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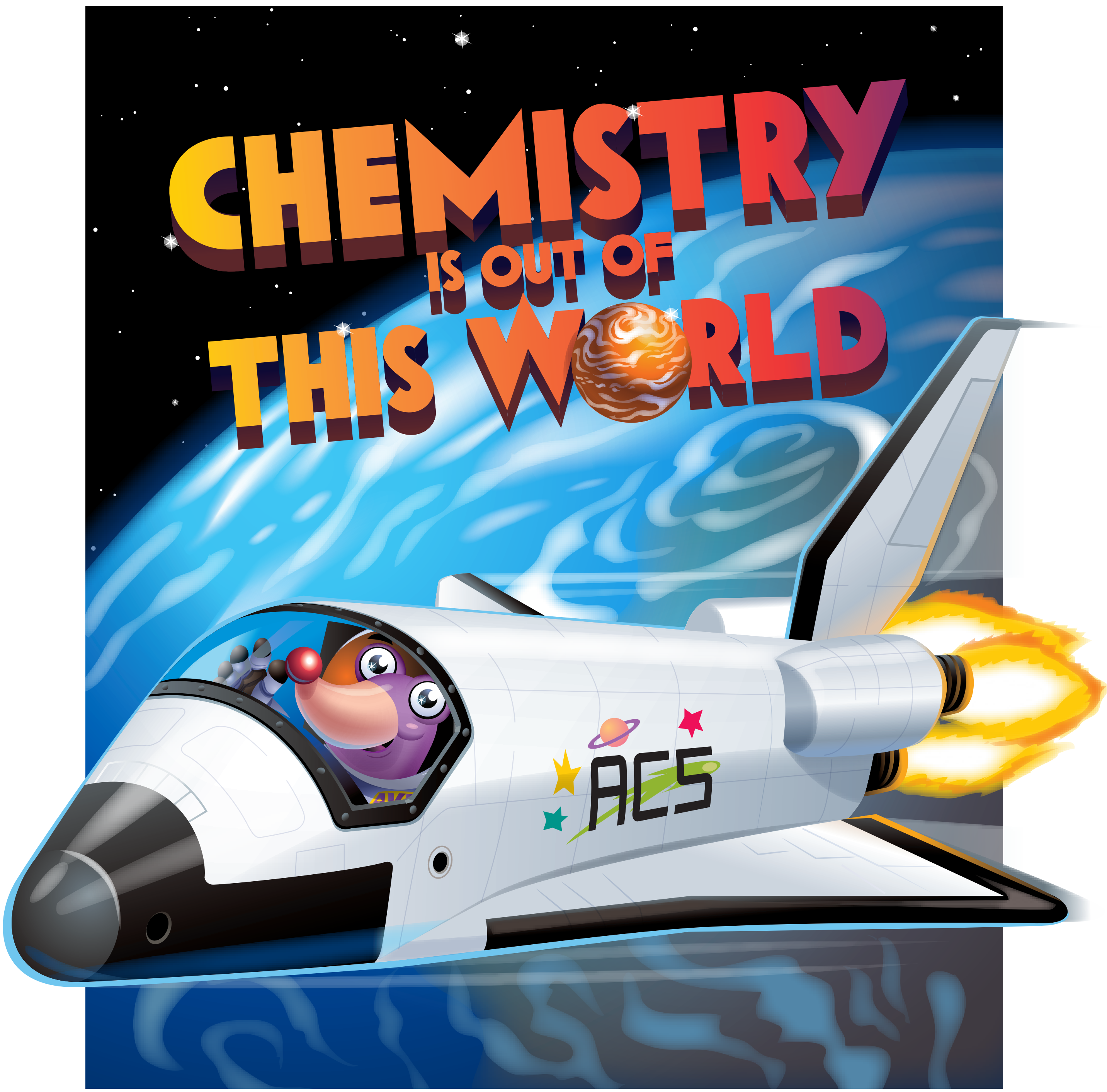
NATIONAL CHEMISTRY WEEK

Celebrating Chemistry

NATIONAL CHEMISTRY WEEK AMERICAN CHEMICAL SOCIETY



Chemistry Is Out of this World!

By Shawn Marie Dougherty

This year's National Chemistry Week (NCW) theme is "Chemistry Is Out of this World!" In this issue of *Celebrating Chemistry*, we will learn about the chemistry of outer space. Let's start with what we mean by the term "outer space."

There is no definite distance above the Earth's surface where outer space begins. However, scientists usually consider that outer space starts at a height of 62 miles (100 kilometers) above sea level. At this height, the air that makes up our atmosphere around the Earth disappears.

Above 100 kilometers, the blue color of the sky near earth becomes black. This is because there is not enough air to scatter light from the sun. It is this scattering that makes the sky look blue close to Earth's surface. Outer space is mostly empty, with some objects such as planets, moons, stars, asteroids, and comets scattered throughout it. Join us as we learn the about the stars, the Sun, and what it takes to live in outer space.

Studying outer space is hard because it is far away. Humans can't travel very far into space. So, most of what we know comes from observations and measurements made here on Earth. Before the age of science, this challenge led to many myths. For example, long ago, some people thought the Earth traveled on the back of a giant turtle. Other people thought the Sun was pulled across the sky by chariots.

As scientists learned about the nature of matter here on Earth, they have been able to better understand what is happening in outer space. You will read about how chemists help NASA in its exploration of outer space. You will also learn how to set up an experiment that uses the same chemistry that scientists use in the International Space Station.

We hope that you'll enjoy reading the articles, doing the hands-on chemistry activities, and learning more about how "Chemistry Is Out of this World!" We also hope that you and your family will participate in National Chemistry Week from October 21-27, 2018.

Shawn Marie Dougherty, Ph.D. *is a Senior Associate Applications Research Chemist at Eastman Chemical Company in Kingsport, Tennessee.*

The "Star" in You

By Verrill M. Norwood, III

You have atoms in your body that are *billions* of years old. It's true! Most of the atoms in your body were made in the core of a star, many billions of years ago. Hydrogen, carbon, and iron are examples of elements that are formed by these atoms.

What are atoms and elements? **Atoms** are the basic building blocks of the 'stuff' that makes up all matter. Atoms are extremely small and are made up of a few even smaller particles. The basic particles that make up an atom are **protons**, neutrons, and electrons. An **element** is a pure substance that is made from a single type of atom. Two or more atoms combined together are called a **molecule**.

Atoms and molecules make up you and everything around you — every rock, tree, butterfly, and building. But where did all the atoms we know about come from?

It all started billions of years ago when our universe was first formed.

The history of our universe started with an event called the Big Bang. We do not fully understand the Big Bang. But scientists think it was a gigantic explosion that started making atoms. It gave birth to the universe. That is when they think *all* the hydrogen in the universe came into being. Hydrogen was the first atom. Over the next billions of years, the universe expanded as a result of the first explosion. The hydrogen gas began to gather into vast clouds.

As these huge clouds of hydrogen collected, the force of gravity began to push hydrogen atoms in the middle with great force. At the high temperature and great force inside the cloud, hydrogen atoms began to fuse together to make a new type of atom. This resulted in creating helium, which is made of two hydrogen atoms combined into one. It also released huge amounts of energy. This process is called nuclear fusion.

This process is still going on today. Nuclear fusion is what powers our Sun and other stars. The same process continues on to make the other elements. Two hydrogens combine to make helium. One helium plus one hydrogen fuse to make lithium. And on it goes, making increasingly heavy elements. The heaviest elements are only formed in huge stars that collapse with great force and explode.

Once the elements are formed, they are ejected in these explosions called **supernovas**. Much, much later they eventually collect in different locations, including on Earth. So, as you can see, we are all made of the stuff of stars. There really is a bit of star in each of us!

Verrill M. Norwood, III, Ph.D. *is an Associate Professor of Chemistry at Cleveland State Community College in Cleveland, Tennessee.*

One way to tell the difference between gases is their colors. Place the name of a gas into the crossword based on its color and the hint provided.

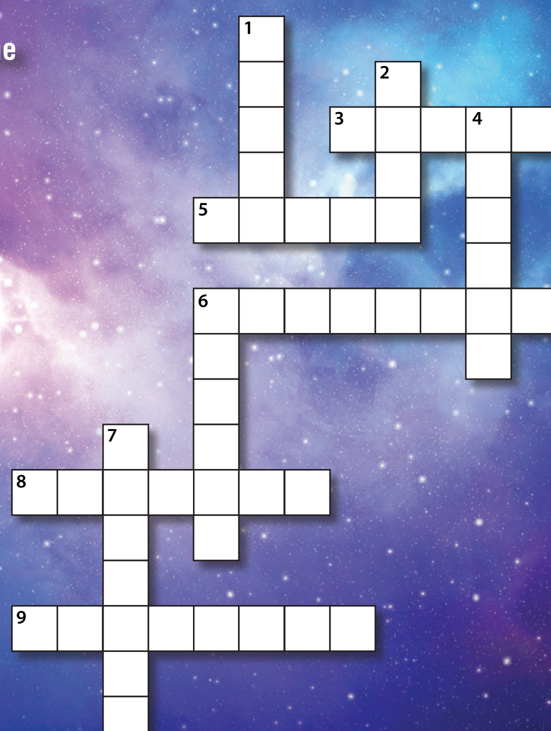
Argon	**Hydrogen**	**Neon**	**Water (vapor)**
Helium	**Krypton**	**Nitrogen**	**Xenon**
	Mercury (vapor)	**Oxygen**	

Down

1. Pink, essential to life
2. Red-orange, original gas for a brightly lit sign
4. Blue-violet, second most abundant element in the air that we breathe
6. Pink-orange, used to fill balloons
7. Lavender, think Superman!

Across

3. Blue, used in strobe lights
5. Violet, first noble gas to be discovered
6. Blue-violet, two atoms of this can be found in one molecule of water
8. Blue-violet, liquid at room temperature
9. Orange-red, first most abundant element in the air that we breathe



How Do We Know Which Elements Are in Outer Space?

By David A. Katz

SAFETY SUGGESTIONS

- Caution: Never look directly at the Sun!

Introduction

You may have wondered how we know so much about what makes up the stars, planets, and the rest of outer space — especially since humans have not gone to most of the places in outer space. In order to learn about things far away, we need sensors and detectors that give us more information about them. But how do these detectors recognize what things are made of when they are far away?

Think about how we recognize people. If you hear your parent's voice, you probably know it's them, even if they are in another room. There is something about the mix of sound (especially what scientists call **wavelengths**) in their voice that is familiar, and you recognize it.

Light waves are similar. When light is given off or reflected by an object, it has a pattern in it that can be recognized by a machine that measures the light wavelengths. Machines like this are called spectroscopes (which means 'light spectrum' + 'viewing').

On Earth, scientists have discovered that different types of atoms and molecules give off their own type of light when they are heated to glowing. By looking at this light, they are able to record a 'fingerprint' for each substance that is unique.

By pointing their spectroscopes to the sky, scientists are able to identify elements in space that are the same as those on Earth.

Materials

- **Diffraction grating slide (available in the ACS Store or on Amazon)**
- **A variety of lamps or lights (incandescent, compact fluorescent, LED, fluorescent, halogen, neon)**
- **Crayons, markers, or colored pencils**

Procedure

1. With a family member, set up various types of lights around the room (it helps if the room is darkened). You can use fluorescent lights, incandescent bulb lights, "neon-type" signs, or whatever is available.
2. Hold the diffraction grating slide in front of one eye and the close the other.
3. Look at the different lights through the slide, and you should be able to see various wavelengths as colors off to either side of the light source.
4. Record what you see for each type of light source in the "What did you see?" section.

How does it work? / Where's the chemistry?

Each element has a unique **spectrum**. Since each type of lamp has a different combination of elements, each gives off a different mix of light. This is called an emission spectrum. It is produced when atoms are heated and emit light. Scientists on Earth have observed and recorded the spectra (the plural of "spectrum") of all the known elements. So, when they see the same spectra — even when they are far away in space — they can identify them.

The diffraction grating works by having thousands of fine lines etched very close together. When light passes through the grating, the light is diffracted, which means it bends around the lines and is separated into its various wavelengths.

What did you see?

Use crayons or colored pencils to draw the spectrum you observe from each of the light sources. Try to space any lines in the spectrum similar to those you observe — but remember, the colors are the most important part. For each spectrum you observe, record the type and color of light you see with your unaided eye.

Type of lamp/light source			
Color of light without diffraction grating			
View through diffraction grating slide			

After recording the light spectra, use a computer with Internet access to search for any website that shows emission spectra of the light sources. Find why each type of bulb gave off certain types of light.

***David A. Katz** is a Consultant of Chemistry Education in Wilmington, Delaware.*

The Sun and Ultraviolet Light: Make Your Own UV Wristband

By Alexsa Silva

Introduction

Sunlight is more complex than it looks. The light coming from the Sun also has other types of radiation that are not visible. Whether or not we can see the various types of radiation in sunlight depends on its wavelength.

For example, our eyes cannot see **ultraviolet (UV) light** because UV wavelengths are shorter than the wavelengths of **visible light**. The light detectors in our eyes aren't sensitive to this shorter wavelength. The Sun emits a variety of UV radiation, with three basic types: UV-A, UV-B, and UV-C. UV-B and UV-C are the most dangerous kinds for humans. Fortunately, the atmosphere absorbs most of the UV-B and UV-C radiation.

The UV-B radiation that passes through the atmosphere is dangerous to living organisms. For example, it can cause sunburn and skin cancer. We protect ourselves from UV-B radiation by seeking shade, wearing sunglasses, and using sunblock whenever possible.

If we cannot "see" UV-B radiation, how can we detect it? Today you will learn how — by making a wristband with UV-sensitive beads!

Materials

- **UV-sensitive beads**
- **Pipe cleaner or piece of string**
- **Pair of sunglasses**
- **UV flashlight or black light (Available on Amazon for under $10)**

Procedure

1. Choose a piece of string or pipe cleaner and make a bracelet by stringing the beads on it, in any order, and then tie the ends.
2. Note the color of the beads.
3. Take the bracelet to a sunny area (or use the UV flashlight).
4. Observe the color of the beads again.
5. Bring the bracelet to a shaded area. What happens to the beads' colors?
6. Hold a pair of sunglasses over the UV beads to see if they can protect the beads from the Sun's UV rays.

SAFETY SUGGESTIONS

- Beads should not be given to children under the age of 3 (choking hazard)
- The ends of the pipe cleaners can be sharp, so children should be careful when handling them
- If UV flashlights or black lights are used, do not to look directly into the light

How does it work? / Where's the chemistry?

Your bracelet has beads that are made of white plastic with dyes added. The dyes are sensitive to UV light. The bracelet beads stay white when they are either covered or placed indoors away from sunlight. Normal house lights do not give off UV light. But when the beads are exposed to the Sun, they change color because of the UV part of the light from the Sun. If you go inside again, the beads change back to white. This happens because the dyes in the beads are sensitive to the energy and wavelength of UV light. The UV light makes the dye molecules change their shape, and this results in a color change. If you take away the source of UV light, the dye goes back to its normal shape. If the UV light is strong, like on a sunny day, the beads change to bright colors. On overcast days when the UV is weaker, the colors are less vibrant.

What did you see?

Here's what the beads look like before and after being exposed to UV light.

__Alexsa Silva, Ph.D.__ is the Director of Instruction and Outreach at the Department of Chemistry at Binghamton University in Binghamton, New York.

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!

SEARCH THE STARS

By Patti Galvan

Fill in the blank circles on the picture with the numbers of the corresponding fun facts.

1. Happy birthday! The International Space Station (ISS) turns 20 years old this year! The first section of the ISS was launched on November 20th, 1998. People arrived to live and work on the ISS two years later. Over the course of twelve years, pieces of the ISS, called modules, were sent to space and connected together to become the largest human-made object in space. It's about as long as a football field!
2. The purpose of the ISS is to do scientific research that will help people live and work in space in the future. Most of the plants grown on the ISS are science experiments, rather than food. However, lettuce and other salad greens have been grown to feed hungry astronauts. There are usually six astronauts from three different countries on the ISS at any given time.
3. We may call it a *spacewalk*, but when astronauts put on their protective suits and go outside the spacecraft, they call it an *extravehicular activity* or *EVA* for short. The cord that connects an astronaut to a spacecraft supplies oxygen and electrical power. It can also help an astronaut return to the airlock.
4. The suits for EVAs are designed to protect astronauts from electromagnetic radiation from the Sun. We categorize this radiation depending on its wavelength. Gamma rays, x-rays, ultraviolet light, visible light, infrared, microwave, and radio waves are all types of electromagnetic radiation. Our atmosphere on Earth protects us from most of the electromagnetic radiation from Sun and other more distant stars. Visible light, radio waves, and some ultraviolet light make it to us on the ground.
5. Do you know anyone who wears metal braces on their teeth? The wire that runs along the teeth is also used on satellites! This wire, called nitinol wire, is very useful because it returns to its original shape when heated. In space, warmth from the Sun causes the wire to tighten and pull solar panels into position so that they always face the sun. The warm mouths of kids tighten the wire which gradually pulls their teeth into position, too! Nitinol wire is made of nickel and titanium.
6. Stars are made of the fourth state of matter—plasma. When they are young, they convert hydrogen, which is the most abundant element in the universe, into helium. As they get older, they make other heavier elements too. These nuclear reactions create a lot energy that radiates through outer space. When we see stars at night, we see light was released from these stars long ago.
7. Sometimes old stars go out with a bang! When stars go supernova, they explode with such a fiery fierceness that they make and eject heavy elements such as iron, gold, and uranium. They also send out such an incredible amount of energy that supernovas from even distant galaxies appear to be extra-bright temporary stars in our night sky.
8. The Asteroid Belt is made up of billions of pieces of rock, some of which contain useful natural resources, such as water, metals, and minerals. These may one day be mined to help build habitats, grow food, and support people so that they can live and work on Mars.
9. The Mars Rover, named *Curiosity*, is busy exploring, taking photos (including selfies!), analyzing rock samples, and returning information to Earth. This solar-powered rover contains 17 cameras along with other amazing tech. One device called ChemCam contains a laser that can vaporize rock! ChemCam then uses its mass spectrometer to analyze these gasses. Scientists on Earth can interpret this information to find out which elements the rock was made out of.

__Patti Galvan__ is a Program Manager of Science Outreach at the American Chemical Society in Washington, D.C.

Living in Space:
What Do We Need to Stay Alive?

By Lori Stepan Van Der Sluys

Living on Earth means that we can eat fresh food and breathe fresh air. But have you ever thought about what life might be like for astronauts? They can't go outside for fresh air, since there is no air in space! So what things are required for human beings to live on a spacecraft, or on another planet such as Mars?

First, we need oxygen, so that we can produce energy from the food we eat. We breathe in oxygen gas and breathe out a mixture of gases including carbon dioxide (CO_2). On Earth, this is not a problem. Our air has plenty of oxygen that is produced naturally by green plants. However, in a sealed spaceship, we would soon use up all the oxygen available if we couldn't make more.

While it is possible to use green plants to make oxygen for a spacecraft, it would require a lot of room. Another way is to make oxygen from water (H_2O). By passing electricity through water, you can separate water into hydrogen and oxygen. This is mostly how modern spacecraft and the International Space Station (ISS) do it.

Water and food both have to be packed and brought along for space travel. Water is saved and recycled within the spaceship. Astronauts breathe out a lot of water vapor, along with a little carbon dioxide. Machines on board the spaceship capture this water vapor and purify it. Shower water, sweat, and even urine are also captured and purified. Astronauts filter the waste to remove impurities and use chemical reactions to disinfect the water. Sometimes it's best to not think about where our drinking water comes from!

All food supplies must be carried along for space missions from Earth. Plants could be grown to supply food, but as with the plan for oxygen, it would require a lot of space to do this. Maybe in the future we will make spacecraft large enough to grow plants for food and oxygen. But for now, all the food for space trips must be packed and brought along by the astronauts.

If astronauts get too cold or too hot, they will die. To keep them and their equipment within a safe temperature range, spaceships use electricity from solar panels to generate hot or cold air. Spacecraft are also heavily insulated to help keep the temperature inside them stable.

Unlike on Earth, astronauts also need protection from radiation. Radiation is constantly given off by the Sun and other stars. On Earth, we are protected by our **atmosphere** and our planet's magnetic field. To protect astronauts, spacecraft are covered by shields.

There are other things that astronauts need to stay alive in space — but oxygen, water, food, and warmth are the most important. Someday, maybe you will study to be an astronaut!

__Lori Stepan Van Der Sluys, Ph.D.__ is an Associate Teaching Professor at Penn State University in State College, Pennsylvania.

Find the Rover!

Astronauts may one day land on Mars. When they do, they must wear their Extravehicular Mobility Units or EMUs to explore the planet because the atmosphere contains very little oxygen. Unlike our atmosphere, which is mostly nitrogen, the atmosphere of Mars is mostly carbon dioxide. Help future Avi get back to the rover.

Creating Oxygen to Breathe in the Space Station

By Alexsa Silva

Introduction

Life on the International Space Station (ISS) is challenging. You can't go outside for fresh air, because there is no air in space! If you lived inside a sealed container of air such as the ISS, and your body used oxygen with each breath, you would soon use up all of the oxygen. So, how would you survive?

When we breathe on Earth, our lungs fill with a mixture of gases in the air. Air is made up of oxygen (~20%) and nitrogen (~80%). Our lungs transfer oxygen from the air into our blood with each breath. Then our blood delivers this oxygen to every living cell in our bodies. Oxygen is important to help us use food to get energy. We need oxygen to live!

Fortunately, specialized equipment on the ISS makes oxygen from water. Water is a compound that is made up of two hydrogen atoms and one oxygen atom. Its abbreviation is H_2O. In this activity, you will make oxygen gas (O_2) from water. You'll make hydrogen gas (H_2), too.

Materials

- **½ cup (about 125 mL) water**
- **½ teaspoon (about 2.5 mL) Epsom salt**
- **1 9-ounce clear plastic cup**
- **2 pieces of insulated wire with "alligator clips" on both ends**
- **Pencil sharpener**
- **9-volt battery**
- **Pliers**
- **1 rubber band**
- **2 pencils (#2 is preferred)**

Procedure

1. With the help of an adult, use pliers to carefully pull the metal and eraser portion off of two pencils.
2. Sharpen both ends of both pencils.
3. Place a rubber band around the middle of the battery. You may need to double the rubber band so that it fits somewhat snugly.
4. Slide both pencils under the rubber band so that they are held on opposite sides of the battery.
5. Use an alligator clip from one wire to connect one terminal of the battery and the end of one of the pencil tips. Be sure to connect the pencil tip that is above the top of the battery. It is important to make good contact with the graphite (lead) in the pencil.
6. Use an alligator clip from another wire to connect the other terminal of the battery to one tip of the other pencil. Make sure that the alligator clips do not touch each other on the battery.
7. Pour ½ cup water into a clear plastic cup.
8. Add ½ teaspoon of Epsom salt and stir the mixture until the salt dissolves.
9. Submerge the pencil tips below the battery in the Epsom salt solution. Look at the submerged pencil tips from the side of the cup. You should see small bubbles form on the pencil tips.

SAFETY SUGGESTIONS

- Safety goggles required
- Do not eat or drink any of the materials used in this activity
- Have an adult assist you
- Do not let the battery get wet
- At the conclusion of the activity, disconnect the wires from the battery to prevent a short circuit
- Disposal: Pour the used saltwater solution down the drain with running water
- Thoroughly wash hands after this activity

How does it work? / Where's the chemistry?

The battery, wires, graphite in the pencil, and saltwater all conduct electricity. In this activity, they are connected together to form an electrical circuit. At first, the circuit is "open." Submerging the pencil tips in water "closes" the circuit, so that electricity starts to flow. This electricity changes the water molecules at both pencil tips. At one tip, the atoms that make up water molecules (H_2O) rearrange to form bubbles of oxygen gas (O_2). At the other pencil tip, the atoms in water molecules rearrange to make bubbles of hydrogen gas (H_2). Some other things are also produced, but the main product we are interested in is the oxygen. It can be collected and used to allow people to breathe on spaceships or the ISS. On the ISS, the hydrogen created is pumped "overboard" (that is, out into space) because it is explosive and dangerous.

Whenever the atoms of substances rearrange, the new groups of atoms are different substances. For example, water and oxygen are different substances. Changing substances by rearranging their atoms is a **chemical reaction**. The process of using electricity to cause a chemical reaction is called electrolysis.

What did you see?

Can you figure out which pencil tip is producing hydrogen gas, and which is producing oxygen gas? Here's a hint: This chemical reaction produces twice as many molecules of hydrogen than oxygen.

Alexsa Silva, Ph.D. *is the Director of Instruction and Outreach at the Department of Chemistry at Binghamton University in Binghamton, New York.*

The Adventures of Meg A. Mole, Future Chemist

Dr. Jamie Elsila

Astrochemist, NASA Goddard Space Flight Center

In honor of this year's outer space theme, I wanted to travel to the moon, but got the next best thing! This year I traveled to the Astrobiology Analytical Lab at NASA Goddard Space Flight Center in Greenbelt, Maryland, where I met Dr. Jamie Elsila. Dr. Elsila is an Astrochemist. "So, what does an Astrochemist do," you ask? Dr. Elsila studies meteorites, moon rocks, and other extraterrestrial samples to learn about the chemistry of the solar system. She tries to understand how the ingredients for life were formed, how they got to Earth, and where else they might be in our solar system so that we can understand the origin of life on Earth and the potential for life elsewhere.

I could not wait to learn more! Dr. Elsila brought me into the lab where I got to see real meteorites. In her lab, visitors can touch a meteorite that is older than any rock on Earth and see how it's crushed into a powder and torched to seal the meteorite powder with some water in a test tube. She heated this tube to make "meteorite tea" (water extract of the meteorite) and then injected that into analytical instruments to find out what it's made of. Lab safety is important too – she made sure we all wore our purple gloves, lab coats, and safety glasses. She also showed me models of the OSIRIS-REx spacecraft, a NASA mission that is on its way to asteroid Bennu to collect a sample of the asteroid and bring it back to Earth in 2023. She even told me she will get to study part of this sample in her lab.

I asked Dr. Elsila what she liked the most about her job. She said, "I like that I get to do different things every day and that I get to work with smart and motivated people to try to understand big questions. I like (and also find frustrating) when the lab results don't make sense and we get to work together to puzzle out what they mean or design new experiments to give us more information to help us understand them."

Growing up, Dr. Elsila was always curious about how the world worked. She said, "My parents were not scientists, but they encouraged my love of science experiments and projects. I was lucky in high school to have a wonderful teacher who started a club to build a radio telescope. As far as we know, this was the first student-built radio telescope in the country. Being part of the radio telescope team let me learn about research, carry out some science fair projects, and learn that doing science can be complicated and has lots of challenges, and how satisfying it is when experiments and research finally produce results."

I wondered where someone might learn about her work. She explained, "A child might see meteorites similar to the ones I study in a natural history museum, or he or she might wonder about how life on Earth got started and whether the ingredients for life exist elsewhere in our solar system." Thanks to Dr. Elsila, I really enjoyed my trip to the Astrobiology Analytical Lab at NASA Goddard Space Flight Center. I learned that chemistry can be not only down to Earth, but out of this world!

Personal Profile

Birthday? October 31 (Halloween)
Favorite color? Blue
Favorite food? Chocolate
Accomplishment you are proud of? After graduating from college, I was a Peace Corps volunteer and taught chemistry and math at a secondary school in Tanzania for two years.
Can you tell me about your family? I am married, and we have two daughters, ages 7 and 9, who love learning about space and planets.

Word Search

Try to find the words listed below — they can be horizontal, vertical, or diagonal, and read either forward or backward.

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

ATMOSPHERE	FLUORESCENCE	NOVA	SPECTRUM
ATOMS	MOLECULE	PHOTON	VISIBLE LIGHT
ELECTRON	NOBLE GASES	PROTON	WAVELENGTH
ELEMENT			

For answers to the word search, please visit the *Celebrating Chemistry* Archive at **www.acs.org/ncw**.

Make a Glowing Sign

By Shawn Marie Dougherty

Introduction

There is something very attractive about neon lights and signs. They draw our attention, and we never seem to tire of looking at them. It is no wonder that stores and businesses use them to attract the attention of customers. But how do these glowing wonders really work?

Neon lights are usually glass tubes filled with a small amount of neon gas. Neon gas is part of a group of elements called the **noble gases**. They were named noble gases because they don't react (or mix) with 'common' elements. To make neon gas glow, you first have to get it "excited," which takes a lot of energy.

By applying electrical voltage, we can cause **electrons** to jump to higher energy levels. As they fall back down to their original level, they emit the energy they gained from the electricity. This release of energy is in the form of a light particle called a **photon.**

Different noble gases produce different colors. Argon glows blue, helium glows pink, and neon glows orange-red. As for the neon signs you see around town, the different colors are made by coating the sign's tubing with paints rather than using different gasses.

Make your own glowing sign using the following directions.

SAFETY SUGGESTIONS

- Safety goggles required
- Protective clothing suggested
- Caution: *hot glue!*
- Have an adult assist you
- Avoid looking at the ultraviolet (UV) flashlight, which can be damaging to the eyes
- Cover your work area to prevent any damage from the hot glue
- Disposal: The tube with liquid and used eye dropper can be disposed of in the trash
- Thoroughly wash hands after this activity

Materials

- **Clear tubing (from a local gardening store or aquarium shop)**
- **UV flashlight or black light (available on Amazon for under $10)**
- **Highlighter or fluorescent marker**
- **Piece of cardboard or foam core**
- **Plastic pipette or eye dropper**
- **Hot glue gun and glue**
- **Glass or plastic bowl**
- **Dish detergent**
- **Water**
- **Pliers**

How does it work? / Where's the chemistry?

Fluorescent inks and dyes work in a very similar way to noble gases in advertising signs, with one big exception. Instead of exciting the atoms in the fluorescent solution with electricity, you are exciting them with UV light. UV light has more energy than visible light. By exposing the highlighter ink solution to the UV flashlight, you cause electrons to jump to higher energy levels. When they fall back, they release energy and, in this case, at least part of the energy is in the range of visible light. This combination of energies gives the fluorescent sign you made its characteristic glowing color.

Procedure

1. With the help of an adult, use pliers to remove the back end of a highlighter or fluorescent marker.
2. Lean the marker over so that the felt cylinder drops into a glass or plastic bowl.
3. Add ½ cup (about 125 mL) of water to the bowl. Let this soak for a few hours, until most of the color is removed from the felt cylinder.
4. Add 1 small drop of dish detergent to the fluorescent solution. Stir gently to mix without creating bubbles. This will prevent some air bubbles from forming as you add the solution to the plastic tubing.
5. Use a plastic pipette or eye dropper to fill the plastic tubing with the fluorescent solution. Hold the two ends of your tubing above the rest of the tubing so that your solution doesn't spill out.
6. When the tubing is filled with liquid, have an adult use hot glue to fill the ends of the tube. Once the glue is dry, ensure that the liquid is sealed in the tube before proceeding. If not, apply more hot glue to the ends of the tubing and wait for the glue to cool.
7. Now use the glue gun to stick the tubing to the piece of cardboard or foam core in the shape of the word you wish to form.
8. Illuminate the sign by taking it into a dark room and turning on a UV flashlight.

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Words to Know

Atmosphere – layer of gases around a planet held in place by gravity

Atom – smallest particle of an element that is the basic building block of all matter

Chemical Reaction – process of changing substances by rearranging their atoms

Electron – part of the atom that has a negative charge and is attracted to protons

Element – pure substance, such as oxygen or copper, that is made from a single type of atom

Fluorescence – release of light that has either been absorbed from a light source or produced by electromagnetic radiation

Molecule – two or more atoms combined together

Noble Gases – elements such as helium, neon, and krypton that do not react with the other elements

Supernova – exploding star that creates and ejects the heavier elements such as iron, gold, and uranium

Photon – particle that carries energy, such as light, has no mass, and travels in a wave-like pattern

Proton – part of the atom with a positive charge, the number of protons determines the identity of the atom

Spectrum – range of wavelengths such as the colors of visible light

Ultraviolet (UV) Light – electromagnetic radiation with more energy than visible light that can cause sunburns and eye damage

Visible Light – electromagnetic radiation we can see as different colors

Wavelength – size of a wave that is used to measure electromagnetic radiation—UV light has more energy and shorter wavelengths, and visible light has less energy and longer wavelengths

Celebrating Chemistry

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

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