E__

B__O__I__S □ L

What is the American Chemical Society?

The American Chemical Society (ACS) is is the largest scientific organization in the 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. Most 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 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 earthday@acs.org!

Celebrating Chemistry

is a publication of the ACS Department of Volunteer Support in conjunction with the Committee on Community Activities. The Department Volunteer Support is part of the ACS Division of Membership and Scientific Advancement. Four editions of *Celebrating Chemistry* will be available for the 2011 celebration of the International Year of Chemistry (www.acs.org/iyc2011). Limited copies are available free of charge through your local section's Chemists Celebrate Earth Day and National Chemistry Week Coordinators.

International Year of CHEMISTRY 2011

Vocabulary words:

Alkaline Batteries—Batteries containing a basic electrolyte, like potassium hydroxide (KOH) instead of an acidic electrolyte, like zinc chloride ($ZnCl_2$).

Condenses—When molecules or atoms change from the gas to the liquid state.

Electrochemical Reactions—Any process either caused by or accompanied by the passage of an electric current and involving in most cases the transfer of electrons between two substances.

Electrolyte—a substance that when dissolved in a suitable solvent can conduct electricity.

Renewable Energy—A source of energy that can be replaced by natural processes as quickly as it is consumed. A sustainable source of energy.

Turbine—A rotary engine that extracts energy from a flowing fluid.

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