

Special Report: *Physics is going nuclear this issue, see how inside*



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HEADLINE DISCOVERIES

Jan/Feb 2012; Issue 1

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**SECRETS TO THE
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ABOUT THE COVER:

The Bohr Model of the atom, which depicts electrons in planet-like orbits around a nucleus, was representative of atomic theory before the advent of quantum mechanics.

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Maximum Capacity: 4 microplates or 2 micro-tube racks



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| Standard 1000 Orbital Shaker | S98867 | 1005.00 |
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TALBOYS
By TROEMNER

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| Aura 30 Ductless Classroom Demonstration Workstation | S01681MF | 8126.00 |
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CAREER SPOTLIGHT: NUCLEAR ENGINEER

By Gwen Myslinski



D-OH!

Though Homer Simpson may portray nuclear engineers as donut-eating slackers, that is certainly not the case. These individuals are “like a cross between a jet pilot and a firefighter: highly trained to keep a technically complex system running, but also prepared to be the first and usually only line of defense in an emergency,” says Michael Friedlander, a nuclear engineer.

According to the American Nuclear Society, “Nuclear engineers harness the power of the atom to benefit humankind.” In other words, they are able to extract natural bursts of energy from disintegrating atoms and find many beneficial ways to use them, including:

- Harnessing electric power through nuclear plants
- Applying radiation to diagnose and treat disease
- Using radiation to produce and reserve food supplies
- Reducing environmental pollutions from fossil fuels through nuclear energy systems
- Powering satellites and deep space probes

CAREERS

Students who are interested in pursuing a career in nuclear engineering must have a strong background in science and math. To enter the field, an individual must earn a bachelor’s degree in engineering, while some positions may require a master’s degree. But the training doesn’t end there; it is critical that engineers continue their education to keep up with the ever-changing technological advancements.

According to the U.S. Bureau of Labor and Statistics, starting salaries are among the highest of all college graduates, averaging \$65,000 and up. For the moderately experienced nuclear engineer, the mean salary is slightly over \$100,000, annually.

JOB OUTLOOK

Job opportunities for nuclear engineers do not look bleak; in fact, the U.S. Bureau of Labor and Statistics expects an 11% employment growth over the next decade. Many of those jobs will be in research and development, defense-related areas, nuclear power as an energy source, nuclear medical technology, as well as improving and enforcing waste management and safety standards.

Having more than 100 nuclear power plants throughout the U.S., California, Virginia, Pennsylvania, Tennessee and Washington sport the highest published employment opportunities, concentration of jobs and wages for this position, according to the U.S. Bureau of Labor and Statistics.

Learn more about our career spotlights at www.fisheredu.com/STEM.

CLASSROOM DISCUSSION

- What kind of regulations would a nuclear engineer working in a power plant need to be aware of and follow?
- What are some of the different types of jobs that a nuclear engineer can find in fission power, medical and health physics, plasma science, radiation detection and nuclear materials?

STEM ADVANTAGE: K’NEX LEADS TO A BETTER AMERICA

By Robert Marshall

Did you know the future development of this nation depends on you? OK, not solely you, but innovation, cognitive engineering solutions and an aptitude for science is the responsibility of you, me and everyone, which is why the government created the federal STEM (science, technology, engineering and math) initiative.

The United States population is continually threatened by scientific illiteracy. Roads, transportation systems, waterways and electrical grids lack the support of their current continued use. Furthermore, world statistics report that the U.S. is lacking in the development of technologies that drive the future of the economy. How can you be a part of the solution to these issues? Participate in STEM education and programming.

THE CHALLENGE

I am an amateur astronomer, museum educator and science workshop guru traveling the country for Fisher Science Education delivering STEM workshops. Recently, I had the distinct opportunity to participate in a unique STEM competition in my own city: the Pittsburgh K’Nex Challenge which is organized and hosted by the Allegheny Intermediate Unit. If you are not familiar with the educational building material K’Nex, think of lanky Lego® pieces that snap together via angled joints. The purpose of the K’Nex Challenge is to provide an opportunity each year for teams of area middle school students to solve an engineering problem using both a creative and realistic process.

STEM is all about preparing the future workforce of America. This year they are asked to build a bridge. But not just any bridge. To get these kids designing, they are asked to span a four-foot gap while only using one support column. In addition, they are required to incorporate a motor into the bridge system for any reason they choose: lift section, draw the bridge, pull a vehicle across, whatever the team decides. After construction, teams are not judged simply on completing the task, but on creativity as well.

For a young engineer it may sound like a fun time. And that is the purpose – to allow students to engage in the learning process while having fun. America has a responsibility to invest in its future engineers. The K’Nex Challenge is a STEM program that is moving in the right direction.



CLASSROOM DISCUSSION

- Discuss other important issues we face in the future that may require STEM education
- Brainstorm challenges or competitions you want to see your school participate in that will excite students to fill STEM career fields

FUEL OF THE FUTURE?

By Alida Cataldo



We all know that magnets have North and South poles ... or do they? Researchers in England recently found a way to (sort of) separate magnetic poles. They then discovered that these “monopoles” transmit magnetic currents, creating a new thing called magnetricity — a combination of the words magnet and electricity.

Electric monopoles are everywhere, but a true magnetic monopole has yet to be discovered. Even if you cut a magnet down to its protons, neutrons, electrons or even quarks, the tiny magnets that are left still have North and South poles.

HOW THEY DID IT

Physicists, especially those who today hold to the string theory, have believed for centuries that magnetic monopoles exist. The latest experiment may have brought them closer to discovery.

Scientists were able to produce a magnetic current in “spin ice” — a collection of pyramid-shaped molecules with four sides. A magnetic field pulsed to the spin ice caused some of the molecules to flip, and when one molecule flips, others do, too. Flipping creates “phantom” North and South poles that move around freely. “Eventually they get so far apart that they lose all memory of each other,” says Steven Bramwell of the University College of London. “The dipole splits in half and becomes two monopoles.”

Flipping carries the molecules from pyramid to pyramid, resulting in a chainreaction of magnetic current similar to electricity traveling through wires.

WHY MONOPOLES MATTER

If magnetic monopoles do exist, and if science can get them to produce enough magnetricity to work like — or instead of — electricity, the world will have a new source of clean energy. Joseph Polchinski of the Kavli Institute of Theoretical Physics declared that the existence of magnetic monopoles is “one of the safest bets that one can make about physics not yet seen.” But he qualified that statement by saying, “... we must continue to hope that we will be lucky, or unexpectedly clever, some day.”

So, if we're lucky — or clever — magnetricity may someday power our cars, appliances, computers and other “magnetronic” devices.

CLASSROOM DISCUSSION

- If a true magnetic monopole is discovered, how can it be used?
- Scientists often believe that something exists but can't prove it right away. What are other examples of recent discoveries?

THE BRAIN: YOUR CONTROL CENTER

By Alida Cataldo

That wrinkled gray matter in your head is what makes you speak, see, hear, taste, smell, move and feel things. If not for your brain, you couldn't blink, breathe, think or learn. Your heart couldn't beat. Your brain controls everything you do all the time; and it never stops, even when you sleep.

THE NEED FOR SPEED

Brains receive electrical and chemical signals from tiny cells called neurons that travel on tiny highways throughout the body at more than 150 miles per hour. Neurons that control movements transmit information even faster: more than 220 miles per hour! There's enough electricity in a person's brain to light a light bulb, and all of the telephones in the world don't transmit as many messages as a human's neurons do!

WHAT IS THAT “GRAY MATTER?”

Every brain is made up of mostly water, 77-78% in fact, so drink up! It also contains about 100 billion neurons, weighs about three pounds and is about the size of a cantaloupe. That “cantaloupe” is divided in two: the left side controls the right side of your body and vice-versa.



No other animal has a brain as complex as a human's. But there are bigger brains: the sperm whale's brain weighs about 78.2 lbs. And the smallest brain — weighing in at less than 0.03 oz. — belongs to the green lizard.

CHANGING YOUR BRAIN

No one can trade it in, but anyone can improve brain power by learning and practicing; as a person learns new things, the structure of the brain changes. Remember the first time you tried to ride a two-wheel bike? It didn't work the first few times, but you kept trying, and now you do it well. While you were practicing, your brain and neurons were building new highways to transmit bike-riding information.

Exercise helps improve brain power, too. It makes the body produce a chemical that

makes a person's brain more open to learning. (Remember that when you can't concentrate or solve that math problem.)

CLASSROOM DISCUSSION

- Because your brain controls your entire body, it needs to be well protected. How does it protect itself? How can you protect it?
- When you learn, your brain changes so that it can keep and use that new information. What else can change the structure of your brain?

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|-------------------------------------|----------|-------|
| GeoSafari™ Talking Planetary Mat | S04114 | 59.95 |
| Far Out!™ Solar System Mapping Tool | S04123 | 15.95 |



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| LED MicroMax™ Pocket Microscope | S90217A | 19.00 |



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| 10mL; Green | S90142B | 25.75 |
| 25mL; Red | S90142C | 34.50 |



USING DNA TO BUILD NANOMATERIALS

By Lisa Paitz Spindler

Nature is full of patterns, from the crystalline lattices of diamonds and silicon salt to the symmetry of the DNA double-helix and the concentric circles of tree rings. Scientists at Northwestern University are now using Mother Nature's lattice structure to build complex nanoparticles with applications for medicine, energy generation and electronics.

A team of scientists led by Professor Chad A. Mirkin is substituting nanoparticles for atoms and DNA for bonds, to create atomic lattice structures in patterns that mimic arrangements found in nature. "We are building a new periodic table of sorts," said Mirkin. "Using these new design rules and nanoparticles as 'artificial atoms,' we have developed modes of controlled crystallization that are, in many respects, more powerful than the way nature and chemists make crystalline materials from atoms."

A CURE FOR CANCER?

One of the most exciting potential uses for these structures is targeting cancer cells at a genetic level, without damaging healthy cells. Mirkin's DNA-laced gold nanostructures could potentially latch on to cancer cells and block the production of proteins that keep such cells from dying. The particles essentially make cancer cells mortal.

While the Northwestern team's project concentrated on gold nanoparticles, this method could also be used with a range of substances. The team is now working on a way for the lattice structures to self-replicate, similar to how biologists use the polymerase chain reaction (PCR) to amplify a single strand of DNA and generate millions of copies. PCR has been used to analyze minute strands of ancient DNA and also to diagnose early-stage leukemia. With a PCR model of nanostructure replication, Mirkin hopes to one day develop software that will enable scientists to choose numerous particle-DNA pairs and build almost any structure ... on demand.



CLASSROOM DISCUSSION

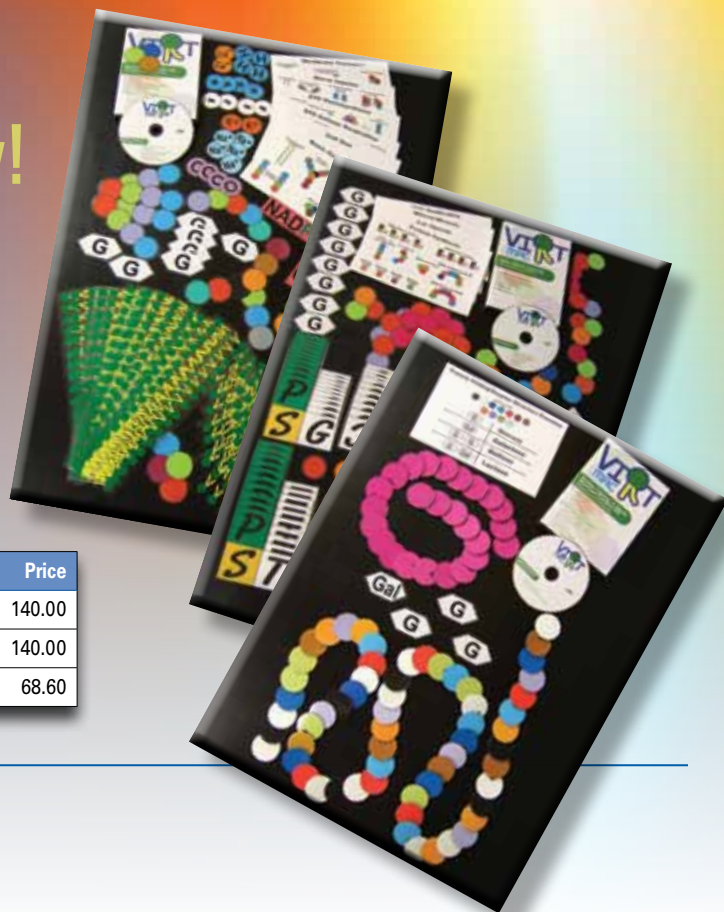
- What are some other examples of structure and symmetry in nature?
- What are some other applications of nanomaterials in other fields, e.g., construction?

VIRTmac will transform the way you teach Biology!

IF YOU BUILD IT, THEY WILL LEARN!

A series of magnetic models demonstrates how the same molecules are used over and over again in different biological processes, giving students a more complete visual picture of cell biology. Students will see the reaction and/or process right before their eyes!

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| Membrane/Protein Kit | S02148 | 140.00 |
| DNA/RNA Protein Kit | S02149 | 140.00 |
| Protein Folding/Enzyme Structure Function Kit | S02150 | 68.60 |



THE KEY TO THE FOUNTAIN OF YOUTH?

By Christina Phillis

People have been trying to fight the aging process for centuries. Ancient Egyptians are thought to have created their own anti-aging elixirs and spells. Now researchers at the University of Gothenburg have identified an enzyme that may bring the world one step closer to the fountain of youth.

Using yeast cells as a model, the researchers discovered that the active enzyme peroxiredoxin (Prx1) breaks down harmful hydrogen peroxide in the cells. Inactivation of Prx1 is what leads to aging and its corresponding diseases such as genetic defects, cancer and possibly Alzheimer's. This can be counteracted by production of the enzyme sulfiredoxin (Srx1), which repairs Prx1.

Previous studies show that monkeys using a calorie-restricted diet can increase their life span by producing more of the enzyme Srx1.

FURTHER STUDY

There are many studies that demonstrate the life-preserving properties of a calorie-restricted diet, but extensive research is still lacking in humans.

The diet received positive affirmation after a fluke of Bio-Dome proportions proved its legitimacy. In 1991, scientists participating in Biosphere 2 had to resort to calorie restriction after realizing they didn't have a sufficient amount of food to last

the duration of their two-year experiment. Upon exiting the bubble, tests proved that the scientists were healthier in regard to nutrition than when they entered.

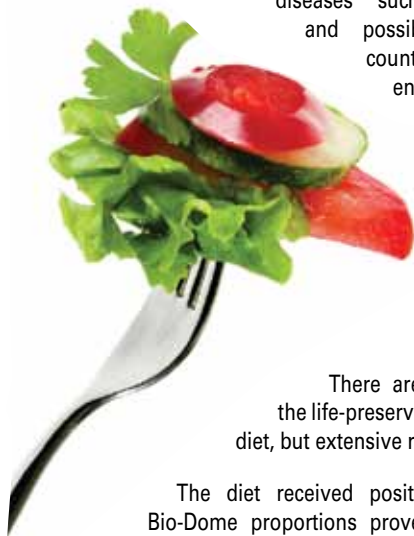
Calerie, a study examining the long-term effects of calorie restriction in humans, has been underway for four years now. The last enrollees will be wrapping up their two years as of February 2012.

Although the verdict is still out, people have already decided to devote their lives to calorie restriction.

Skepticism still exists though. One criticism is that the diet is extremely challenging to maintain. Some scientists feel the complete side effects are unknown.

According to University of Gothenburg researchers, calorie restriction is not a necessary element for reducing age. It can be achieved by increasing Srx1 in the cell alone.

Further study will be required to determine which method can best lead to a life of eternal youth. Until then, we are left to wonder if Ponce de León should have simply changed his diet instead of traveling thousands of miles by sea.



CLASSROOM DISCUSSION

- Do you think calorie restriction will ever become a way of life for the majority of people?
- Discuss both the positive and negative aspects of people living longer and without sickness.

Finally, a PCR machine at an affordable price!

The EdvoCycler™ is a standalone classroom PCR machine that is easy to use. The 0.2mL tube block has room for up to 25 student samples and comes pre-programmed with all Edvotek PCR kit protocols. These programs may be modified or deleted, plus there's extra memory for more. The vivid seven-line LCD displays all program parameters simultaneously on a single screen. A heated oil-free lid makes operation a snap. Proudly made in the U.S. and backed by a two-year warranty!

Research supported in part by NIH SBIR NCCR Grant #5R44RR18670.

EdvoCycler Features:

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- Maximum Ramp Rate: 3°C/sec.
- Dimensions: 16 x 8.5 x 7"

| Description | Cat. No. | Price |
|-------------|----------|---------|
| EdvoCycler | S68640 | 1875.00 |



GLOW, CAT, GLOW!

By Sara Nedley



Big cats and little cats. Black cats and white cats. Fluorescent cats and FIV-resistant cats? Although this might seem out of place, fluorescent cats might be the key to advancing FIV (feline immunodeficiency virus) and HIV (human immunodeficiency virus) research. Scientists have recently developed cats that have the ability to glow in the dark in order to further study FIV.

A WORLDWIDE PANDEMIC

Millions of cats suffer and die from FIV/AIDS each year and HIV/AIDS has surged to pandemic proportions, having infected some 60 million people worldwide, resulting in more than 25 million deaths. FIV and HIV both cause AIDS (acquired immunodeficiency syndrome) by depleting infection-fighting T-cells.

It is understood that part of developing immunizations, as well as cures for the viruses, involves mimicking the evolution of different versions of protective proteins known as restriction factors. Current research has developed a method that utilizes monkey proteins already known to block FIV. To impart the protein to cats, a monkey gene is inserted into feline eggs before fertilization. To make it easier to check which cells have the monkey gene, the team also inserts a green fluorescent protein gene from the jellyfish to make them glow green. It is the kittens' ability to fluoresce that enables the scientists to know if the monkey restriction factor genes are present.

ENCOURAGING RESULTS

This method works so well that nearly all offspring from the modified eggs have been found to have the restriction factor genes. And these defense proteins are made throughout the cat's body. Two of the three original fluorescent cats have produced litters that make glowing cells as well. Also, when researchers tried to infect blood cells from the genetically modified kittens with FIV, the virus did not replicate well. Researcher's next plan is to test whether the cats are resistant to FIV. If the new cats are immune to FIV, the scientists hope to better understand how proteins can be used to prevent HIV infection.

Although fluorescent cats may not be the type of thing that is described in children's storybooks, perhaps they should be. They could possibly be the key to advancing FIV research, as well as HIV research for humans. Put those together and it could make for a very happy ending for felines and humans alike.

CLASSROOM DISCUSSION

- What is the difference between fluorescence and phosphorescence?
- What is the main function of a T-cell? What type of T-cell does FIV and HIV affect?

Altay Scientific Frog Model

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Skull

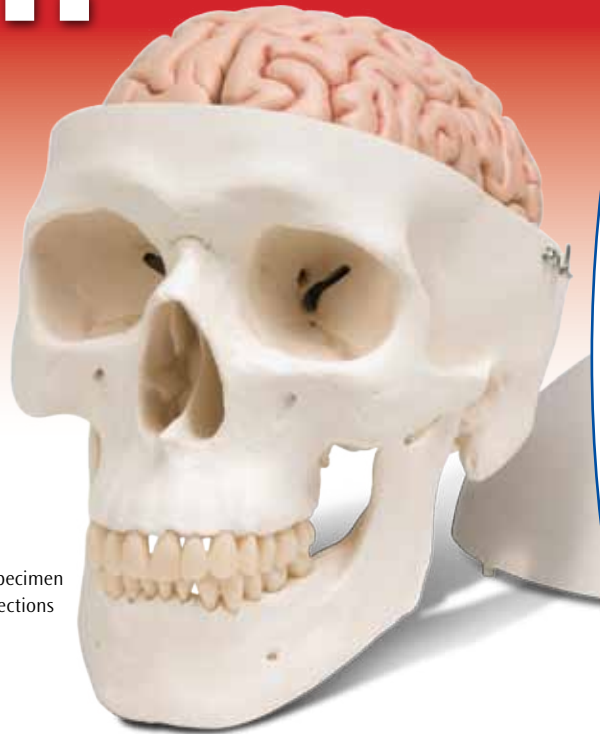
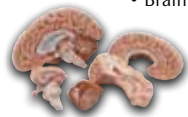
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- Left frontal, parietal, temporal and occipital lobe
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3B Scientific

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THE DOLPHIN'S SIXTH SENSE

By Ashley Peterson

If you look closely at the snout of a dolphin, you'll notice two rows of tiny pits. At some point in the dolphin's evolutionary past, these pits, known as vibrissal crypts, housed whiskers, and it has long been thought that these crypts no longer served a purpose — until now. In at least one species of dolphin, the Guiana dolphin, they can sense electricity.

All living organisms generate tiny yet measurable electric fields. Researchers in Germany have recently discovered that the Guiana dolphin uses its vibrissal crypts to detect changes in the electric fields in order to find food. While this fascinating capability, known as electroreception, is fairly common among fish, only a small number of mammals are able to locate their prey in this way. Until recently, the exclusive list included only the four species of echidna (spiny anteaters) and the duck-billed platypus.

To test their idea, the German researchers worked with Paco, a Guiana dolphin living in captivity. They taught Paco to swim next to a device that could create a tiny electric field. Then the team taught Paco to swim away from the device if he detected any changes in the electric field. The scientists determined that Paco was able to detect the tiny electric variations, except when his snout was covered in plastic. After conducting 186 trials of the experiment, their theory was confirmed that the dolphin uses its vibrissal crypts to detect the electric fields created by its prey.

German biologist Wolfe Hanke led the team that made the sensory discovery. He said, "We were really surprised to find this in the dolphin. Nobody had expected it."

While this is a surprising new discovery in the animal world, it makes perfect, practical sense for dolphins to evolve in this way. Visibility is often drastically reduced in the murky waters these mammals call home, and the ability to electrically sense their dinner may make all the difference when it comes to survival. Nevertheless, the study opens an exciting door to researchers who have a whole new sensory system to explore and further emphasizes that the animal kingdom will continue to surprise us.



CLASSROOM DISCUSSION

- Can you name any other animals that possess a sixth sense?
- How can humans benefit from studying the evolution and behavior of animals?

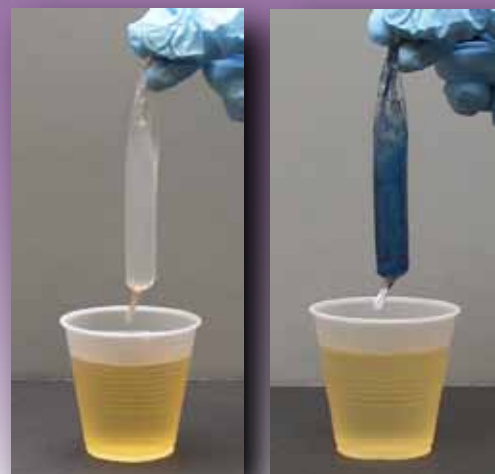
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by Aldon Corporation

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| Osmosis and Diffusion Lab Activity | S98658A | 52.55 |



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Learn more about the new SPECTRONIC 200 at www.thermoscientific.com/spectronic200.

Thermo
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THE SAME, BUT DIFFERENT

By Gwen Myslinski

Sapphires, emeralds, rubies and diamonds — all gemstones that usually form below the Earth's surface where they stay, patiently waiting to be discovered and potentially cut and polished for a stunning piece of jewelry.

Jewelers no longer have to wait for miners to unearth the precious or semi-precious gems to create spectacular pieces. Now they can turn to scientists for exquisite gems that have the same appearance and chemical structure as the natural ones, but can be produced in months or even days. Yes, there are a few small differences, according to James Shigley, a geologist at the Gemological Institute of America in Carlsbad, California:

- Natural gems contain small amounts of water, where lab-grown gems do not
- Certain lab-grown gems could hold traces of platinum that a natural gem would not have
- Oftentimes natural gemstones will have more inclusions than the lab-grown counterparts because the scientists can control the growth conditions

EXTRAORDINARILY ORDINARY

Lab-made gems aren't just for glitz and glam. They have many extraordinary uses, or really, ordinary uses. Who would have thought that a local supermarket could use a lab-grown sapphire in the check-out scanner? When the cashier scans the product, the laser shines through the hard and scratch-resistant sapphire plate. Talk about a blue-plate special.

Create a laser beam with lab-made rubies? Yep, and these lasers will even help remove certain colors of tattoo dye in a person's skin. (**Note:** Do not try this at

home.) Place a ruby rod in between two mirrors and flash an extremely intense light at the rod. The ruby will shoot out a beam of red light.

The most useful lab-grown gem is the diamond because it is so hard. It has been used to cut rock and drill for oil; it's even been added to the tips of some dentists' drills to help remove tooth particles. Now John Carlisle, a physicist and chief technical officer at Advanced Diamond Technologies Inc. is looking to take its usefulness even further by replacing a cell phone's acoustic filter with a diamond filter so the battery will last longer.

"These diamonds could also be used in devices that help blind people see, in radar equipment for the military and in advanced computers for sending secret information that can't be decoded. There's just 101 uses for it," said Carlisle.



CLASSROOM DISCUSSION

- What one element and how many atoms of that element make up a diamond?
- What is the cost difference between lab-grown and mined gemstones?

GROWING PLASTIC

By Michele Cervi



It takes an estimated 200,000 barrels of oil a day to produce the conventional plastic containers used for food and consumer goods in the United States. While some of these plastics are recycled, large amounts of them wind up in landfills, where the polymers that give plastics their durability prevent the items from naturally breaking down. Plastic shopping bags create about 300,000 tons of landfill waste each year.

As disposal sites continue to fill up and the supply of petroleum they are derived from shrinks, bioplastics are emerging as a viable alternative. The building blocks for your next take-out container just might be growing in a cornfield in Iowa or the lush sugar cane farms of Brazil.

More and more packaging materials are being manufactured from plant-based plastics, with corn and sugarcane leading the pack of eco-friendly starting points. Chemists are converting sugars from sugarcane into polyethylene terephthalate plastic, which can be used in the manufacture of clear plastics most commonly used for beverage bottles. Corn can be soaked, ground and combined with enzymes to produce dextrose. This simple sugar is then fermented into lactic acid in a process similar to the way beer is produced. The lactide molecules then form polymer chains that can be used as the basis for bioplastics.

While bioplastics offer some obvious advantages, such as a renewable source, they also present some challenges. Bioplastics generally have a lower melting point than their traditional counterparts and although they contain biodegradable components, some can contaminate recycling efforts if intermingled with conventional plastics.

COLAS AND KETCHUP GOING GREEN

CLASSROOM DISCUSSION

- Bioplastics must still be manufactured. What are the environmental costs?
- What are the best uses for bioplastics? When might bioplastics not be the best option?
- Would you be more or less likely to buy a product made from bioplastics? Why?

Some of America's most popular brands are experimenting with bioplastic packaging. The Coca-Cola Company and Heinz have introduced the PlantBottle, which they use in beverage bottles and squeezable ketchup containers. Up to 30% of the PlantBottle is derived from plant-based material and it can be recycled. During 2011, PepsiCo announced it had found a way to create a bottle entirely made from plant waste.



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NOTABLE DATES IN PHYSICS HISTORY:

January



- **January 3** – William Wilson Morgan was born in 1906; he was an American astronomer who provided the first evidence that the Milky Way Galaxy has spiral arms



- **January 7** – Nicola Tesla died in 1943; he was a Serbian-American inventor and researcher who designed and built the first alternating current induction motor in 1883



- **January 8** – In 1935, the first U.S. patent for a spectrophotometer was issued to Professor Arthur Cobb Hardy of Wellesley, Massachusetts



- **January 16** – In 1967, Robert J. Van de Graaff, U.S. nuclear physicist and designer of the Van de Graaff generator, died at the age of 65



- **January 22** – French mathematician and physicist André-Marie Ampère was born in 1775; Ampère founded and named the science of electrodynamics, now known as electromagnetism

February



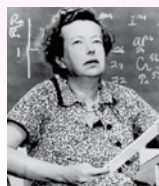
- **February 5** – Robert Hofstadter, U.S. atomic physicist, was born in 1915. He coined the term “Fermi” (unit) in honor of the Italian physicist Enrico Fermi



- **February 13** – In 2004, the Harvard-Smithsonian Center for Astrophysics discovers the universe’s largest known diamond, white dwarf star BPM 37093



- **February 15** – Sometimes referred to as the “father of modern physics,” Galileo Galilei was born in Pisa, Italy in 1564



- **February 20** – Maria Goeppert-Mayer died in 1972; she was a German-born American theoretical physicist and the second female Nobel laureate in physics for proposing the nuclear shell model of the atomic nucleus (The first was Marie Curie)

BLACK HOLES, HOLOGRAMS AND THE NATURE OF REALITY

By Robert Marshall



Most people do not usually stop to think how strange we see and experience the Universe. I can see you and you can see me. Yet our eyes are only sensitive to a very small portion of all light in the Universe. People exist on the surface of a celestial ball that rotates on its axis and revolves around a star. Yet we feel no motion. And the atoms that make up each of our living cells are made up of mostly empty space. Yet we appear to be solid. What is real? The lesson here is our minds are limited in their understanding of the nature of reality.

Recently, astrophysicists made a startling discovery in pursuing the quest to figure out our bizarre Universe. Their findings spawned from an equally bizarre idea pertaining to black holes and matter. Black holes — once only theory — are known to exist at the centers of most galaxies and elsewhere, and are the end of the road for massive stars. After burning all of its nuclear fuel, a star, which is at least eight times the mass of our sun, has potential to not only explode, but leave behind a core so dense that no force can hold it up any longer. The result is an infinite mass whose gravitational pull is so strong, not even light can escape!

For decades it had been believed that matter could be lost forever in the infinite, unobtainable depths of a black hole. To many, this was a concept to argue with. How can matter go from existing to not existing? Today, there is a complicated and very puzzling mathematical solution to this dilemma. After falling in, matter, and the information it carries, might be stored on the surface of the black hole — kind of like a hologram.

And this theory can be taken a step further. If information and matter can be stored on the surface of black holes, then maybe the information and matter in everyday, ordinary lives is stored on the surface of the Universe. Who knows, we might all just be holograms ...

CLASSROOM DISCUSSION

- Why do we not feel the motion of the Earth?
- Mass determines all properties, including the life span, of a star. Research other outcomes for the death of stars

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NOBEL LAUREATES TELL A CHILLY TALE

By Merry Morris

What do you do, as a scientist, when you work so hard, only to uncover something that can't possibly be true?

You swallow hard and repeat the experiment — again and again. Then, when the totally unexpected result turns out to be true ... you win a Nobel Prize!

That was the story with this year's Nobel Prize for Physics, awarded in Stockholm in early October. The recipients were Saul Perlmutter, Brian Schmidt and Adam Riess, who received recognition for their startling 1998 research showing that the universe's expansion was accelerating.

UNBELIEVABLE, BUT TRUE?

Contrary to the longstanding notion that the universe was expanding but at a gradually slowing rate, these scientists found that the reverse was true.

They focused their attention on supernovas, stars that catastrophically collapse. They uncovered alarming data that led to the theory that some force — now called "dark energy," is acting against gravity. Dark energy is speculated to comprise three-quarters of the universe.

According to the faster-and-faster-expansion theory, galaxies will move farther and farther apart, growing colder and darker as they separate. Expanding exponentially, the universe may tear itself apart, resulting in a "big rip."

A BIG CHILL


That chilly end to the universe joins other "big" theories in astrophysics: the "big bang" theory of the expansion of the universe and the "big crunch" theory that the universe will eventually implode and collapse back into itself.

Saul Perlmutter is currently associated with Lawrence Berkeley National Laboratory and the University of California, Berkeley; Brian Schmidt is at the Australian National University; and Adam Riess is at Johns Hopkins University and Space Telescope Science Institute in Baltimore.



CLASSROOM DISCUSSION


- The 2011 Nobel Prize in Physics was awarded for research conducted in 1998. Why do you think there is a long delay between the research results and the prize?
- This research will not produce immediate applications like new products or changes in policy. Why then do you think it's important?



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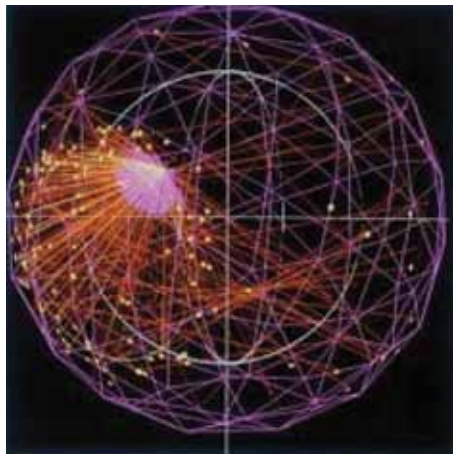
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FASTER THAN THE SPEED OF LIGHT?

By Ashley Peterson



Did you feel that? Billions of neutrinos just zoomed through you. With a neutral charge and nearly zero mass, neutrinos slip through our bodies, all physical structures and the Earth at a constant rate. Neutrinos have long been considered the most mysterious of particles. Now, recent findings suggest that they are also the fastest – so fast that they may disprove Einstein's Theory of Relativity.

NEUTRINOS ... WHAT'S THE BIG DEAL?

Neutrinos are the smallest particles that exist everywhere. They are able to travel through almost any material without slowing or stopping. Some researchers believe that unseen neutrinos may account for the universe's mysterious dark matter or are evidence of extra dimensions. Some study neutrinos in the hope of creating a communication system that could transmit messages without the use of wires or satellites. Others hope that a better understanding of these elusive particles may help locate secret nuclear reactors.

THE EXPERIMENT

In a recent Italian experiment called OPERA, scientists used highly precise GPS equipment to determine that neutrinos travel .0025% faster than light. To put this in perspective, if a neutrino raced a light beam to the moon and back one million times, the neutrino would win by about a minute. Though the difference is seemingly tiny, scientists believe the implications are tremendous. According to Einstein, if a person could send a message faster than the speed of light, "You could send a telegram to the past."

NOT SO FAST ...

While findings from the initial experiments are thrilling to many in the science world and beyond, the results have also created a great deal of scrutiny. There are plenty of potential sources of error that could account for the experiment's astonishing results; even the OPERA researchers are hesitant to celebrate. "My dream would be that another, independent experiment finds the same thing," OPERA spokesperson Dr. Antonio Ereditato told the BBC. "Then I would be relieved." Until the results are corroborated, Einstein remains king ... relatively speaking.

CLASSROOM DISCUSSION

- Discuss the possibilities that would exist if neutrinos actually can move faster than the speed of light
- Imagine the findings that will be made by the next few generations of scientists who are sitting in classrooms right now. If you were a scientist, what would you hope to discover?

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SURPRISING INGREDIENTS OF EARLY GALAXIES

By Lisa Paitz Spindler

Gamma-ray bursts (GRBs) are flashes of electromagnetic radiation observed happening in very distant galaxies. Usually lasting about 30 seconds, these supernovae provide scientists with a glimpse of space millions of years ago. A team of astronomers led by the Max Planck Institute for Extraterrestrial Physics has used a particularly brilliant gamma-ray burst, called GRB 090323, as a probe to study the make-up of faraway galaxies 12 billion years ago, only 1.7 billion years after the Big Bang.

The probe revealed two young galaxies merging, the GRB passing through another neighboring galaxy enabling astronomers to observe both. More importantly, though, scientists also observed higher amounts of heavier metal elements than expected. The amount of heavier chemicals present in galaxies is often used as a measure of its age: the older the galaxy, the more chemical enrichment.

“When we studied the light from this gamma-ray burst we didn’t know what we might find. It was a surprise that the cool gas in these two galaxies in the early Universe proved to have such an unexpected chemical make-up,” explained Sandra Savaglio from the Max-Planck Institute for Extraterrestrial Physics and lead author on the paper describing the phenomenon. “These galaxies have



more heavy elements than have ever been seen in a galaxy so early in the evolution of the Universe. We didn’t expect the Universe to be so mature, so chemically evolved, so early on.”

WINDOW TO A NEW WORLD

Because of dense gas obscuring the area and absorbing some wavelengths of light, the gamma-ray burst lit up an area of space scientists might not have been able to observe otherwise. For such heavy elements to be present in young galaxies, the pair must be forming new stars very quickly. “We were very lucky to observe GRB 090323 when it was still sufficiently bright, so that it was possible to obtain spectacularly detailed observations... Gamma-ray bursts only stay bright for a very short time and getting good quality data is very hard,” said Savaglio.

CLASSROOM DISCUSSION

- One of the telescopes used to observe this GRB was the Very Large Telescope (VLT) in northern Chile. What are some other telescopes that astronomers use to observe galactic phenomena?
- Gamma rays are one type of light wavelength. What are some other wavelengths of light?

SCIENCE EXPOSES MUMMIES’ SECRETS

By Patricia Rogler

Mummies, preserved bodies usually encased in wrappings, have long been a mystery to scientists. Although mummies contain important scientific information, until now, it has been impossible to probe their secrets without destroying these ancient relics. Thanks to the development of new scientific technology, like CT scans and endoscopes, scientists are finally uncovering the secrets held within the mummies and their wrappings.

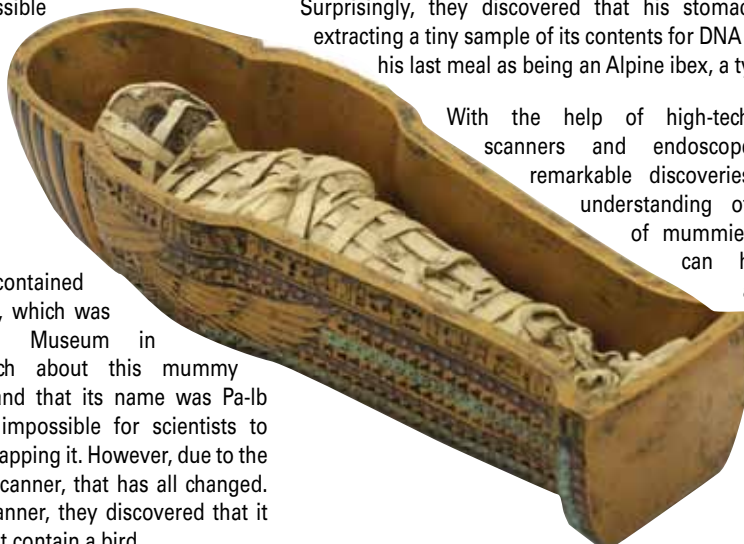
THE MYSTERIOUS PA-LB

Legend has it that the mummy of a bird is contained inside a 4,000-year-old Egyptian human mummy, which was part of the collection at the Barnum Museum in Bridgeport, Connecticut. No one knew much about this mummy other than that it was believed to be a man, and that its name was Pa-lb (pronounced pie eeb). For years it had been impossible for scientists to discover the truth about this mummy without unwrapping it. However, due to the invention of the computerized tomography (CT) scanner, that has all changed. When scientists put the mummy through this scanner, they discovered that it was, in fact, the mummy of a woman, and it did not contain a bird.

ÖTZI’S FINAL MEAL

One of the oldest mummies in the world, Ötzi, was discovered in the Italian Alps. His corpse was naturally mummified about 5,000 years ago by snow and ice. Scientists wanted to examine the contents of his stomach but could not find it. Recently, they were able to put the mummy through a CT scanner and were

able to locate the stomach, which was found in his upper torso. The scientists believe it had slipped upwards because he was found lying over a rock. Surprisingly, they discovered that his stomach was completely full. After extracting a tiny sample of its contents for DNA testing, the scientists identified his last meal as being an Alpine ibex, a type of mountain goat.



With the help of high-tech lab equipment, like CT scanners and endoscopes, scientists are making remarkable discoveries that have broadened our understanding of ancient life. The analysis of mummies using this new equipment can help us know what our ancestors ate, how they lived and what they valued. There are still more mysteries to unlock, but scientists are taking the first steps to exposing the mummies’ secrets.

CLASSROOM DISCUSSION

- In what ways can discovering more about mummies help our understanding of ancient life?
- What is the difference between a naturally mummified and an artificially mummified corpse, and what valuable information can each offer to science?



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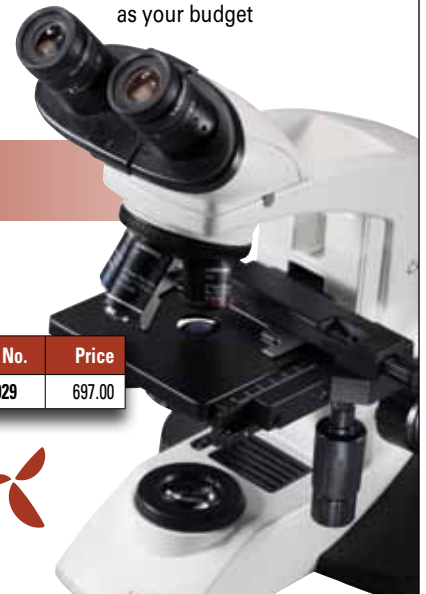
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THE GREAT SMARTPHONE DEBATE

By Sarah McGann

In today's smartphone market, consumers have a wide range of devices from which to choose. Apple®, Google®, Microsoft® and RIM® have all created operating systems for smartphones as diverse as the needs of the people buying them, and it can be a challenge for customers to know what phone is right for them. Rumors regarding each system don't help, as supporters and opponents of each system battle it out online and in the news with oft-exaggerated claims. In order to help you get the right information, the following are some basic facts about the three most common smartphone operating systems.



BEGINNER FRIENDLY: Apple's iPhone™ iOS takes the cake on this one, as it is a highly polished and extremely user-friendly phone. Google's Android™ is less beginner-friendly due to its highly customizable interface and the complexity of its still relatively new operating system. RIM's Blackberry™ comes in last place in this category, as it does e-mail, messaging, calendar and Microsoft® Outlook syncing well, but not much beyond that.

WEB BROWSING: Android comes out just ahead of the iPhone in this category, which should come as no surprise given the quality of Google's Internet search capabilities. Both Android and Blackberry offer Adobe® Flash support, whereas the iPhone does not. Blackberry offers a solid experience, but its phones have smaller screens as compared to the others, making Web browsing more challenging.

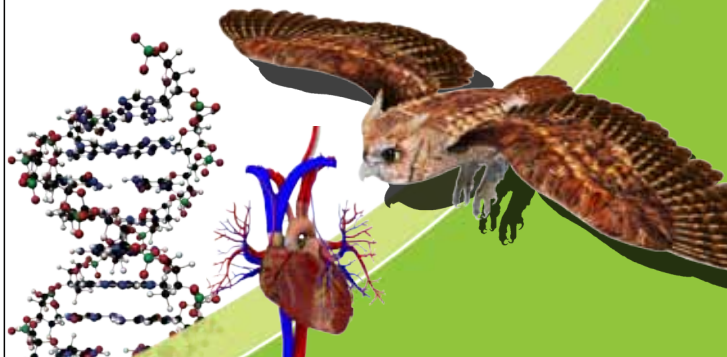
E-MAIL AND MESSAGING: Blackberry wins this category. Both services are excellent, and the Blackberry Messenger system is great for both professionals and teenagers. The physical keyboard on most Blackberry phones is also appealing to many customers. Android comes out ahead of the iPhone for e-mail due to its full Gmail™ integration capabilities; but the iPhone is superior in messaging with its iMessage™ system that sends free text, video and photo messages between Apple devices.

PHOTOS AND VIDEOS: The iPhone has the edge in this category due to its high-quality hardware as well as its abundance of apps that can be used to enhance the images it creates. The Android ties the iPhone in terms of quality of video-calling and is only slightly behind in the photo category, with features like built-in photo editing and panorama shots. Blackberry is far behind here, as the cameras on its devices tend to be lacking and have no ability to make video-calls.

CLASSROOM DISCUSSION

- Now that smartphones and tablets are available, what do you think the next big device will be?
- What do you think is the most interesting or fun thing smartphones can do?

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CARS OF THE FUTURE

By Gwen Myslinski

Self-driving cars, like KITT from the sci-fi, action television show *Knight Rider*, seemed like another fantastical futuristic fantasy created from the mind of a brilliant science fiction visionary. But like many other small- and big-screen “futuristic” fabrications, it looks like this one will come true too.

“Auto accidents cost society billions of dollars and too many lives, so automated systems that could increase both the safety and efficiency of our roads only make sense,” said André Platzer a computer scientist from Carnegie Mellon University in Pittsburgh, Pennsylvania. The biggest concern is that anyone who uses a computer, or really any type of machine, knows that software can be buggy and no one wants to suffer the automotive equivalent of a “blue screen of death” while driving at any speed.

HOW IT WORKS

To address these issues, Platzer and his colleagues are developing a distributed control system. This system allows cars to communicate with each other, similar to a pack of wolves; so if one car reacts, every other car reacts as well. For example, if a car were to merge from an onramp to the highway, the rest of the cars would separate to make room, or if a car in front speeds up, the cars behind it would speed up too.

Using formal verification methods, the team was able to mathematically prove with 100% certainty that two cars on a single lane would not crash into one



another. With each test, the team increased the complexity of the system to the point that they can safely control any number of cars in any number of lanes –as long as the road is straight; the system doesn’t do corners ... yet.

THE FUTURE

Platzer says that piece by piece, driverless technology is arriving. Already, some cars are equipped with automatic braking systems and warnings that alert drivers to dangerous situations; others actually take control of the wheel to help drivers parallel park. Who knows what will be added next.

“Will [today’s] kids do their driver’s license test first, or will robot cars do their driver’s license test first?” wonders Platzer. “I don’t know, but I’m working on the driver’s license test for robot cars, which is difficult.”

CLASSROOM DISCUSSION

- If cars can drive themselves, will people still need to learn to drive? Will someone still need to be behind the controls of a self-driving car?
- Which would have better reaction time if a deer jumped in front of a car, a self-driving car or a person driving a car? (Consider the age and the driving experience of the person)

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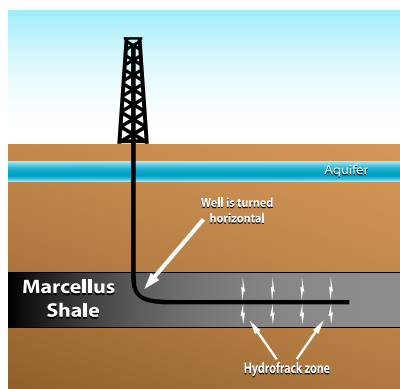


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FRICK AND FRACK

By Sara Nedley



For many people in the U.S., hydraulic fracturing, or fracking, and its link to the natural gas industry has become a very important topic. Technological advancements have made access to pockets of natural gas contained in shale beds easier and therefore more profitable.

Fracking is a process used to inject fluids under high pressure into a well. By doing so, fractures are created in deep shale rock,

enabling natural gas to escape. While fracking has been in use in the drilling industry since the 1940s, fracking combined with horizontal drilling has made extracting natural gas from shale easier. Horizontal drilling is a process by which wells are drilled first vertically then horizontally for several thousand feet. On average, three to five times more natural gas is produced by horizontal drilling when compared to vertical drilling. Both the increased quantity and access equal increased revenue for the natural gas industry. The current boom in natural gas fracking can also be equated to availability of new jobs.

Despite the benefits, concerns over the environmental impact continue to cause debate. Environmental concerns include ground water contamination, decreasing air quality, potential migration of gases and fracking chemicals to the surface and mishandling of waste. There is also concern that the fracking process can cause small earth tremors. And despite natural gas being touted as a fuel

that burns more cleanly, it is projected that 3.6-7.9% of methane produced by a well will be leaked into the atmosphere. Methane, a powerful greenhouse gas, and its leakage, means shale gas could be worse for the environment than coal or oil.

At the center of current debate in the U.S. is the Marcellus Shale, which covers approximately 90,000 square miles of West Virginia, Pennsylvania and New York. Between January and June 2011, Marcellus wells produced 432.5 billion cubic feet of natural gas.

In the fight to keep their backyards safe and clean, residents are leaning on lawmakers for their staunch support. Steps are being taken to ensure the safety and well-being of residents in this area. In Pennsylvania, gas wells cannot be drilled within 200 feet of structures, water wells or freshwater springs or within 100 feet of streams and wetlands.

Only time will tell the full story of fracking for natural gas, but in the meantime there are many facts and figures to be considered. To learn more about fracking, visit www.exploreshale.org for more information.

CLASSROOM DISCUSSION

- How did the Marcellus Shale form?
- What is a greenhouse gas and why is it bad for the environment?
- What other areas of the country are dealing with the issues related to hydraulic fracturing?

OH! ZONE

By Terri Sota

The Southern Hemisphere may no longer have the only pole with a hole on top. A recently published paper makes the case for “an Arctic ozone cavity” of significant, but lesser magnitude than the scene-stealing void over Antarctica. More than 80% of the ozone — at altitudes of 11 to 12 miles — disappeared between January and March, leaving populations in Russia, Greenland and Norway susceptible to harmful, ultraviolet (UV) rays. Although some disagree whether the depletion of the ozone up north constitutes a true “hole” (a threshold for ozone loss has never been established), all concur that the hit to the Arctic’s stratosphere is unprecedented.

What was unique about the winter of 2010-2011? According to NASA’s Gloria Manney, lead author of the climate study, daily temperatures were no lower than in high-ozone winters. The difference was that “the extreme cold lasted more than a month longer than any previously studied Arctic winter [and produced] ozone-destroying forms of chlorine for a much longer time.” The cause of the prolonged cold was an unusually strong polar vortex (a frigid, cyclonic air mass) that encircled Santa’s home, blanketing approximately six million square miles. The atmosphere over the North Pole was locked up and prevented from mixing with warmer air from the mid-latitudes.

Antarctica’s hole is an annual occurrence. Winter temperatures of -108°F (-78°C) create stratospheric clouds that accumulate inactive chemical pollutants, which react to form active, ozone killers. This process continues until the polar vortex breaks up and temperatures rise. Unlike the Arctic, which regularly receives new ozone, Antarctica experiences ozone levels that drop to zero year after year.


Global warming may promote continued long-term cold in the Arctic. At stake is the ecosystem; more UV radiation will impede the growth of some ocean algae that anchor the polar food chain. Lower-latitude cities including New York,



San Francisco and Rome will also be impacted, as ozone-poor air increases in mass and travels south. Without ozone protection, more of the planet will be exposed to high-frequency UV radiation, which can damage DNA and cause skin cancer and cataracts. And, according to researchers, only a slight drop in Arctic winter stratospheric temperatures is necessary for all of this to occur. Despite successful global initiatives to reduce pollutants, climate change is configuring a hole new world ... at the North Pole.

CLASSROOM DISCUSSION

- Discuss the 1987 Montreal Protocol (initiated a global phase-out of CFCs) and why CFCs continue to be an issue in the atmosphere, but not on Earth
- Talk about the advantages and disadvantages of using sunscreen (vitamin D deficiency)




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IN THE BEGINNING...

By Gwen Myslinski



Some of the best ideas and inventions are discovered when a person, who knows a subject well, stops thinking about the issue at hand, and lets his/her mind rest. (When do you get your “ah-ha” moments? In the shower or maybe right before you fall asleep?) The same was true when two physicists accidentally discovered x-rays and radiation. In fact, they almost didn’t believe their own discoveries.

THE “HANDY” X-RAY

Wilhelm Röntgen was a physicist who, like many others of his time, had been experimenting with Hittorf-Crookes tubes. It just so happens he had been using the tube to study cathode rays (electrons). On November 8, 1895, he decided to completely wrap the tube with black paper. Several feet away there was a small screen that was covered with barium-platinum cyanide, and in a darkened room, much to his surprise, mysterious rays penetrated the black paper and appeared on the screen. He began investigating. He turned the screen so the side without the barium-platinum cyanide faced the tube, and still the screen fluoresced. It didn’t work when he placed objects between the tube and the screen. Then he placed his hand in front of the tube. Much to Röntgen’s astonishment, he saw his own bones appear on the screen — he had discovered the x-ray. “... a momentous event that instantly revolutionized the fields of physics and medicine,” according to the American Nuclear Society.

RADIATION

After learning of Röntgen’s discovery, Henri Becquerel thought other fluorescing materials would emit x-rays too, and began his experiments. He tested several phosphorescent and fluorescent substances unsuccessfully, until he tried a uranium salt, uranyl potassium sulfate. He exposed the substances to sunlight and placed them on photographic plates that were wrapped in black paper. After developing the plates, he saw the silhouette of the phosphorescent substance in black on the negative. He tried again, and the experiment was delayed because the skies were cloudy, thereby forcing Becquerel to place the plates in a drawer for a few days. When he retrieved the plates, he expected only faint images. To his surprise, the images were clear and strong, meaning the uranium emitted radiation without an external source of energy such as the sun. Becquerel had discovered radioactivity, but only investigated the rays emitted by uranium. It was Marie and Pierre Curie who experimented with other elements, including polonium and radium, and later gained the full understanding of the process of radioactive decay.

CLASSROOM DISCUSSION

- How has radiation changed the world, and what are some everyday applications?
- What are some of the benefits of radiation?

THE YEAR OF MARIE CURIE (1867-1934)

By Joe Giacobello

To honor the most famous female scientist in the world, France and Poland declared 2011 to be the Year of Marie Curie. A devoted wife, mother and two-time Nobel Prize winner (physics, chemistry), Marie Curie was voted the “most inspirational woman in science” in a 2009 poll by *New Scientist*. Curie’s pioneering research on radioactivity laid the groundwork for modern nuclear physics. What’s more, she succeeded at a time when women faced great barriers, in both society and the workplace.

MAGNETIC ATTRACTION

Born in 1867, Maria Sklodowska began her practical scientific training in Warsaw. At 24, she moved to Paris where she earned advanced degrees in physics and mathematics. In 1894, she met a Sorbonne instructor named Pierre Curie, and it was, quite literally, “magnetism” that drew the two together. Bonded by their mutual interest in the magnetic properties of various steels, the two married in 1895 and were inseparable thereafter.

STUDYING URANIUM RADIATION

In 1897, Marie needed subject matter for her Ph.D. thesis. Pierre suggested that she begin with Becquerel’s latest observation — radioactive rays emitted from uranium. Using a sensitive device called an electrometer (invented by her husband 15 years earlier), Marie launched an intensive study of uranium radiations, and made some startling discoveries.

NEW ELEMENTS DISCOVERED

Working with two uranium-rich ores — pitchblende and chalcocite — Curie found that the radiations from the ores were far more intense than those from the

uranium itself. She concluded that unknown, highly radioactive elements must also be present. Pierre quickly put aside his own work on magnetism to help Marie with her research. In 1898, they weighed out a 100-gram sample of pitchblende and ground it down with a mortar and pestle. Soon after, they announced their discovery of two new elements: polonium and radium.



RADIATION EXPOSURE

During the next four years, the Curies would process a ton of the pitchblende, isolating a fraction of a gram of radium. Working in a leaky wooden shed, they ground the components, dissolved them in solvents, heated and stirred everything by hand — without the protection of a fume hood. Marie’s death at age 67, caused by aplastic anemia, was likely a result of her years of exposure to radiation. A true inspiration to female scientists and women worldwide, Marie Curie lived a life of discovery and adventure, fueled by a “glowing” curiosity about the radiation phenomena.

CLASSROOM DISCUSSION

- Discuss ways in which the discovery of radiation had an impact on the world, both positive and negative
- Marie Curie achieved a great number of things during her lifetime. Research and list 10 of her accomplishments

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