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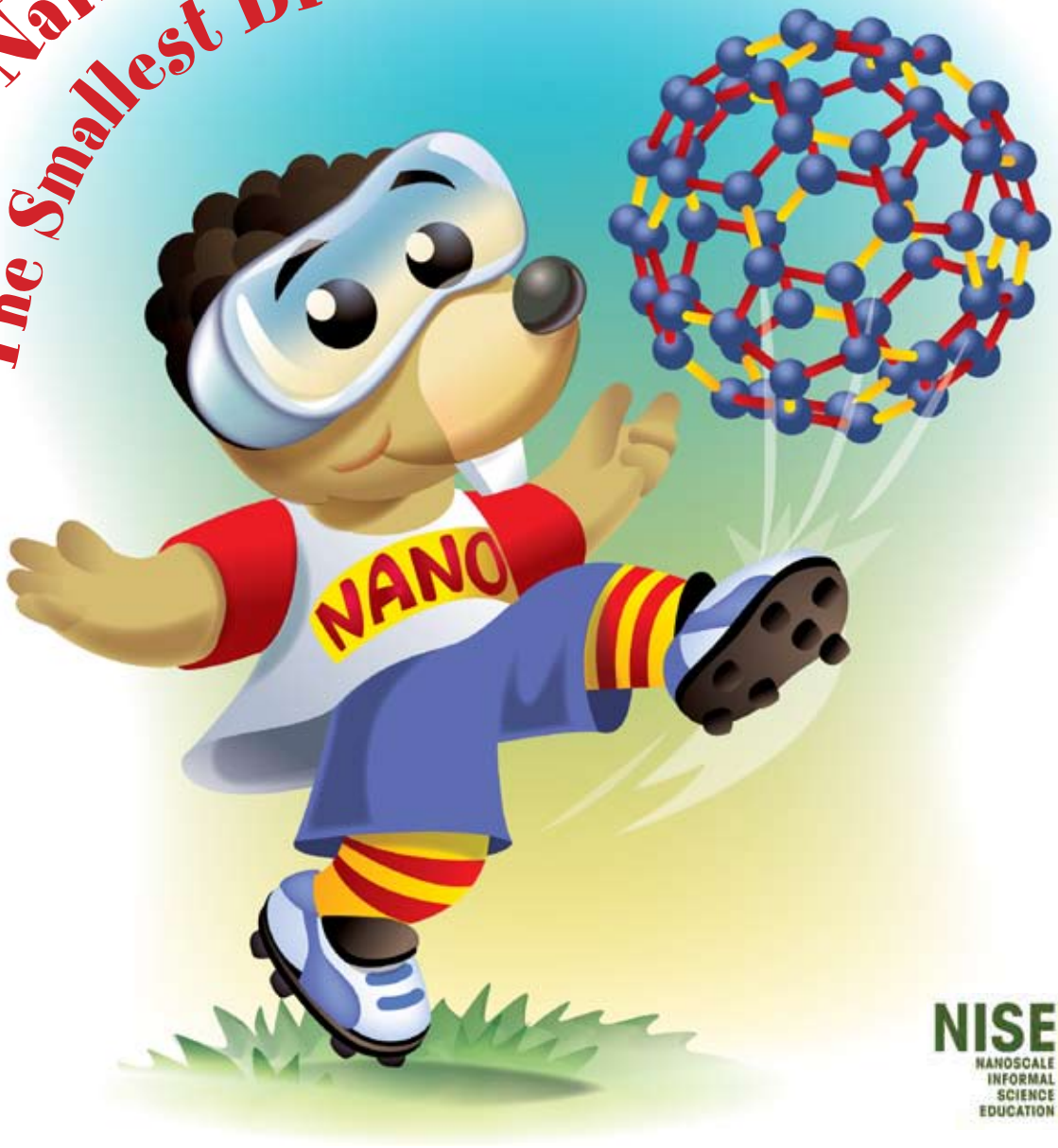
Nanotechnology: The Smallest BIG Idea in Science



NISE network
NANOSCALE INFORMAL SCIENCE EDUCATION

Nanotechnology: The Smallest BIG Idea in Science

By Robert de Groot

Think small. Think really, really small – smaller than anything you've seen through a magnifying glass or a microscope at school. Think atoms and molecules, and now you're there. You're down at the nanoscale. Working at the nanoscale, scientists and engineers are creating new tools, products, and technologies.

Nanotechnology will help solve some of the world's biggest challenges. Someday you may be a scientist or engineer who will use nanotechnology to develop techniques to clean up hazardous substances in the environment. You might develop lighting that uses a fraction of the energy or even develop stronger, lighter, or more durable materials for bicycles. Or you might work with other engineers who are developing low-cost water filters using nanotechnology.You might even become a doctor, working to develop nanoscale devices to detect and treat diseases more effectively and with fewer side effects.

How small is a nanometer? There are one billion (1,000,000,000) nanometers (nm for short) in one meter. Dr. Shaquille O'Neal, scholar and famous athlete, is 2,160,000,000 nm tall!

The smallness of objects at the nanoscale is a hard concept to understand. Here are some other ways to think about the size of a nanometer:

- A sheet of notebook paper is about 100,000 nm thick
- If you are blond, your hair is probably about 15,000 to 50,000 nm in diameter
- If you have black hair, its diameter is between 50,000 and 180,000 nm
- A large raindrop is 2,500,000 nm in diameter

Nanoscientists try to discover new things about substances that are roughly 1 to 100 nm in size. Nanotechnology is the way these discoveries are put to work.

Why is the nanoscale so special?

Materials can have very different properties at the nanoscale. Some materials are better at conducting electricity or heat, while others are stronger.

For example, nanoscale tubes of carbon (1/100,000 the diameter of a human hair) are incredibly strong. They are already being used to make bicycles, baseball bats, and some car parts. Carbon nanotubes also conduct both heat and electricity better than any metal. They can be used to protect airplanes from lightning strikes and to cool the temperature of computer circuits.

Nanoscale materials are all around us, in smoke from fire, volcanic ash, and even sea spray! Nanoscale gold was used in stained glass and ceramics as far back as the year 1100. It took nearly another 900 years before machines were developed in order to see and control substances at the nanoscale.

Today, many of our nation's best scientists and engineers are finding new ways to use nanotechnology to improve our environment and develop new sources of energy. They are creating new materials, improving health care, and bringing clean water to people everywhere. There are over seven billion people on earth who could benefit from such inventions, so this is a huge job!

During a meeting at the California Institute of Technology in 1959, the famous scientist Richard Feynman gave a speech titled, "There's Plenty of Room at the Bottom." What he meant was there are many opportunities for discovery by experimenting with matter at the smallest (bottom) scale of size, the atomic or nanometer scale. Even over fifty years ago, scientists and engineers knew there were many amazing discoveries in nanotechnology on the horizon.

Most importantly, Feynman knew that it would take creative and hardworking students to make these

discoveries. Feynman issued two challenges at the end of the meeting. One was to make a motor that could fit in a cube just 1/64th of an inch on each side. The other was to write the entire contents of the *Encyclopædia Britannica* on the head of a pin. Believe it or not, both challenges have already been met! Just imagine: even you may create a really BIG idea in the science of the very small!

Try This!

Nanoscale materials have far larger surface areas than similar volumes of larger scale materials. This means that more surface is available for interactions with other materials around them.

To demonstrate the importance of surface area, chew a piece of gum and then divide it into two chunks. Put one of the chunks on a piece of wax paper. Take the other piece and stretch it into as thin a sheet as possible. The surface, or area visible on the outside, is much greater for the stretched-out gum than the other piece of gum. The stretched-out gum is likely to dry out and become brittle faster than the other piece, due to more contact at the surface with the air around it.

HOW SMALL IS NANO?


Basketball player Shaquille O'Neal (height: 7 feet, 1 inch) is about 2 billion nanometers tall


A hand is 100 million nanometers long


An ant is 5 million nanometers long


A strand of hair is about 100,000 nanometers wide


Bacteria are about 1,000 nanometers long each


A typical protein such as hemoglobin, which carries oxygen through the bloodstream, is 5 nanometers in diameter


A water molecule is much less than 1 nanometer- about half a nanometer

This article and activity is an adaptation of material found in the publication *Nanotechnology: Big Things from a Tiny World* (www.nano.gov), which was federally funded by the National Nanotechnology Coordination Office (a multi-agency consortium including NSF, NIH, DOE, and FDA), and *Nanooze*, a publication of the National Nanotechnology Infrastructure Network.

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!

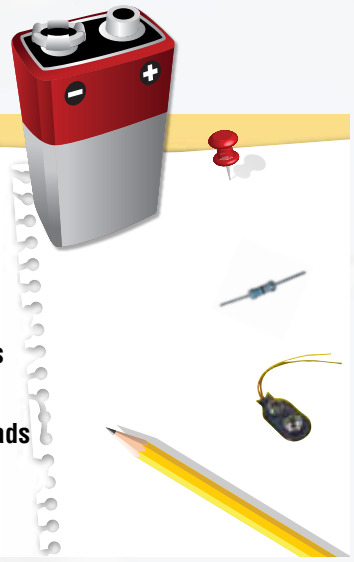
Exploring Materials-Graphene

By NISE Network and Robert deGroot

Graphene is a single layer of carbon atoms arranged in a honeycomb pattern. Graphene is only one atom thick — that's a fraction of a nanometer! (A nanometer is a billionth of a meter.) In the field of nanotechnology, scientists and engineers make new, nano-sized materials and devices. Graphene has a lot of potential in nanotechnology because of its useful properties: it's flexible, super-strong, nearly transparent, and conducts electricity. Computer chip manufacturers are developing circuits from graphene, by modifying it to make it a semiconductor. One day, graphene could be used to make see-through, bendable electronic displays, and tiny, fast computer chips.

Materials:

- Pencil (#2)
- Paper
- 5mm LED bulb
- 9 volt battery
- 9 volt snap connectors
- 330 ohm resistor
- Two insulated wire leads

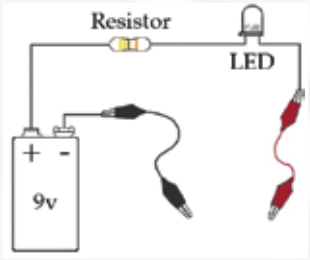


Note: Battery and bulb circuit materials can be purchased from www.radioshack.com (LED bulb #276-021, 9v battery #55039849, battery connectors #270-324, resistor #271-1113, insulated leads #278-1156).

SAFETY!

☑ *Safety glasses required*
☑ *No food or drink in the area*

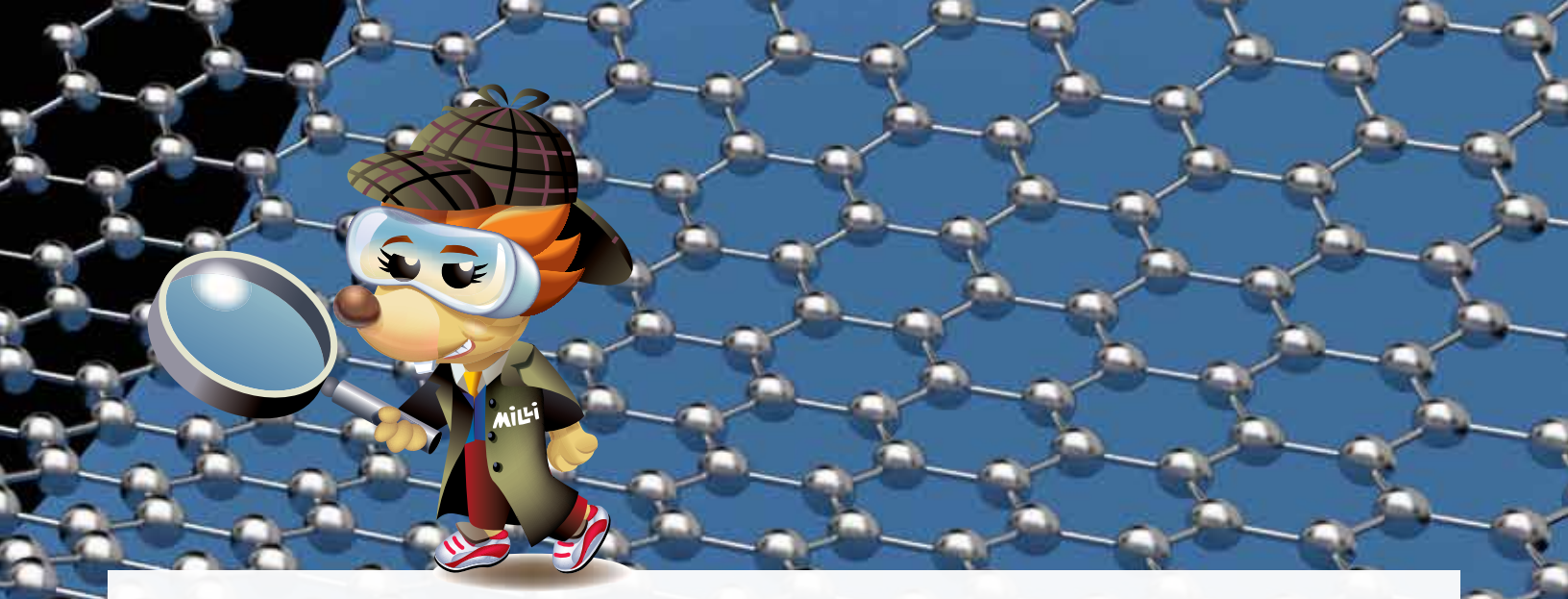
Do not short-circuit batteries. When the positive (+) and negative (-) terminals of a battery are in contact with each other, the battery can become short-circuited. This can lead to venting or an explosion. This is avoided in the activity by inserting the resistor in the circuit. Never use a plain wire to connect the + and – terminals directly.



NISE Network

Procedures:

1. Make the battery and bulb circuit (see diagram).
   Have your adult partner help you assemble the apparatus.
2. Kids, lay down some graphite! (Graphite is the real name for pencil "lead.")
   Use the pencil to draw and color in a thick, dark box on the piece of paper. Make it several inches long and around half an inch wide.
   Tip: Make the box as dark as you can — try not to let any patches of paper show through.
3. Touch the two insulated wire leads to the graphite box. Watch the bulb—what happens? Record the distance between the two leads and record your observation in the table. Now try moving the leads closer together and further apart. What differences do you notice? Record your results in the observation section.
4. Draw some other heavy dark paths that are not straight and check them with your battery apparatus. Record your results in your observation.



What did you see?

	Distance between leads (cm)	Observation
Trial 1		
Trial 2		
Trial 3		

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

Graphene comes from graphite. The "lead" in your pencil is made of graphite, which is made of carbon atoms. In this activity, in some places you made a single-atom layer of graphene when you rubbed the graphite onto the paper using your pencil. If you could see graphene on the nanoscale, you would see a single sheet of carbon atoms that look like a bee honeycomb or chicken wire (that is, a repeating pattern of hexagonal shapes). Although the bonds that hold the carbon atoms together in the hexagonal sheets are quite strong, the bonds between the layers are relatively weak. This is what allows us to easily separate the pure graphene from the bulk of the graphite. The sheets are incredibly thin, only one atom thick. A sheet of graphene is almost one million times thinner than a human hair! Graphene is the thinnest and strongest material ever made. It is 200 times stronger than steel.

Scientists at Columbia University say that it would take an elephant, balanced on a pencil, to break through a sheet of graphene made to the thickness of plastic wrap. Graphene also conducts electricity better than any material known. It has the potential to improve the speed of computer chips and could lead to better solar cells. Now you know that any time you write with a pencil, you are making a few traces of a promising new nanomaterial on your paper!

References:

This activity was adapted from "Draw a Circuit," a product of the Nanoscale Informal Science Education (NISE) Network.

The "Where's the chemistry" was written by Robert deGroot.

The Adventures of Meg A. Mole, Future Chemist

Dr. Chad Mirkin

Mitch Jacoby/C&EN

In honor of this year's focus on nanotechnology, I was lucky enough to travel to Evanston, Illinois and meet Dr. Chad Mirkin, Director of the International Institute for Nanotechnology at Northwestern University. Dr. Mirkin is also a professor of chemistry, chemical and biological engineering, materials science and engineering, and medicine!

Dr. Mirkin told me that his main focus is to "study and teach people about nanoparticles," which are "very small materials with diameters 10,000 times smaller than that of a human hair." I asked, "What can studying such small particles tell us?" Dr. Mirkin smiled and explained that "these tiny structures have properties that are very different from larger materials of the same composition, and that makes them useful in many fields ranging from biomedicine to energy." Wow! I couldn't wait to hear more.

So where does a nanotechnology expert do most of his or her work? Dr. Mirkin said, "I like to work at my desk and do a lot of reading and writing. Also, I get to travel all over the USA and the world to give presentations on my research work." He told me he was even invited to present at the ACS national meeting in Philadelphia! Dr. Mirkin explained that what he enjoys most about his job is that "Every day I learn something new, and no two days are ever the same." That sounds like a lot of fun!

Dr. Mirkin told me that he was interested in science when he was growing up because he "liked to discover new things that no one in the world had ever discovered before — that's the greatest thrill and the best part of being a scientist!" His favorite subjects in school were chemistry, math, and history.

Next time you hear stories about new medicine and energy resources, just remember that chemists like Dr. Mirkin are working hard every day to learn new things about the smallest of particles — nanoparticles — and learning how to make them useful in everyone's lives!

Personal Profile

Favorite food/drink? Chipotle burritos and Diet Coke
Favorite hobbies? Playing/watching tennis and going to the movies
Birth date? November 23
About his family? Married, with two daughters in high school and a son in college

The Adventures of Meg A. Mole, Future Chemist

Dr. Christine Payne

My next visit for NCW 2012 was in Atlanta, Georgia. Here I met Dr. Christine Payne, an assistant professor at Georgia Tech. Dr. Payne teaches quantum mechanics and statistical mechanics. I needed help understanding what the students in those classes learned about! She told me that one of the "fun projects" that she uses in her quantum mechanics class involves "using a microwave oven to measure the speed of light." I could not wait to see and hear more!

Dr. Payne explained that she really enjoys how her position allows "professors to have many different jobs." She can perform "experiments, teach students, and travel to learn from other people and teach them about her work." She told me that her job has even allowed her to travel to places like Germany, China, and Tunisia!

So how does Dr. Payne do her experiements in the lab? She showed me how she uses "lasers and microscopes to understand how chemical reactions occur inside of cells." I liked the microscope the best! She then told me how her lab "records movies of biomolecules and nanoparticles as they are transported through cells." They use a "fluorescent tag" in the molecules to learn "where and when a chemical reaction occurs." By doing this, they can learn "how low density lipoprotein (bad cholesterol) is broken down by the cell and where nanoparticles go after they are inside of the cell. These experiments can help make drug delivery and gene therapy work." Dr. Payne told me that the best thing about being a scientist is "doing experiments to understand how things work."

Dr. Payne explained that she was very interested in science while growing up. She collected rocks and bugs and had a chemistry set, and even particiapted in the junior high science fair twice! Her favorite subjects in school were math, physics, and history. She decided to pursue a career in chemistry because she "wanted to understand how the world works."

So how does Dr. Payne's work apply to a child's life? She told me that the "body is made up of cells, and each of these cells is controlled by chemical reactions. Understanding how chemical reactions occur inside cells helps keep people healthy."

Personal Profile

Favorite Food? Lobster
Favorite Color? Blue
Favorite Hobbies? Camping and reading
Birth date? July 24
Accomplishment you are proud of? I was part of a team of chemists that competed in a triathlon relay. We won!

1. Medicine / Hospital

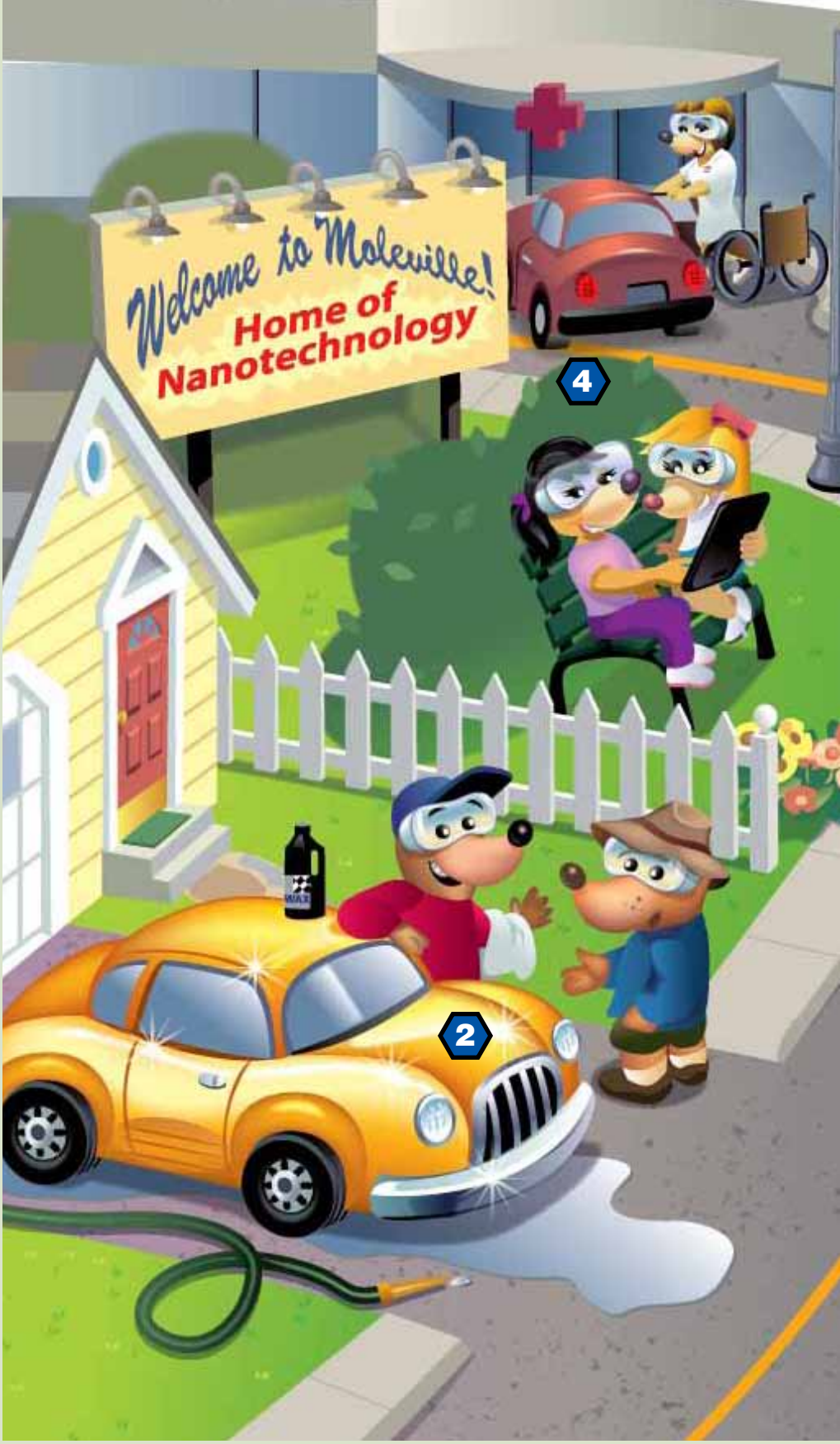
- Nanotubes and other nanoparticles could be a way to deliver medicines more specifically into cancerous or diseased cells without harming healthy cells nearby.
- Nanoscience is helping develop the technology to send medical images (X-rays, CAT scans, etc.) using cell phones.
- Nano-coatings are designed to allow implants such as pacemakers and artificial joints to better interact with the body's own tissues.

2. Cars / Fuel

- Nanotechnology has helped develop lighter, but stronger, materials for use in car manufacturing. This means that, because the car is lighter, the engine runs more efficiently and the car needs less gas to run. You fill up your gas tank less often! In addition, batteries based on nanomaterials are used in hybrid and all-electric cars.
- Nanotechnology has helped make automobile paint last longer and resist chipping, and also made tires perform better.

3. Coatings

- Thanks to nanotechnology, we already have fabrics that repel dirt and spills.
- Silver nanoparticles are used in the coating on the insides of refrigerators, washers, and vacuum cleaners. These nanoparticles not only help eliminate odor, but also help resist the growth of harmful bacteria.



4. Computers

- The key components that allow modern computers to be small but powerful are transistors that are less than 100 nanometers in diameter.

5. Sports / Bike

- Carbon nanotubes are tiny cylinders of carbon atoms that have 100 times the strength of steel, but weigh much less. This type of nanotechnology has helped make a bicycle that weighs less than three pounds while still being extra durable. It has also helped strengthen hockey sticks and tennis racquets while making them weigh less.

6. LED / Traffic Lights

- Light emitting diodes (LEDs) use less energy and need to be replaced less often compared to regular incandescent bulbs. LEDs are being used increasingly where brightness, low power consumption, and long lifetimes are important safety concerns. Today LEDs are also found in automobile lights and displays, home lighting, commercial signs, exit lights, and dozens of other places.

Exploring A Hydrogel

By Lynn Hogue and Michael McGinnis

People have always used the materials in their environment to make their lives better. Early man used stones as tools. Different types of rocks were chosen for different purposes, based on the properties of each rock. We still do the same thing today. Each material used to make a product is chosen because of its properties. Scientists and engineers have always tried to make new products that are better. They do this by changing the mix of chemicals used, or sometimes making brand new materials.

Many products that you use every day are made of chemicals called polymers. Polymers are very long molecules made of repeating units hooked together (poly = many, mer = unit). Plastics are one type of polymer. Hydrogels are another type of polymer that can attract and hold many water molecules inside its long chains. They are super-absorbers. One kind of hydrogel is found in silicon contact lenses. These lenses let more oxygen get to the eye so the lenses are safer to wear for longer periods of time. Another hydrogel is mixed with soil, so you don't have to water your plants as often. Still another kind is used in baby diapers.

Now it is time for you to explore a hydrogel. You will be a scientist–because you will plan your own experiment to answer a question. The question is, "How much water can the hydrogel in a baby diaper hold?"

SAFETY!

- ☑ ***Safety glasses required***
- ☑ ***Thoroughly wash hands after this activity***
- ☑ ***Protect your work area using several layers of newspaper***
- ☑ ***Diapers can be placed in the trash***

Materials:

- **2 baby diapers (same size)**
- **Measuring tools**
- **Water**
- **Anything else you need to do the experiment that you plan**

Procedures:

Design your own experiment that allows you to determine how much water the diaper can hold. Record your results with your observations in the data table.

Scientists always do things more than one time and compare the results. Do your experiment a second time on the remaining diaper. Record your results with your observations in the data table.

What did you see?

Brand of Diaper:	Amount of Water Absorbed	Observation
Trial 1		
Trial 2		

What do these observations mean?

How did the results of your two trials compare? If they were very different, why do you think this happened? How would you change your experiment if you were to try again?

If you want to continue investigating, here are two other things you can try. (1) Does changing the liquid affect how much the diaper can absorb? Make a salt solution by adding 1/4 cup of salt to 1 quart of water. Retry your experiment to see how much salt water your diaper will absorb and compare the results to your original experiment. (2) Compare different brands of diapers to see if one brand holds more water. In an experiment you should only change one thing at a time so that you can evaluate the effect of that change.

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

The hydrogel in a baby diaper is sodium polyacrylate. This hydrogel can absorb 300-1000 times its weight in water and about 30 times its weight in urine. Yep, 1 gram of sodium polyacrylate can absorb up to 1 liter of water!

So how are hydrogels used in nanotechnology? The way a material behaves on the macroscale (objects you can see) is affected by its structure on the nanoscale. The gels can be designed to respond to changes in their environment, such as pH, temperature, or humidity. When the gels get bigger or smaller, they can move tiny structures around them. For example, researchers are using hydrogel "muscles" to move tiny structures. This research is inspired by the way muscles move parts of the human body, such as the tiny hair-like cilia that help sweep away dust from our lungs.

References:

This activity and description was adapted from an activity created by the Nanoscale Informal Science Education (NISE) Network.

Word Search

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

Bucky ball
Diamond
Graphene
Hydrogel
Light emitting diode
Nanometer
Nanoscale
Nanotechnology
Nanotube
Polymer
Properties
Sea spray
Sodium polyacrylate
Sun screen
Surface tension
Transistor

Sunscreens

By Christine H. Jaworek-Lopes and David Sittenfeld

"Remember to put on your sunscreen before you go outside today." You might hear this same advice every morning before you head out the door. So, why is it important to wear sunscreen? Exposing the skin to too much sunlight may damage your skin.

What is sunlight, anyway? The sun sends out, or emits, many different types of radiation. We see the visible light emitted by the sun and we *feel* the infrared radiation emitted by the sun as heat. The sun also emits ultraviolet (UV) rays, which can burn our skin and cause wrinkles. There are three types of UV rays: UV-A, UV-B, and UV-C. The ozone layer that surrounds the earth blocks the most harmful of these, UV-C rays, before they reach our skin. But it does not block all of the UV-A and UV-B radiation.

There are many ways to protect our bodies from UV radiation. We can wear hats, long-sleeved shirts, and sunglasses. We can also put on sunscreen, which is a mixture of chemicals that keeps UV radiation from reaching our skin. These chemicals may absorb UV radiation or reflect it.

Different sunscreens protect us from UV radiation in different ways. Some chemicals used in sunscreens, such as oxybenzone or octocrylene, absorb only certain parts of the UV. The companies that make sunscreens combine several chemicals, and together they block out most of the UV rays. These kinds of ingredients are mostly made from carbon-based (organic) materials. These organic chemicals do a great job of covering the skin. But some people find that these kinds of sunscreen ingredients irritate their skin. Other people worry that they could cause other kinds of health problems.

Some sunscreens contain inorganic (not carbon-based) ingredients, such as zinc oxide or titanium dioxide. People have been using these kinds of sunscreens for many years. These chemicals block most of the dangerous UV rays, and don't need to be mixed with other chemicals that can irritate the skin. But they usually look like white paint or toothpaste on the skin. Not everyone likes the way this looks, so people don't always use enough sunscreen to protect themselves.

To make sunscreen that blocks out most of the UV but goes on clear, scientists have started making sunscreens with very tiny particles of titanium dioxide. These "nanoparticles" can be one thousand times smaller in diameter than a human hair! The smaller particles don't scatter light the same way, so they don't look white. Plus, they cover the skin better! Even so, some people worry that absorbing or breathing in such small particles might be dangerous.

Nano-sunscreens are available in many stores, and people are using them. What do you think could be the biggest problems with using sunscreens made of nano-particles?

References

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3. Karukstis, K. K.; Van Hecke, G. R. Chemistry Connections: *The Chemical Basis of Everyday Phenomena*; Harcourt Academic Press:Boston, 2000.
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Safe in the Sun

In addition to the rays of light that we can see, sunlight also has ultraviolet, or UV, rays. These UV rays harm our skin. If we stay in the sun too long without sunscreen or protective clothing, the UV rays will cause sunburn, or even worse, may lead to skin cancer. In this activity, you will use a special plastic card that has been painted with a chemical that changes color when it is in UV light. The more UV rays there are, the darker the painted portion on the card will turn.

Materials:

- **PULS card (or other UV indicator card), or uv detector beads**
- **Letter-size envelope**
- **Zip-closing bag (snack size)**
- **Watch with second hand**
- **Clear spray-on sunscreen (SPF 30 or greater)**
- **Paper towel**

Procedures:

1. Before going outside, place the PULS card inside an envelope to keep it out of the sunlight.
2. Find a sunny spot where the card can be placed in the sunlight. Be careful to avoid shadows from buildings or trees.
3. Using terms like "partly cloudy", "raining", or "sunny" describe the weather in the "What Did You Observe?" section.
4. Remove the PULS card from the envelope and place it in a zip-closing bag.
5. Hold the bag with the card (face up) in the sun for 20 seconds.

SAFETY!

- ☑ ***Safety glasses required***
- ☑ ***Caution hot liquids***
- ☑ ***No food or drink in the area where you are doing this activity***
- ☑ ***Thoroughly wash hands after this activity***
- ☑ ***Do not spray sunscreen in a drafty area***

6. Look closely at the color-changing portion of the card and compare it with the "Level of Sun Exposure" section. Pick the block color from the scale that most closely matches the color-changing portion of the card. Read the word below the color block (minimum, low, moderate, high or critical), and record it in the "What Did You Observe?" section.
7. Take the card out of the plastic and place it back into the envelope so that it is out of the sunlight for at least 3 minutes.
8. While you are waiting, spray the outside of the zip-closing bag with sunscreen. Be careful to make an even coating. If the sunscreen does not spray on clear, you will need to spray it on and wipe away the excess with a paper towel.
9. Write the SPF rating for the sunscreen in the "What Did You Observe?" section.
10. After three minutes have passed, open the zip-closing bag, and place the PULS card inside.
11. Repeat steps 5 and 6 recording your results in the "What Did You Observe?" section.
12. Throw the plastic bag in the trash, but keep the card and the sunscreen for future use. Thoroughly clean your work area and wash your hands.

What did you see?

Describe the weather (partly cloudy, sunny, raining?). SPF of sunscreen _____

	Reading on PULS Card
PULS Card in bag	
PULS Card in bag with sunscreen	

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

Sunscreens protect our skin from harmful UV rays. We can have some idea of how well they will work based on the SPF number indicated on the bottle. The higher the SPF, or Sun Protection Factor, the stronger the sunscreen. The American Academy of Dermatology recommends that everyone use sunscreen with SPF 15 or higher whenever working or playing outside.

Try this...

Try the activity again on a different day when the weather is different, or try a sunscreen with a different SPF number.

25 Years of NCW

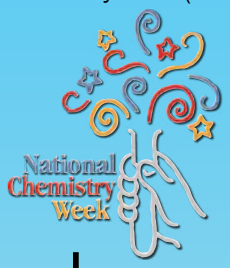
By Michael McGinnis

In 1986, then-ACS President George Pimentel had a big idea: to organize a national event celebrating the impact that chemistry has on our everyday lives. He then led the planning of the first National Chemistry Day, which took place on November 6, 1987. This "bold and exciting undertaking" by Dr. Pimentel soon evolved into an annual event, National Chemistry Week (NCW), which celebrates its 25th year in 2012. Officially introduced in 1989, NCW continues to be the leading outreach event for ACS. NCW encourages thousands of ACS and non-ACS members alike to share the amazing story of chemistry in everyday life with the public, especially primary and secondary school children. By planning and conducting hands-on activities and demonstrations, NCW participants have inspired a passion for celebrating chemistry now … and for generations to follow.

1986: Dr. George Pimentel (then-President of ACS) declares that during his time as president, his principal mission will be to enhance public understanding of the basic and applied chemical sciences.

November 6, 1987: The country celebrates its first National Chemistry Day. Dr. Pimentel urges chemists everywhere to hold a nationwide "open house" involving all chemistry facilities, in industry as well as education.

1989: National Chemistry Day expands to become National Chemistry Week (NCW).



1993: NCW becomes an annual event.

1997: NCW's 10th anniversary features its first unified theme ("Planet Chemistry") and also produces its first publication as a supplement to *WonderScience* magazine.

1999: NCW becomes a part of the International Celebration of Chemistry.

2002: NCW's 15th anniversary. NCW moves to the fourth week in October with the theme, "Chemistry Keeps Us Clean."

2007: NCW's 20th anniversary introduces the theme, "The Many Faces of Chemistry."

2011: NCW explores the theme, "Chemistry: Our Health, Our Future!" and also joins in the celebration of the International Year of Chemistry.

2012: NCW's 25th anniversary kicks off with the theme, "Nanotechnology: The Smallest BIG idea in Science."

Does Size Make a Difference?

By Lynn Hogue

Today, we are at the beginning of a new age of technology that will change our lives. Nanotechnology uses very small particles to make new products. New nanomaterials are changing sports equipment and clothing, medicine, and how we produce energy. The reason is that they have properties that are very different from ordinary materials.

In this activity you will learn about how materials and also physical forces behave differently when things get very, very, small. Throw a baseball in the air and you can predict what will happen – it will fall to the ground due to gravity. The diameter of a baseball is about 73 millimeters. What if that baseball were only 73 *nanometers* in diameter? Would it behave differently? Would gravity be the only force influencing the ball? We are going to explore this idea… but instead of baseballs, we are going to water drops.

Materials:

- **A canning jar (pint or quart)**
- **Ring part of the lid for the jar**
- **A Styrofoam plate**
- **A ruler**
- **A sharp pencil**
- **Scissors**
- **A pail (optional)**

SAFETY!

- ☑ ***Safety glasses required***
- ☑ ***Only use room-temperature water***
- ☑ ***Do not drink any of the water used in this activity***

Procedures:

1. Trace the opening of the jar with your pencil on the Styrofoam plate and cut it out.
2. Fill your canning jar with water.
3. Place your Styrofoam circle into the ring lid and screw it onto your jar.
4. Poke a small hole into the center of your Styrofoam circle with your pencil point. Measure and record the diameter of the hole in your data table.
5. Working over a sink or pail, place your finger over the hole and turn the jar upside down. Ask your adult lab partner for help if you need it. Keep the upside-down jar straight up and down, and hold it steady. Slide your finger off of the hole. Water should not come out of the hole.
6. Turn your jar upright. Make the hole bigger by pushing your pencil a little farther into the hole and repeat the procedure. Record your observation. Record the diameter of the hole and your observations.
7. Keep increasing the size of the hole with your pencil and repeating the procedure until the water comes spilling out. Record all diameter measurements in your data table.

What did you see?

Data Table		
Trials	**Diameter of hole**	**Observation**
1		
2		
3		
4		

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

Water molecules have strong attractions for each other. Water molecules at the surface are being pulled down toward the other water molecules below them and form a kind of "skin." Water bugs use this property of water to skate across the surface of ponds without sinking. Scientists call this **surface tension**, and it enables water at times to defy gravity. During this experiment, you discovered that there is a limit to the effect of surface tension. The size of the hole makes a difference. Surface tension holds the water in the jar until the hole gets too big. Experiments have shown that the hole can be almost 1.3 cm in diameter before the water falls out.

In nanotechnology, the size of the particles changes things. When materials are built from nano-sized particles, their properties change — which means new and better products and medicines can be made. Carbon nanotubes are strong and conduct heat and electricity better than any metal. They can be used for protective body armor for police and soldiers or to make smaller electronic devices. Nano-balls, hollow soccer ball-shaped particles, can be used to deliver medicine or trap harmful agents in your body.

References:

Chemistry with Charisma, vol. 2, Sarquis, Arlyne, Hogue, Lynn, Terrific Science Press, Middletown, OH, 2010.

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 164,000 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 **outreach@acs.org**!

ACS Chemistry for Life®

Words to Know

1. Buckyball – a nickname for a form of carbon that is a soccer ball-shaped molecule containing at least 60 carbon atoms. It is incredibly strong, yet amazingly light.

2. Fullerene – a category of carbon molecules that are hollow spheres or tubes. Buckyballs and nanotubes are in this category.

3. Graphite – a form of carbon in which atoms bond to form flat sheets. It looks metallic, feels greasy, and conducts electricity. Graphite is actually the "lead" in pencils.

4. Hydrogel – a highly-absorbent polymer gel where water is the dispersion medium. Hydrogel is used in soft contact lenses and wound care.

5. Nanometer – one-billionth of a meter.

6. Nanotube – a hollow, cylinder-shaped molecule of carbon 1-3 nanometers in diameter, and 100 times stronger than steel … but only one-sixth the weight.

7. Polymer – a natural or synthetic chemical compound or mixture of compounds and consisting essentially of repeating structural units.

8. Sun Protection Factor (SPF) – a number from 1 to 90 that represents the number of minutes required for unprotected skin to become damaged by harmful sun rays.

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