Science News Explores

February 2024

IN PIKMIN, PLANTS AND ANIMALS MASH UP
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POTENTIAL ENERGY VERSUS KINETIC ENERGY

MAKE YOUR ONLINE LIFE BETTER

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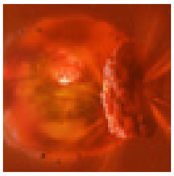

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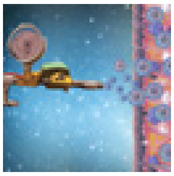

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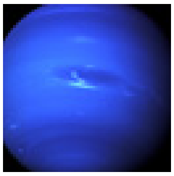

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ROBERTO CASTILLO, DARKO 1981/SHUTTERSTOCK

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Q I know that scorpions glow in black light. Why? And can other animals see it?

— Mohi K.

A "Black light contains ultraviolet light," says Carl Kloock. He's a biologist at California State University, Bakersfield. Molecules in scorpions' exoskeletons absorb UV light and then give off visible light, Kloock says. In nature, UV rays in moonlight can set scorpions aglow. "Why they do it is still a bit of [a] mystery," Kloock says. Scientists suspected scorpions' glow might attract insect prey. But in experiments, insects avoid glowing scorpions more than non-glowing ones. So scorpions' glow may instead help them find each other or warn other animals not to eat them, Kloock says. Other evidence suggests that it is scorpions' ability to absorb UV light, not give off visible light, that matters. "Basically, the body of the scorpion acts like a large ultraviolet light detector," Kloock says. "We suspect that scorpions use this information to help make decisions about whether and when to come out of shelter."

Q How is insulin created from bacteria?

— Highland School of Technology Dental Class

A Bacteria need a bit of help to produce insulin, an essential hormone your body uses to convert food into energy. Scientists can create insulin-producing bacteria by adding human genes to bacterial DNA. They use enzymes to cut open a loop of bacterial DNA called a plasmid. These enzymes leave behind uneven or "sticky" ends on the bacterial DNA. Human insulin genes then attach to the plasmid using a different set of binding enzymes. Known as "recombinant DNA," this plasmid is reinserted into harmless bacteria. These bacteria grow and multiply in fermentation tanks, where they produce insulin. Scientists collect and purify this insulin, which can be used to treat diabetes.

Q Why do string instruments make the sound they do?

— Emily Z.

A All sounds are vibrations of air, says Andrew Morrison. Morrison teaches physics at Joliet Junior College in Illinois. String instruments — such as guitars and violins — produce sounds using taut strings that are tied down at both ends. When a string is plucked or bowed, it vibrates. This vibration travels along the string to the two ends and then is reflected back down the string. This causes the string to vibrate in a certain pattern. Some parts of the string move back and forth while others stay still. This is called a standing wave. How fast the string vibrates in this pattern determines the pitch. Smaller vibrations are also happening along the string at different speeds. The frequencies made by these different vibrations help shape each instrument's unique sound. The moving string alone isn't strong enough to make music, though. "A string can only move a tiny amount of air molecules," says Morrison. So the string is attached to a part of the instrument called the bridge. It amplifies the sound by passing those vibrations onto the instrument's body. The body of the instrument acts like a loudspeaker, moving enough air molecules for us to hear the sound produced.

FIND OUT MORE USING THE QR CODES.

Do you have a science question you want answered? Reach out to us on Instagram (@SN.explores), or email us at explores@sciencenews.org.

Sarah Zielinski
Editor, *Science News Explores*

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GENETICS

A new look for Ötzi the Iceman

New DNA analysis shows he was balding and dark-skinned

Ötzi's dark skin tone is genetic — it's not only due to being frozen in a glacier for thousands of years.

In 2012, scientists sequenced the DNA of a mummy found in a glacier in the mountains along the border of Austria and Italy. The man — known as Ötzi the Iceman — had been frozen for some 5,300 years. A new look at his DNA reveals that Ötzi's ancestors weren't who scientists had thought.

The 2012 genetic analysis suggested Ötzi had ancestors from southeastern Europe. His DNA looked a lot like that of people living on the island of Sardinia. Part of Italy, it's in the Mediterranean Sea. That's quite a hike from where Ötzi was found in central Europe.

Something just didn't add up.

Other people with similar ancestry didn't appear in central Europe until about 4,900 years ago. Ötzi "is too old to have that type of ancestry," says Johannes Krause. He's a geneticist at the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany. There, he studies ancient humans and their DNA.

Krause was part of a team that did a new genetic analysis of the Iceman. They found no trace of that southern ancestry. The old genome was heavily contaminated with modern people's DNA, they concluded in *Cell Genomics*.

The new analysis shows that Ötzi had male-pattern baldness, a type that's inherited. He also was much darker-skinned than artists had depicted him in the past.

"People that lived in Europe between 40,000 years ago and 8,000 years ago were as dark as people in Africa," Krause says. That makes a lot of sense because Africa is where humans came from, he explains.

Genes for light skin tones didn't become common in Europe until 4,000 to 3,000 years ago.

— *Tina Hesman Saey*

SÜDTIROLER ARCHÄOLOGIEMUSEUM, MARCO SAMADELLI/EURAC, GREGOR STASCHITZ

SPACE

Possible exoplanet smashup spotted

Telescope images hint that two planets around a distant star collided

Astronomers may have just spotted two planets smack into and vaporize each other. This smashup took place some 1,800 light-years from Earth.

Telescopes saw a surge of infrared light from a star at that distance. The light appeared to come from a glowing blob of broken-up planet. Debris surrounding the star would also explain why visible light from the star later dimmed.

Researchers reported these findings in *Nature*. Until now, no one has seen the smoldering remains of a collision between exoplanets.

Detecting the aftermath of this cosmic smackdown involved more than a little luck.

Matthew Kenworthy, who made the discovery, wasn't hunting for giant impacts. "I was looking for rings" around exoplanets, he says. Kenworthy is an astronomer at Leiden Observatory in the Netherlands.

He scoured telescope data for stars that flicker or dim in strange ways. Such flickering could happen when rings block out light from a star.

He found what he was looking for in data from the ASAS-SN survey. That survey had captured visible light from a sunlike star called ASASSN-21qj. The star's visible light dimmed. "I immediately jumped on it," Kenworthy says.

While studying the varying light, he posted on Twitter (now called X) about ASASSN-21qj's weird dimming. That post caught the eye of citizen scientist Arttu Sainio.

"I tweeted out saying: 'Oh, this is amazing. This star is fading!'" Kenworthy says. "Then he added: 'By the way, did you realize the star had brightened up [in infrared]?'"

Sainio pointed to data from NASA's WISE telescope. It orbits Earth. WISE had tracked infrared light from ASASSN-21qj. Those data showed a strong surge in this light years before the star's visible light started dimming. "It just totally changed the story," Kenworthy says.

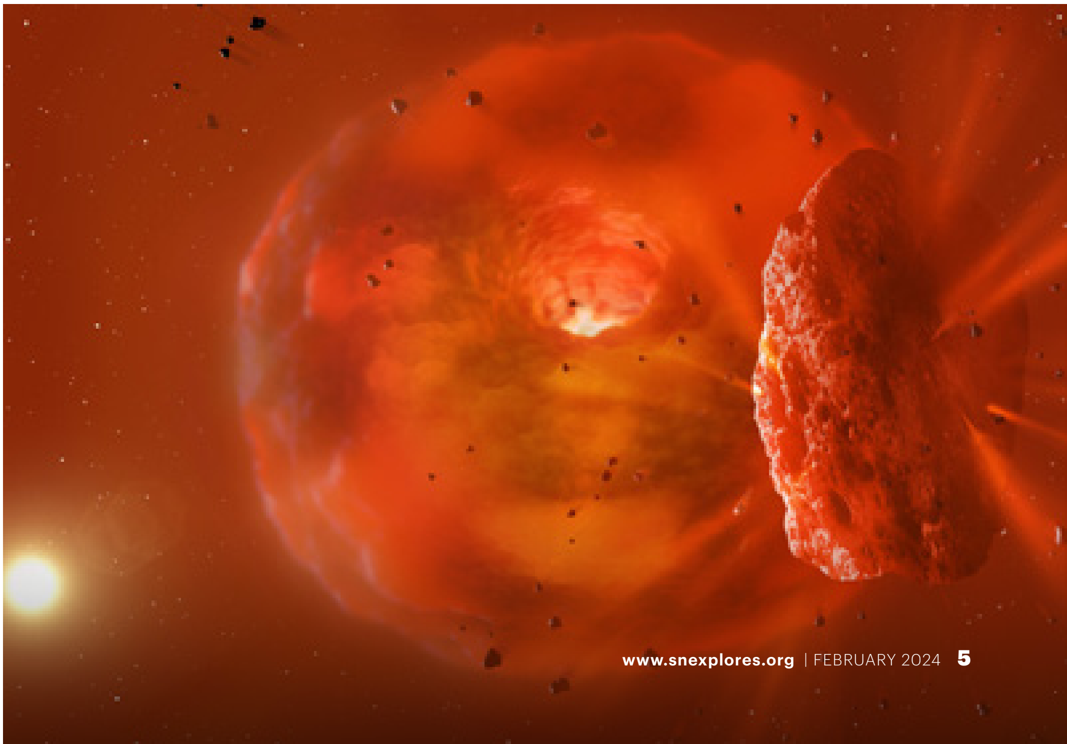
The researchers realized that a single event — the collision of two Neptune-like planets — could have caused both the infrared glow and dimming of the star's visible light.

Those worlds would have vaporized each other on impact. This would have left a donut-shaped mass of vaporized rock and water that glowed infrared. Later, the impact debris would have smeared out around the star. And that would have blocked some of ASASSN-21qj's visible light.

This isn't the only possible explanation for what the team saw. Two separate events could have caused the infrared glow and visible-light dimming. Perhaps the small, rocky seeds of two young planets collided close to the star. The leftover dust might then have been warmed by starlight to glow infrared. Then, a lot of unrelated material might have passed in front of the star, dimming its visible light.

But either of those events would be rare. So both happening that close together is "really, really, really unlikely," Kenworthy says.

If two Neptune-like planets did collide to make a huge blob of debris, this wreckage might one day bunch together to form a new planet. Some bits could even form moons around the new world.
— *Elise Cutts*



The collision of two exoplanets might have left behind a donut-shaped cloud of vaporized rock and water (illustrated). Such a plume would seem to explain an infrared glow visible to telescopes.

MARK GARLICK

HUMANS

Race car drivers' blinks aren't random

They time their blinks for lower-risk parts of the course

Each time you blink, the world goes dark for about one-fifth of a second. Most people hardly notice that blip of blindness. But race car drivers zoom at up to 350 kilometers (220 miles) per hour. For them, that sliver of a second means almost 20 meters (65 feet) of lost vision.

People blink up to 30 times every minute. At that rate, a racer could lose nearly 600 meters — more than a third of a mile — of visual information per minute. A new study shows drivers have a way of coping with this challenge.

Scientists usually assume that people blink at random times. But brain researcher Ryota Nishizono was surprised to find that blinking in sports hasn't been studied much. Nishizono used to be a professional racing cyclist. In a race, "a slight mistake could lead to life-threatening danger," he explains. So he thought the timing of blinking could be important.

Nishizono works at NTT Communication Science Laboratories in Atsugi, Japan. He and other researchers worked with a Japanese car-racing team. The scientists put eye trackers on the helmets of three drivers. Then the drivers zipped through 304 laps on three Formula race circuits.

The drivers' blinking was surprisingly predictable. They often blinked at the same spots on the course during each lap. These tended to be on relatively safer, straight parts of the course. Drivers usually didn't blink while changing speed or direction. Nor did they blink much while going around curves. The researchers reported their findings in *iScience*.

People need to blink often enough to keep our eyes moist while not losing vision during important tasks, says Jonathan Matthis. He studies human movement at Northeastern University in Boston, Mass., and was not involved in the research. "Blinking is a part of our visual system," he says. "It's not just wiping the eyes. … There's deeper stuff going on there."

— *Darren Incorvaia*

Blinking causes short bursts of blindness that can be dangerous when traveling at high speeds. Race car drivers may time their blinks to stay safe.

JAY HIRANO PHOTOGRAPHY/SHUTTERSTOCK

Think you know what you're seeing? Find out on page 32

BIG BATTERIES

Gravity could help solve renewable energy's storage problem

There's a big hole in the ground at a site in the eastern Czech Republic. The hole looks like a dark pit of nothingness. But in it, several researchers see a potential solution to a looming energy problem.

By **Stephen Ornes**

MARLON TROTTMANN/SHUTTERSTOCK

This huge "battery" in the Swiss Alps, built by Energy Vault, can store energy by raising heavy blocks and generate electricity by lowering them.

The pit measures some 7 meters (23 feet) across and more than 900 meters (3,000 feet) down. That makes it almost three times as deep as the Eiffel Tower is tall. The shaft plunges into a wide, underground coalfield that stretches into Poland. Until 2021, the hole was used as a mine. The coal that came out of it was burned to generate electricity.

But if everything goes according to plan, that hole will soon play a very different role in generating electricity.

Engineers believe the mine could be remodeled to store energy. It would work as a kind of underground rechargeable battery. But it's nothing like a AAA or AA, nor the batteries that power electric cars. It wouldn't be small and would stay in place for years, if not decades. And it wouldn't use rare metals or have positive and negative terminals.

Instead, this battery would be enormous — and run on gravity.

"It's a gravity energy-storage system," explains Gavin Edwards. He works for Gravitricity, a company based in Edinburgh, Scotland. Edwards is a mechanical engineer on the project.

The idea is simple. Suspend a tall column of metal blocks from thick cables inside a shaft. The heavy steel blocks will be filled with iron. "We'll basically be trying to support a Statue of Liberty from her head," explains Edwards. The cables will wind around sturdy pulleys and attach to winches at the top.

To generate electricity, the winches will let the blocks slowly sink down the shaft. As the blocks drop, the attached cables will turn turbines that run generators. The machine runs in reverse to store energy. When aboveground wind turbines or solar panels make more energy than is needed, the extra energy will be used to crank the winches, lifting the blocks back up the shaft. That recharges this "battery" so that it's ready for the next time electricity is needed.

Such gravity-charged batteries could help address a looming problem as the world transitions to greater use of renewable sources of energy. Renewables such as wind and solar can generate electricity without producing greenhouse gases. That's better for the environment.

But solar panels produce electricity only when the sun shines. Wind turbines only make electricity when breezes move the blades. Sometimes, these systems produce no energy. Other times, they may make more energy than can be used right away. To expand the use of these systems, society needs bigger, better ways to store any surplus energy and hold it until needed.

Conventional batteries offer one solution. They "are pretty good for phones and cars," says Joe Zhou. "But," he adds, "they're too expensive for the power grid." Near San Francisco, Calif., Zhou runs Quidnet, an energy-storage company. "There's gotta be something else that's cheaper," he says.

GRAVITRICITY

At this old coal mine in the Czech Republic, engineers are building a new type of energy-storage device that uses gravity. The system will lift and lower heavy blocks in the mine shaft as a way to store energy and make electricity.

Wet beginnings

Projects around the world — Scotland, China, Switzerland, Texas — have highlighted a range of ways researchers have been turning to gravity for storing energy. All can be traced back to a kind of energy-storage system that was first built more than a century ago. It's called pumped hydropower. It generates electricity from water flowing downhill.

This type of hydro system requires a large body of water — such as a lake — at a high elevation, with a second body of water at a lower site. A turbine turns when water flows down from the higher site, generating electricity. Inside a powerhouse, a pump can send water from the lower lake back up to the higher one. This type of battery is fully "charged" when the upper lake is full. And it will be fully "discharged" if the upper lake ever runs dry.

If you tally all the energy stored in the whole world, in all types of batteries, pumped-hydropower systems account for 99 percent of it. (The rest includes batteries found in cars and homes.)

China, which is building dozens of new facilities, is the global pumped-hydro leader. It can produce 50 gigawatts of power this way. A watt is a measure of electrical power. The rate at which power is generated, or at which it moves from one place to another, is measured in watts. A gigawatt is 1 billion watts. One gigawatt can power about 750,000 homes. In total, China's pumped-hydro plants can electrify some 50 million homes. Similar systems in the United States can produce about 22 gigawatts, enough for more than 17 million homes.

But when it comes to pumped hydro, "there are some serious limitations," notes Edwards. A big one is geography. Pumped hydro works well in steep terrain. "In Norway, where you have dense, mountainous regions," he explains, "hydro is the way to go." But even there, the water can't flow if it's frozen. And this won't work in flat countries.

Zhou points to other challenges. "You have to tunnel through a mountain. You have to excavate a space the size of an airplane hangar," he says. These are very expensive projects that take years to plan and build. Finally, he notes, the demand for global energy storage will be more than 1 terawatt of storage — 1,000 gigawatts — by the end of 2030.

Argues Zhou, "There just aren't enough mountains in the world for that. You can only do so much with pumped hydro."

In a pumped hydropower design, water flowing downhill turns a turbine to generate electricity. Later, energy from renewable sources (the sun or wind) can power pumps that move some of that water back into the reservoir to recharge it.

From lakes to deep holes

Jim Fiske is an engineer who helped start Gravity Power, based in Goleta, Calif. Inspired by pumped hydro, he began thinking about ways to get big power without a big investment. "I thought, 'There has to be a better way to lift massive objects other than lifting water up a hill.'"

GO TO PAGE 29 TO LEARN MORE!

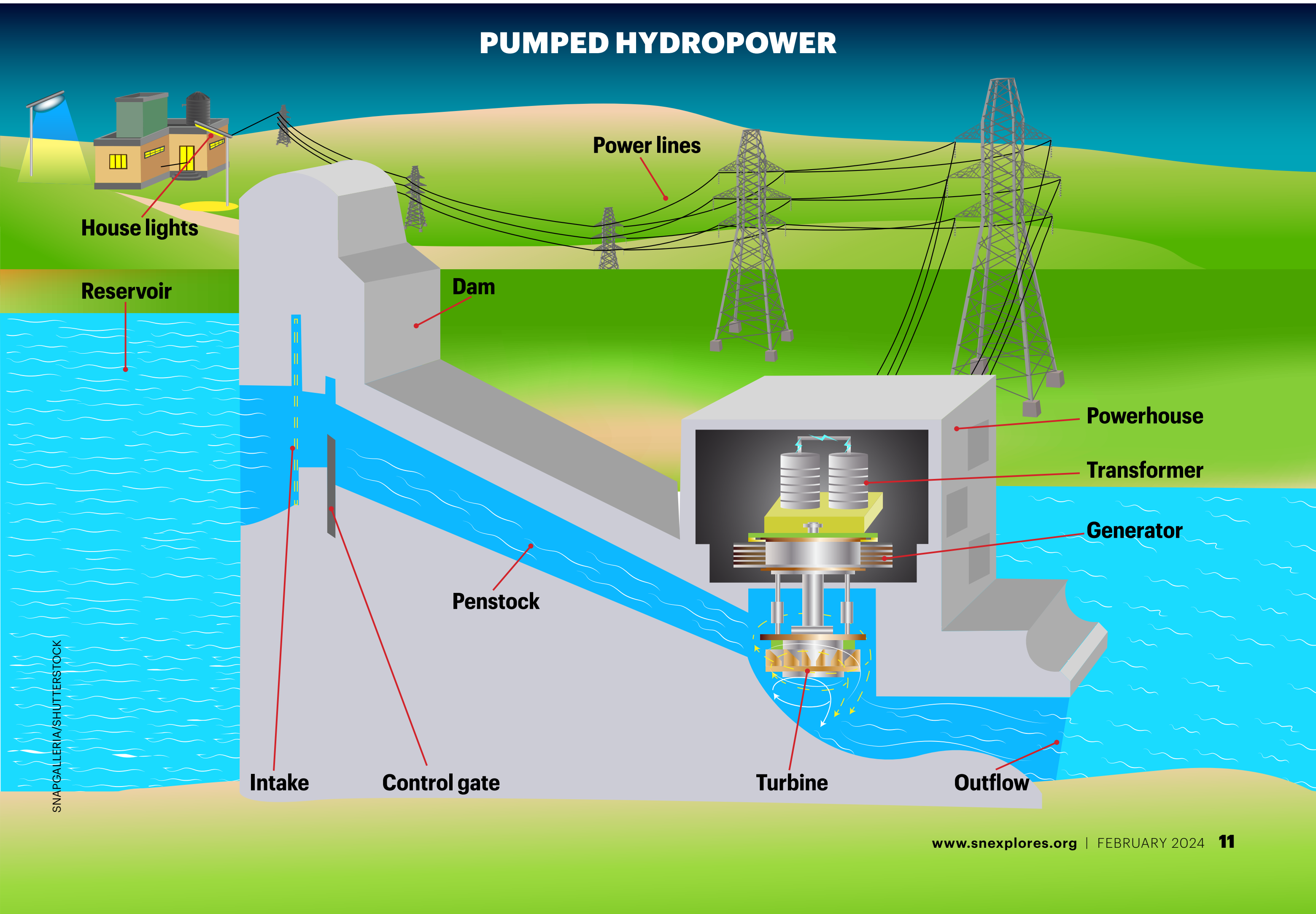
Power in Potential

Gravity-based systems exemplify the idea of potential and kinetic energy.

POTENTIAL ENERGY is defined by something's position, such as its height above the ground.

KINETIC ENERGY is defined as the energy embodied by something in motion.

Gravity systems gain more potential energy as something heavy — such as stone or gravel — is hoisted up. Potential energy becomes kinetic energy that can turn a turbine as the heavy material is lowered in some controlled way.



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Gravity Power's system will use a deep shaft filled with water. Inside sits a large, heavy piston. When the piston slides down, it pushes water out the bottom of the shaft. That water moves up another, smaller tunnel to a pump house at the top. Inside it is a turbine. The water turns that turbine's blades to generate electricity. A wire then ferries that electric power to where it's needed.

The used water flows from the turbine into the top of the shaft, filling the space above the piston. When solar panels or wind turbines produce more energy than is needed, the extra goes to pump water from the top of the shaft back down to the bottom. To recharge the system, the incoming water pushes the piston up again.

This system wouldn't require any new technology, Fiske says. Its pump is identical to what's found in a pumped-hydro powerhouse.

"The physics of a gravity-power plant are very simple," Fiske says. It's the same basic idea here as in the Gravitricity and the Energy Vault systems.

Harnessing potential energy

In physics, scientists study ways that matter and energy interact. And for them, gravity is a main figure. It's the force that attracts any two things to each other. Gravity allows the moon to orbit Earth and the Earth to orbit the sun. It's why you don't fly off planet Earth.

If you lift an apple, that fruit takes on gravitational potential energy. That means it has energy because of its position above the ground. Drop that apple and its potential energy will get converted to kinetic energy.

Gravity power plants are all based on that same idea: Lift something heavy to increase the gravitational potential energy. When the weights drop, their potential energy goes down, the kinetic energy goes up — and turbines spin to generate electricity.

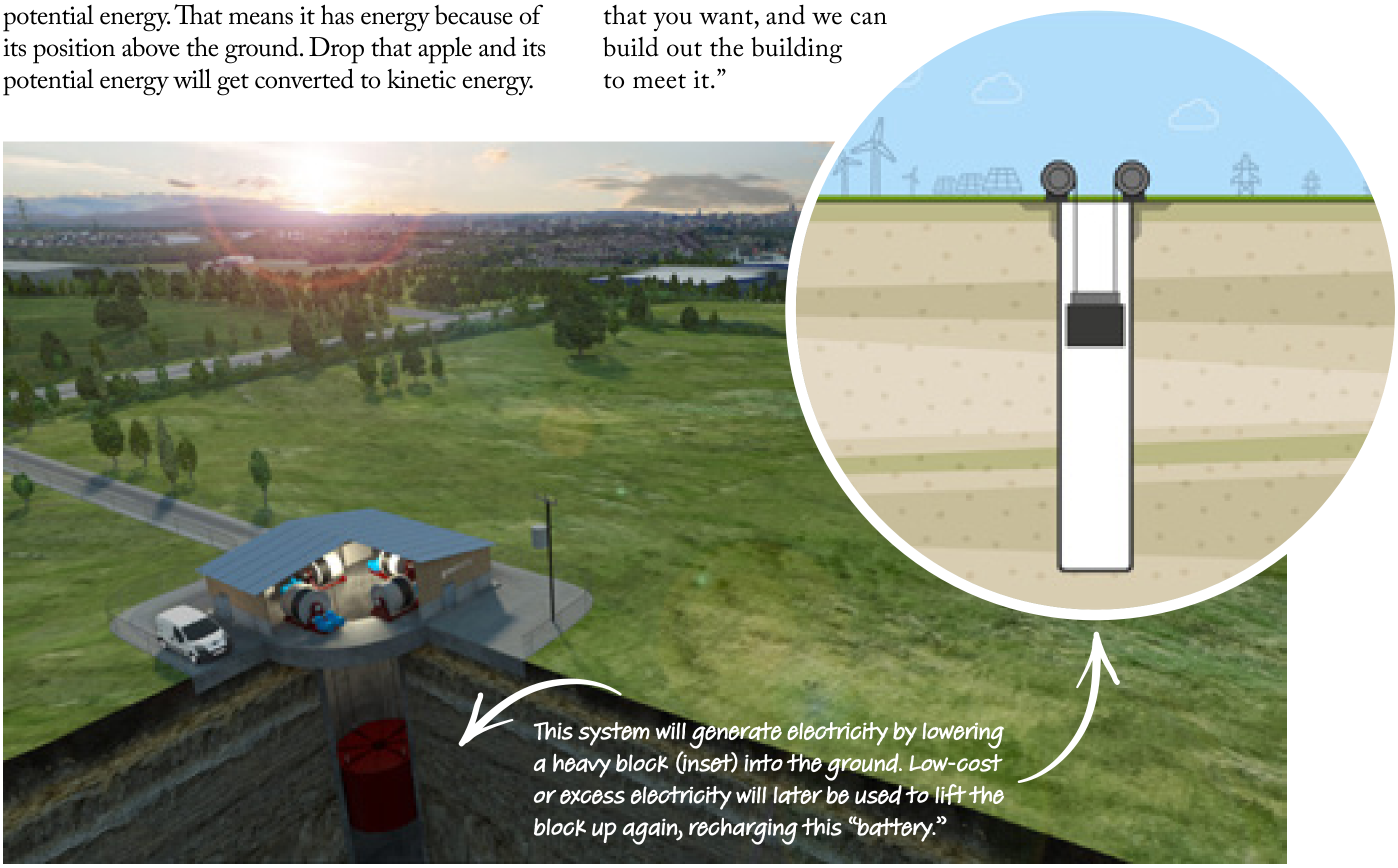
In an alpine valley in Switzerland surrounded by snow-capped mountains, Energy Vault installed a giant, six-armed crane in July 2020. "It looks like a Transformer," says Robert Piconi, who runs Energy Vault. His company is located in Westlake Village, Calif.

The crane's arms can lift and lower blocks weighing 35 metric tons (about 77,000 pounds) each. When stacked, the blocks hold potential energy. By lowering the blocks, the crane generates electricity that can move through the power grid to homes and businesses.

More recently, Energy Vault has been building gravity energy systems that store big, heavy blocks inside what looks like a giant metal box. Pulleys and motors move the blocks around, horizontally and vertically. Still, the idea remains the same. Higher blocks store more energy, which can generate electricity when they later get lowered. This system is modular, which means it's built from smaller, identical parts. The more modules used, the more energy it can store.

Says Piconi: "Define the energy and power that you want, and we can build out the building to meet it."

This is an artist's rendering of Energy Vault's new design for an energy-storage facility (right). It would hold a grid of heavy blocks that could be raised or lowered to store energy or later generate electricity.



This system will generate electricity by lowering a heavy block (inset) into the ground. Low-cost or excess electricity will later be used to lift the block up again, recharging this "battery."

GRAVITRICITY

One Energy Vault facility uses large, heavy blocks that move horizontally on tracks for energy storage.

Scaling up

Early tests of gravity-based storage systems show they can generate electricity. And systems like Gravitricity's can be built near where they'll be needed most. If placed where they can repurpose abandoned mines, these new systems won't even need to drill costly, giant holes.

But these recent projects also have revealed challenges. One thing has become very clear, says Piconi. No one solution will work everywhere and equally well.

These gravity systems are limited in how much energy they can store. If Gravitricity's test project in the Czech Republic works perfectly, it will be able to power about 750 homes but only for 30 minutes. "It's a lot of power, but you can only do it for a short period of time," Edwards explains.

It can, however, be scaled up. By building more systems, they may be able to power about 16,000 homes for 30 minutes. Edwards says a network like that would be useful when other power supplies have short-term gaps.

Julian Hunt works at the International Institute for Applied Systems Analysis in Laxenburg, Austria. An engineer, he studies energy-storage systems. Even batteries like those driven by gravity, he says, only offer solutions for short-term gaps. Pumped hydro can store the most energy, he says. It also can release it over the longest period of time.

System evolution

New solutions will be needed for areas that might need to supplement their power for longer periods — especially if they need just small amounts at one time. In a recent paper, Hunt described a system that could be built on the side of a mountain. It would generate electricity by letting sand or gravel flow downhill. To store electricity, cables and buckets would lift the material uphill again. This system could work in areas with limited access to water.

Now that society can generate power from renewable sources, Hunt says, we need to store that energy in renewable ways. Piconi, at Energy Vault, predicts that future energy-storage solutions will include both conventional batteries and gravity-based ones.

Edwards says these efforts are part of the transition to a reliance on clean energy. He points to his home country, Scotland, as an example. "We're making the transition away from oil and gas," he says — "as the whole world is." There's a big shift to renewable sources. "We have a lot of wind power and a lot of wave power," he notes.

The challenge is how to hold onto extra power. "Nobody has cracked this egg yet," he says. "But we're part of a network of engineers and companies trying to help solve these energy-storage problems."

A gravity-based power system (left) could be built by installing a piston in a deep shaft underground (inset). Gravitricity, a company working on this idea, is investigating whether old mines could be used for this purpose.

ENERGY VAULT

This civil engineer turns to math to make energy more affordable

Destenie Nock's algorithms can help people struggling to pay utility bills

In college, Destenie Nock taught math to students in Malawi, a country in East Africa. But there wasn't always enough electricity for the school. That meant the lights wouldn't turn on, and printers and lights wouldn't work. In addition, students often didn't have the supplies they needed to complete their work or attend classes. Nock also noticed that many girls dropped out once they started getting their periods.

Nock came up with some creative solutions. Working with local painters, she designed a "pathematics" runway that let students work out math problems without pencils and paper. And Nock taught girls how to sew reusable feminine pads she designed herself. "That experience really made me want to work in energy, because if kids had access to computers, then the lack of paper in the country would not be as big of an education barrier," says Nock. "I realized I could impact classrooms overseas if I helped build a better energy system."

Today, Nock teaches civil and environmental engineering at Carnegie Mellon University in Pittsburgh in Pennsylvania. She also cofounded a company, Peoples Energy Analytics, that uses computer algorithms to help identify households struggling to afford gas and electricity so they can get assistance. In this interview, Nock shares her experiences and advice with *Science News Explores*. (This interview has been edited for content and readability.) — *Aaron Tremper*

Q How did you get to where you are today?

A I've always tried to balance my love for math with my desire to help people. How do I make sure that the human connection doesn't get lost in a bunch of math equations? Math can help us understand the world. But sometimes it misses everyone's unique story. The more I hear people's stories, the more I realize each person is just trying to build a better life for themselves and their families. Combining this with my experience in grad school, I realized I wanted to make a career for myself in poverty work grounded in math, coding and data analysis.

Q What's one of your biggest successes?

A I created an algorithm showing that many low-income households don't use a sufficient amount of energy. When people don't use enough, they could be at risk of having their pipes freeze, getting hypothermia or dying of heat stroke. Most utility companies and energy planners will assume that people set their thermostats where they want them. My work has shown that isn't the case.

That feeds into other work I do, such as advocating for bill assistance and installation upgrades. Before I had the data, it was really hard to get people to listen. Now, I can actually show

People often hold beliefs about poverty that are "just incorrect," says Destenie Nock. These misconceptions can make it hard to help households struggling to pay for energy and utilities. Nock's company, Peoples Energy Analytics, uses computer algorithms to help people get assistance.

D. NOCK

that this is a problem throughout the United States. That is why we built Peoples Energy Analytics, because we realized we needed a company to help us work with utility companies.

Q What piece of advice do you wish you had been given when you were younger?

A It's OK to not know what you want to be when you grow up. Try to get good skills along the way, and everything will be fine. That was something I undervalued when I was young. Now I'm a person with four different degrees, and I work in none of those fields.

> It's OK to not know what you want to be when you grow up.

MAKE YOUR ONLINE LIFE BETTER

Science points to how you can maximize screen time's benefits while limiting its risks >>

By **Kathiann Kowalski**

CARLOSBARQUERO, LANA SHAM, FLEUR_DE_PAPIER/SHUTTERSTOCK

Being online is "essential" for Sam Cao of Mason, Ohio. The teen graduated from high school last year. "Everyone is on technology," he says. "It's really hard to communicate with anyone without social media." It also has sparked a movement among young people with their political activism, he adds. By that, he means their active involvement with social issues.

Sam used social media to connect with like-minded people beyond his local area. He even used it to run for the Ohio state legislature when he was 17. Although Sam lost his 2022 primary race, he remains active in politics. (He's also urging as many older teens and young adults as possible to register and vote.)

Platforms like Instagram and X (formerly Twitter) alert Sam to breaking news, too. "Of course, I also use Google to check the sources directly," he adds.

Yet screen time has its downsides, he says. For example, while many people supported Sam's run for office, he also had to deal with some nasty comments.

Ninety-seven percent of U.S. teens surveyed by the Pew Research Center in 2022 said they go online daily. About 95 percent report having access to a smartphone. Roughly one-third think they spend too much time on social media, yet more than half said it would be at least somewhat hard for them to give it up.

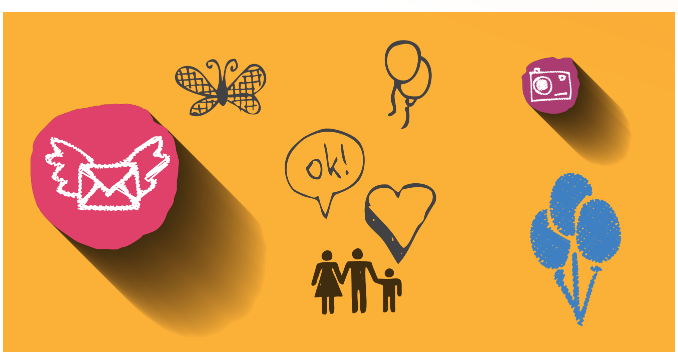
Researchers agree that some online experiences can benefit even young members of Generation Z. But studies have also linked time spent online with not getting enough sleep, plus mental-health issues. These have included anxiety, depression and unhappiness over how one looks.

So, how can you get the most from your screen time while managing the risks? We surveyed the experts, and these are their top 10 tips.

1 Be active instead of passive.

Choose what you do and view. Chat over video with friends or family. Write or comment on posts. Create works of art. "You can have really meaningful, supportive conversations" with friends, says Sam Ehrenreich. He's a psychologist at the University of Nevada at Reno.

He contrasts this with "passive" screen time — "sitting there and scrolling continuously, without actually interacting with anybody." That can sometimes be a downer. Teens tend to compare themselves unfavorably to what they read on Instagram and elsewhere. This may lead them to feel they're missing out on all the great experiences that make others seem so happy and accomplished. Or they may just feel left out.



2 Think about what makes you feel good — and what doesn't.

"Start by being honest with yourself about when your tech use makes you feel good," says Emily Weinstein. She's a social scientist at Harvard University in Cambridge, Mass. She co-wrote a book about healthy online behaviors called *Behind Their Screens: What Teens Are Facing (and Adults Are Missing)*.

"Once we start noticing our experiences more intentionally, we can be more mindful and intentional about making changes," Weinstein says. "The changes will look different for different people." Keep doing the things that feel good, as time allows. But some people's posts might make you feel angry or anxious. Or you might enjoy some kinds of videos but feel inadequate as you watch others. Figure out what those things are. Then avoid the negative ones.

Also, be wary of and report online racism, bullying or other hurtful material if you come across it. And block anyone who bullies you or uses hate speech online.

3 Have a plan when you go online.

Alissa Mrazek also advocates being intentional about what you do online. She's a research psychologist at the University of Texas at Austin. In short, choose what you will do online. And plan how to get off your screen once that's done.

"If you don't have any kind of exit strategy, then it's really easy to go from that dog training video to scrolling pictures of cute dogs for two hours," Mrazek says. Check if apps have a built-in tool to let you limit your time on them. Or set a timer on your phone that will remind you when to log off.

4 Focus on one thing at a time.

Working on math homework while texting with a friend may sound productive. But it actually wastes time. Digital devices and mind-wandering account for much of the time teens are distracted from their homework, Mrazek says. Her research group has tallied that this equates to an extra 204 hours per year per person! That's like wasting nearly every waking hour for two full weeks per year.

Multitasking may also make it take longer to learn the material in your homework, Mrazek adds. Despite what you may think, she points out that science has shown "we can't learn two things at a time." Planning can cut down on distractions, she says.

For example, you can have a prewritten reply ready for texts or calls you get during homework time, such as "Can't chat now." Better yet, put the phone on "do not disturb" or leave it outside the room.

5 Support your friends online.

For the most part, connecting online can strengthen relationships, says Lucía Magis-Weinberg. She's a developmental psychologist at the University of Washington in Seattle. People in your online circle can help you feel better if you're upset, she notes. They can help you get information. They can make you feel part of a group.

But there's often a mix of good and bad in life online, she adds. People's actions online mirror how they act offline. So, "it's unrealistic to ask our online friendships to be completely rosy and completely perfect when our in-person friendships are never like that," she says.

So, understand that snags can crop up. And be ready to deal with them like other friendship problems. You can reach out privately if a friend hurts your feelings, for example. And you can say you're sorry when you are wrong.

6 Be realistic about what you see online.

"We don't post Instagram pictures of us sitting at home bored," notes Ehrenreich at the University of Nevada. Neither do your friends! Like you, they have homework, chores, school and other not-so-fun responsibilities. They don't usually look picture-perfect. Some teens, however, "spend an incredible amount of time making sure what they post is perfect," he observes.

Without that reality check, you may feel left out or jealous when you see fun party scenes or glamorous posts. Or you may feel bad about how you look. Chances are your friends feel the same way, so talk about it with them.

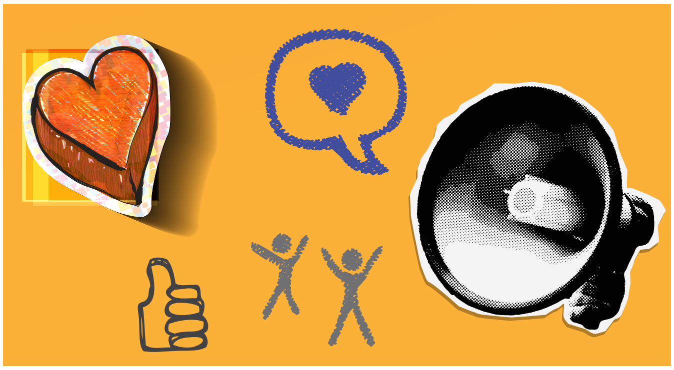
"So many of us feel the instinct to compare [ourselves] to others," says Weinstein. But, she adds, "When we give voice to these feelings, we help reduce some of their power."

7 Get support online.

Online groups can sometimes be very helpful, Ehrenreich says. For instance, teens might have health issues that can feel very isolating. Online groups can help in communities that have faced discrimination, such as LGBTQIA+ youth. And they can help you explore interests as you figure out who you are and what you enjoy. "We love hearing from teens about the ways they use social media and screens to pursue different interests and hobbies," Weinstein says — "from BookTok to accounts that teach new skills related to sports, art, music, makeup or any number of other things."

But be careful how much you share, Ehrenreich warns: Not everyone online is who they say they are.

Also, he adds, if you feel particularly upset or need advice for a very specific situation, "that's the point that you really need to be looking for counseling services" in real life. A trusted adult or health care provider can connect you with the right people. Remember the 24-hour 988 free suicide hotline and the 211 free mental health crisis numbers, too.



EVGENIY YATSKOV/SHUTTERSTOCK

8 Learn how platforms and tech tools work.

No one expects you to be an expert driver the first time you get behind the wheel of a car. Yet many teens and tweens get smartphones without knowing how to handle online risks, notes Magis-Weinberg at the University of Washington. Training can help.

One example is Social Media TestDrive. It was developed by researchers at Cornell University in Ithaca, N.Y. Twelve sessions cover topics such as passwords, privacy and healthy screen habits. Another program is the Common Sense Digital Citizenship Curriculum, which addresses topics such as cyberbullying and news literacy.

9 Protect your privacy.

Whatever platforms you use, learn who can see your posts and how to change your privacy settings. Know how to report problems, such as abusive posts. And "be careful of what you post," says Sam Cao, the Ohio teen. Photos, videos and other posts become part of your digital footprint. "There's a [tendency] to overshare every detail of your life," he says. "I think it's very important to leave some things private."

Sharing details about yourself online, such as your birthplace, parents' full names or planned vacation dates, may leave you vulnerable to scammers. Some strangers online may endanger you — either your personal safety or your wallet. They can do this through phishing or other scams. Control who is in your online network, suggests Linda Charmaraman. She heads the Youth, Media & Wellbeing Research Lab at Wellesley Centers for Women in Massachusetts.

Be extra wary if someone pressures you to send them sexually explicit images or messages. Sadly, you can't always trust what someone says in the moment — even if you're dating that person. "You just don't know what's going to happen to that once you break up," Charmaraman notes.

If someone does something "really heinous," like publicly share explicit images, report it to the platform, she says. If you're younger than 18, many platforms will take down offensive images. People who spread the images may face consequences, too.

10 Set limits, and ask others to respect them.

"There is so much that can be great about tech, but it's also totally normal to need boundaries to make sure your tech isn't taking over your life," says Weinstein.

For starters, you need your sleep — and screen time can mess with that. "So getting phones out of the bedroom is really good for teenagers," Ehrenreich says. Phone settings can remind you to turn the device off so you can wind down.

Set limits with friends, too. Tell them you want to limit screen time during homework, before bedtime or at meal times. Let them know not to expect you to respond to texts or calls right away.

If you don't like how you look in a photo someone posted, ask them to take it down or at least remove your name tag, Charmaraman says. Or just ask each other for permission before tagging photos, Magis-Weinberg suggests.

And when you're with your friends in real life, "be with your friends," Ehrenreich says. Agree to put off answering calls or texts unless it's a parent, for example.

Finally, remember that how you act online and what you want others to see from your online presence will probably change over time. As Magis-Weinberg says, "That's part of the journey. And it's part of the learning."

EVGENIY YATSKOV/SHUTTERSTOCK

YOUR DIGITAL FOOTPRINT

WHAT IS IT?

This is all of the information about you available online. Posting on social media, visiting websites and signing up for apps adds to your footprint. This digital "trail" doesn't just include the information you post online. It includes the data websites collect when you visit those pages. Comments, messages and tags from other people are also part of your online presence. Digital footprints aren't good or bad, though. Everyone who uses the internet has one.

WHY IS IT IMPORTANT?

Once something is posted online, it can be impossible to remove it completely. An inappropriate comment or unflattering video can affect your relationships or future career. Even a private message or photo meant for friends can easily be made public or altered. Colleges and companies often look up applicants before accepting them. This information may be used to determine if someone is a good fit, even if it's inaccurate. Criminals also use personal information to harm or steal from others. Having a positive digital footprint, though, can be useful. Sharing work online, for instance, can show off your skills and achievements.

HOW DO YOU PROTECT IT?

» **Be careful about the information you share online.** Don't post comments, videos or photos that might hurt or offend someone. If you're unsure, ask an adult you trust for advice. If someone you know has posted something about you, ask them to remove it.

» **Keep personal information such as addresses, birthdays and phone numbers private.**

» **Create strong passwords** and change them often to help prevent hackers from accessing your accounts.

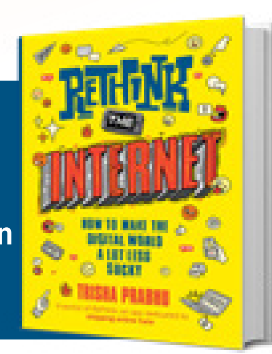
» **Don't talk to strangers** online and never agree to meet with them offline. A person can easily pretend to be someone they're not.

» **If you see or receive anything inappropriate, tell an adult.**

READ MORE

ReThink the Internet:
How to Make the Digital World a Lot Less Sucky
— by Trisha Prabhu

The internet lets people connect more easily than ever before. Learn how to be a responsible digital citizen with this handbook on online safety.



PENGUIN RANDOM HOUSE; KAROON CHA/SHUTTERSTOCK

PHYSICS

How a bouncing basketball loses energy

Let's investigate why bouncing basketballs gradually lose height

By Science Buddies

If a basketball is dropped and left to bounce on its own, it will quickly lose height. Eventually, the ball will come to rest on the floor, having lost all its potential and kinetic energy. But where does that energy go? Some is transferred into sound each time the basketball smacks the ground. But is it possible that some other energy is lost to heat? Let's investigate.

EXPERIMENTAL PROCEDURE

1. Put on a pair of thick, insulating gloves.

2. Use an infrared thermometer to take the temperature at three different spots on a basketball's surface. Record the data in a notebook.

3. Bounce the basketball on a flat surface as fast as you can 100 times in a row.

4. Take the temperature at three different spots on the ball's surface and record the data.

5. Set the basketball down and wait until it has a similar temperature as it did in Step 2.

6. Repeat Steps 2–5 at least nine more times for a total of at least 10 trials.

7. Calculate the average temperature of the ball before and after bouncing it in each trial.

8. Make a bar graph of your results. Put each trial on the x-axis and the average ball temperature on the y-axis.

9. For each trial, make two bars: one for the average temperature before bouncing the ball and one for the average temperature after bouncing.

10. Based on your results, does a bouncing basketball seem to lose energy as heat?

Find the full activity, including how to analyze your data, at snexplores.org/basketball. This activity is brought to you in partnership with Science Buddies.

SCIENCE BUDDIES

BAMIC_ILLUSTRATIONS/SHUTTERSTOCK

These words are hiding in this issue. Can you find them?

The words below came from the stories in this magazine. Find them all in the word search, then search for them throughout the pages. Some words will appear more than once. Can you find them all?

Check your work by following the QR code at the bottom of the page.

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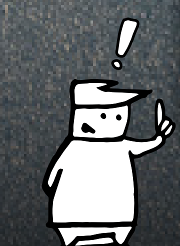


PATPITCHAYA/SHUTTERSTOCK

HEALTH

A puff of air could deliver vaccines needle-free

This device may make injections safer, faster and easier

Imagine if getting a shot felt like getting popped with a foam Nerf dart. That could be the case with a new drug-delivery system. It replaces needles with puffs of air.

This innovation could make vaccines faster, easier and cleaner.

"People really don't seem to like needles," said Jeremiah Gassensmith in a video describing the work. "That's really why we invented this thing."

Gassensmith studies bioengineering at the University of Texas at Dallas. His team's new tech goes beyond patient comfort, though. The device quickly delivers drugs without touching the bloodstream. And that could reduce the risk of spreading disease. He tested it out on his own arm. It "felt like being shot with a Nerf dart," he reports. "I could feel it, but it wasn't painful."

J.J. GASSENSMITH

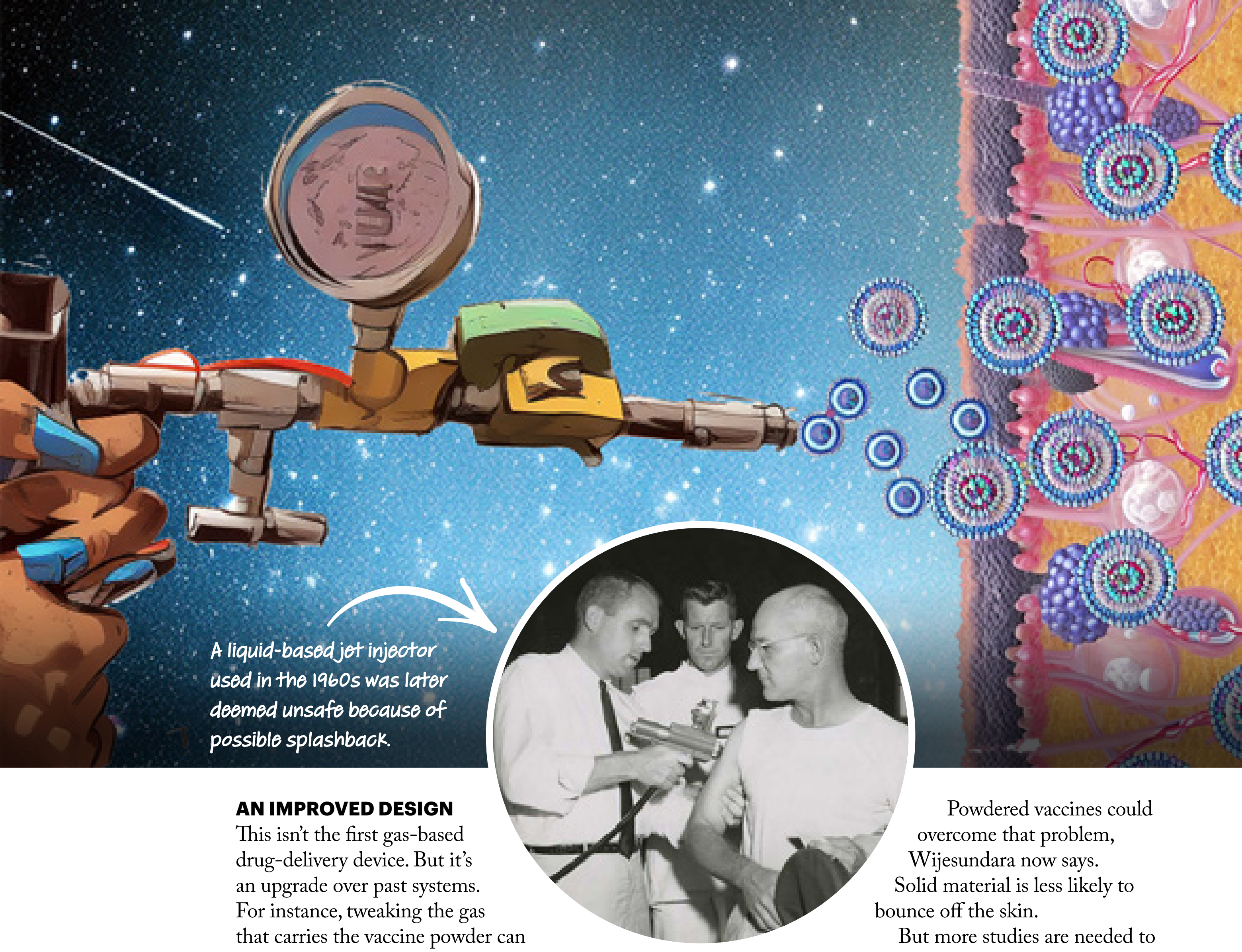
The technology works by blasting a puff of air through the skin. That gas carries a powder made of tiny bits of vaccine wrapped in metallic crystals. The crystal coating is really strong, Gassensmith says. As a result, the vaccine powder does not have to be refrigerated while stored.

The air contains carbon dioxide, or CO_2. Once in the body, the CO_2 that carries the powder will mix with water. It creates a weak acid that dissolves the crystal shield. Released, the vaccine bits are then able to enter the bloodstream.

The new device was inspired by "gene guns" used in agriculture. These shoot DNA directly into crops. Giving a plant those genetic instructions "temporarily tells the plant to do something," Gassensmith explained in the video. For example, "You can tell a plant to hold off on fruiting if you know a frost is coming."

Gassensmith decided to build a homemade gene gun for fun. This was early in the COVID-19 pandemic, when he was spending a lot of time at home. In early tests, he shot table salt around his home office. But he soon realized his design could have a more practical use. When he was able to go back into the lab, Gassensmith adapted it into an air-based vaccine system.

His team described its device at a meeting of the American Chemical Society.



A liquid-based jet injector used in the 1960s was later deemed unsafe because of possible splashback.

Scientist Yalini Wijesundara (left) demonstrates a new drug-delivery system that could someday deliver vaccines using a puff of air. The device blasts vaccines and other medicines through the skin, encased in tiny metal capsules that dissolve in the body (illustrated, above).

AN IMPROVED DESIGN

This isn't the first gas-based drug-delivery device. But it's an upgrade over past systems. For instance, tweaking the gas that carries the vaccine powder can customize how fast the tiny crystal capsules release the drug. Testing showed that the drug released fastest when delivered with carbon dioxide. Plain air led to a slower, gentler release.

Vaccines work best when released slowly. That allows them longer contact with the immune system. But the team hopes the device could work for other medicines too. And some medicines must be released quickly. One such example is insulin, a crucial drug for many people with diabetes.

The new system is also cheaper than previous designs, which often used gold or other expensive metals to hold DNA, says Yalini Wijesundara. The new setup uses zinc, which is fairly inexpensive. Wijesundara is a materials scientist who works with Gassensmith on this project.

Hurdles remain before this technology could replace needles in doctors' offices, says Bruce Weniger. A doctor, he teaches at Emory University in Atlanta, Ga. He also studied vaccine technology for 30 years for the U.S. Centers for Disease Control and Prevention.

Starting in the 1960s, U.S. doctors delivered some vaccines using needle-free liquid jets. But problems arose. The liquid could splatter off a patient's skin. If that person was sick, that splashback could contaminate the tip of the vaccination device with germs and spread disease.

Powdered vaccines could overcome that problem, Wijesundara now says. Solid material is less likely to bounce off the skin.

But more studies are needed to confirm splashback isn't a concern, Weniger says. He also worries that gas-based vaccines might leave scars. That was a problem with older gas-based systems.

Future research must also ensure that gas-delivered vaccines build immunity to disease as expected, Weniger says. So far, researchers have only tested that the system delivers DNA inside the cells.

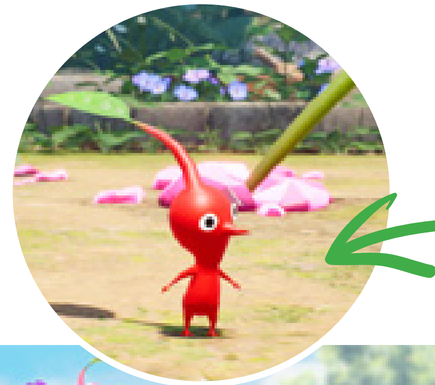
This tech might even find use on farms — for livestock vaccines, Gassensmith says. It could beat walking up to a cow with a big needle.

Fear of needles keeps many people from getting vaccinations. Gassensmith is optimistic that this new system might get around that.
— *Katie Grace Carpenter*

LIFE

In Pikmin, plants and animals mash up

These hybrids may have the best of both worlds when it comes to food



Meet the Pikmin. These tiny video game critters can swim, carry explosive rocks and fly. Such behaviors suggest that Pikmin have a complex nervous system.

NINTENDO

In the *Pikmin* video games, strange beings help you survive on an alien planet. Each of these brightly colored Pikmin starts off as a sapling with rootlike toes and a single leaf on its head. As the creature matures, the leaf transitions into a flower.

But these plantlike lifeforms behave like animals. Pikmin cooperate to forage for nectar, hunt giant creatures and haul prey back to their nests. Some clear obstacles with explosive rocks. Others breathe underwater using gills.

Plants here on Earth aren't quite that talented. However, says Holly Moeller, "It's not unheard of for an animal to be able to practice a bit of photosynthesis." Known as mixotrophs, these creatures fuel themselves by harnessing sun energy, like plants do, and eating other organisms, like animals do. Some of these animals get their light-absorbing powers from microbes stored in their bodies. Others do it by stealing energy-producing chloroplasts from the food they eat.

Some mixotrophs even look like they're growing their own tiny leaves, just like a Pikmin.

TWO-IN-ONE

Pikmin are most likely animals, says Moeller, an ecologist from the University of California, Santa Barbara. Despite their leaves, Pikmin move on their own and work in groups. This suggests that they have a complex nervous system.

Pikmin might be a mix of two different species. While they look like a single organism, these leafy critters might in fact be animals that host a plant or alga in their body, says Moeller. Like plants, most algae practice photosynthesis. They have special structures called chloroplasts that convert light and carbon dioxide into sugars. Certain animals in the real world have come to rely on these solar-powered algae for food.

Stony corals are one example. They often look like plants. But they are actually colorful cousins of jellyfish. Calcium carbonate skeletons anchor them in one place. At night, most corals hunt using stinging tentacles. They aren't picky. They'll feast on everything from small fish and floating eggs to microscopic animals called zooplankton.

Coral reefs — the buildup of thousands of years of coral skeletons — attract divers and snorkelers because of their crystal-clear waters, notes Moeller. But these unclouded views often mean there's little food for corals to eat.

Tropical corals make up for this food shortage by housing algae, zooxanthellae, in their tissues. The corals offer these algae carbon dioxide and shelter. Safely tucked away, the algae produce sugars and amino acids. The corals get most of their nutrition from these substances. Up to 90 percent of the materials the algae photosynthesize are passed on to their coral hosts. The corals use these compounds for food and to grow their exoskeleton.

SOLAR SLUGS

Not all animals that get energy through photosynthesis are as great about sharing as corals and zooxanthellae. Some sea slugs steal chloroplasts from the algae they eat in a process called kleptoplasty.

Sacoglossan, or "sap-sucking," sea slugs use tiny teeth to pierce algae and slurp up their innards. Some of these slugs stockpile chloroplasts from these meals in digestive glands lining their thin bodies. The leftover chloroplasts help supplement the slugs' diets, especially when algae are scarce.

Unlike corals, these slugs get most of their nutrition from digesting the algae itself, says Terrence Gosliner. This marine biologist studies sea slugs at the California Academy of Sciences in San Francisco.

The chloroplasts are often hidden in the slugs' bodies within fleshy folds called parapodia. "If you open up the parapodia, the inside is just this bright green from the chloroplasts," says Gosliner.

Some slug species can keep using the same chloroplasts for nearly a year. But that kind of mileage is highly unusual, says Gosliner. Most sacoglossan slugs maintain their energy-harvesting machinery for a couple of weeks, at most. They must regularly replace their chloroplasts.

Could a Pikmin be hoarding stolen chloroplasts in the leafy structure on its head? Probably not. Animals that steal chloroplasts tend to be slow-moving, says Gosliner. Chloroplasts wouldn't provide enough energy to fuel the lifting, sprinting and battling Pikmin do. This would lead to Pikmin using more energy than they consume. "And if [an action] requires more energy than you're capturing, you're not going to last long."

Also, Pikmin would need a lot more leaves to soak up sunlight like sea slugs. Slugs that photosynthesize often sport lots of leaf-like appendages, says Gosliner. All that surface area lets them support more energy-producing chloroplasts. "Rather than a single leaf, you'd see a head of lettuce growing on the top of the head," says Gosliner.

But Pikmin might have another use for that foliage atop their heads. It could be used to lure prey. The flower could attract insects looking for a sip of nectar, says Gosliner. "They could be fooling pollinators to come closer before scarfing them up." In that way, Pikmin could just be big Venus flytraps with legs.
— *Aaron Tremper*

All Pikmin sport a single leaf that can develop into a flower. Pikmin might host these leafy additions to get an added energy boost.

Many mixotrophs live in environments that offer few nutrients. Some, such as stony corals and certain sacoglossan sea slugs, thrive along shallow coastlines by hosting solar-powered algae in their bodies. Others, such as the Venus flytrap, rely on snaring invertebrates to help them survive in nutrient-poor bogs.

Stony corals

Sacoglossan sea slug

Venus flytrap

TANK200BAR, SONJA OOMS, CHRIS VDV/SHUTTERSTOCK

PHYSICS

Kinetic energy vs. potential energy

Let's take a swing at understanding the difference

In science, the word energy has a very specific meaning. It refers to the ability to perform some type of work on an object. That could be lifting an item. Or it could be speeding up molecules to kick-start a chemical reaction. Two common types of energy are kinetic and potential.

Every object in motion has **kinetic energy**. This could be a car zooming along the highway or a ladybug walking along a leaf. Kinetic energy depends on just two quantities: mass and speed. Each has a different impact on kinetic energy.

For mass, it is a simple relationship. Double something's mass, and you'll double its kinetic energy. A single sock tossed toward the laundry basket will have a certain amount of kinetic energy. Ball up two socks and toss them together at the same speed; now you've doubled the kinetic energy.

For speed, it's a squared relationship. When you square a number in math, you multiply it by itself. So if you take that single sock and throw it twice as fast, you've quadrupled the kinetic energy of its flight.

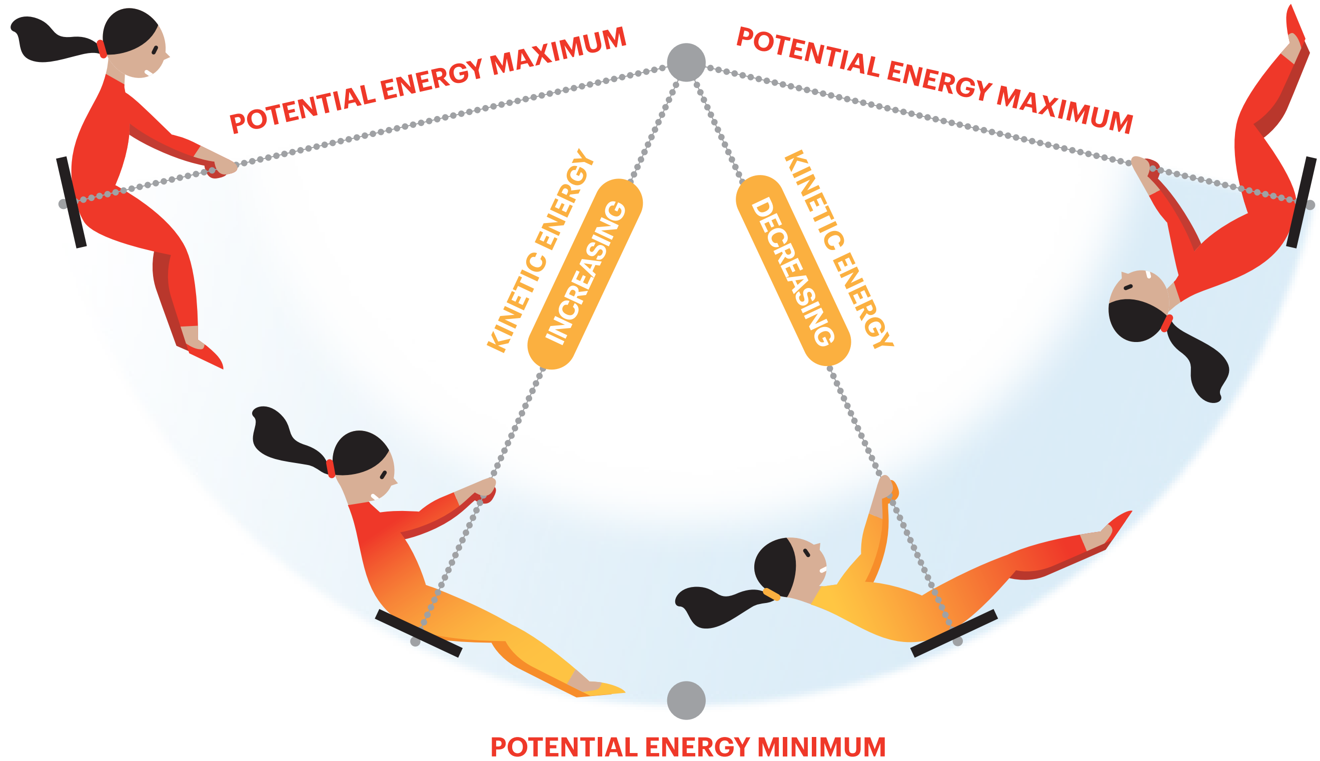
An object has **potential energy** when something about its position gives it the ability to do work. Usually, potential energy comes from being elevated above Earth's surface. This could be a car at the top of a hill or a ball held in your hand.

An object's potential energy is directly related to its height above Earth's surface. Doubling its height will double its potential energy.

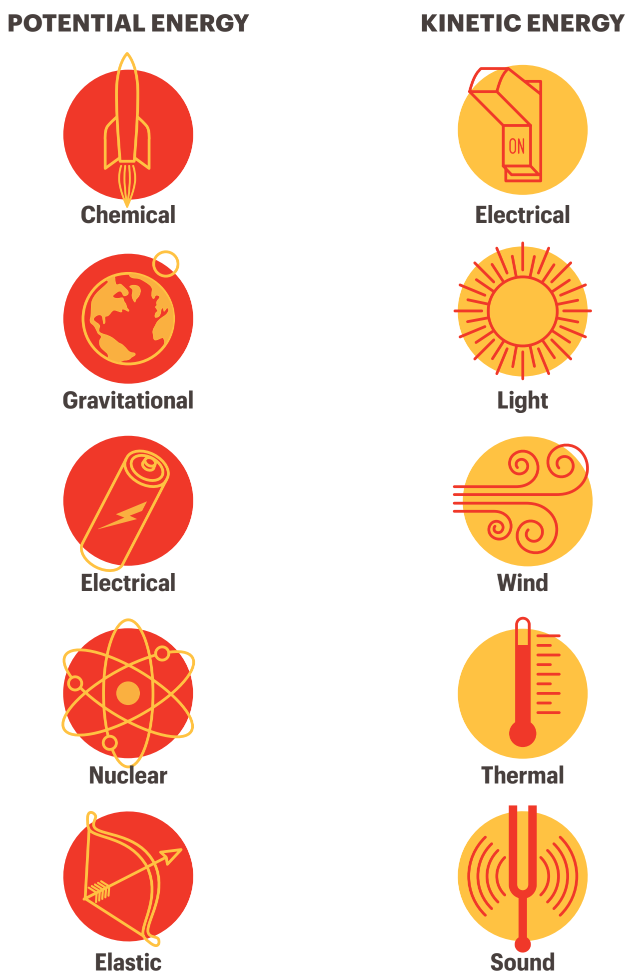
Energy can switch from kinetic to potential and back. Consider a swing set. At each high point in your swing, you stop just for a moment. Your kinetic energy drops to zero. At that same point, your body's potential energy is at its highest. As you drop back to the bottom of the arc (closest to the ground), it reverses: Now you're moving your fastest. Your kinetic energy is also at its max. And since you're at the bottom of the swing's arc, your body's potential energy is at its lowest.

— *Trisha Muro*

JEEP5D/SHUTTERSTOCK



Objects in motion — such as a moving swing — have kinetic energy. The person on the swing also has potential energy. Potential energy is highest when at the top of the swinging arc. As the person falls toward the ground, the potential energy decreases. And it increases as they swing back up.



There are many types of energy. Many of these types can be classified as either potential or kinetic energy.

ILLUSTRATED BY STEVE MCCRACKEN

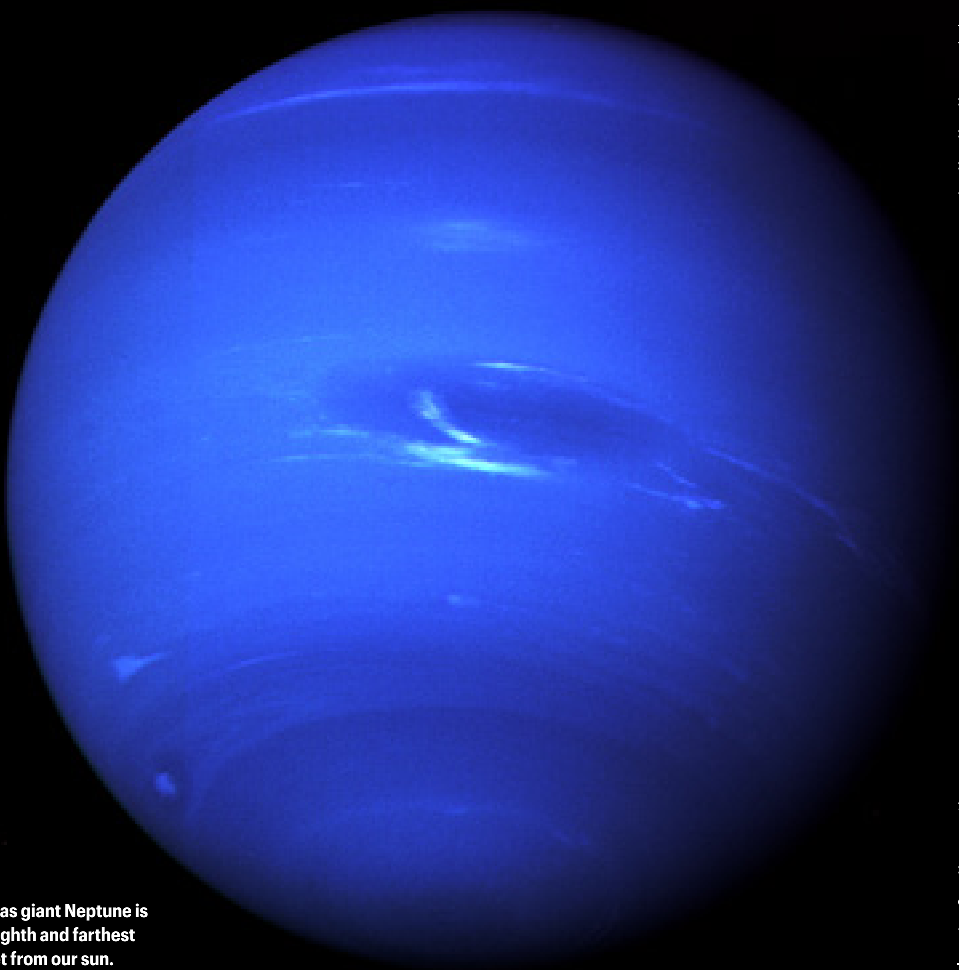
SPACE

Brighter sunlight may bring cloudy skies to Neptune

The giant planet's weather seems linked to the solar cycle

The sun's rays may prompt cloudy days on our solar system's farthest planet.

Neptune's atmosphere swirls with storms and clouds. "It has one of the most active atmospheres of all the planets in our solar system," says Erandi Chavez. They're an astronomer at Harvard University in Cambridge, Mass. Neptune's intense winds and fast-changing weather have inspired Chavez and others to watch the gas giant's clouds. Recently, they noticed something unusual.



The gas giant Neptune is the eighth and farthest planet from our sun.

NASA/JPL

The areas between the planet's equator and the poles are usually quite cloudy. But in pictures taken in early 2020, the planet was strangely bare. The smidge of Neptune's usual cloud cover was confined to near the south pole. "The fact that those are the only clouds left was like, 'Oh, this is very weird,'" Chavez says.

To investigate, Chavez and their team looked to telescope images going back almost 30 years. From the pictures, the researchers measured the clouds' brightness, or how much sunlight they reflect. This provides a way to gauge how dense the clouds are. The researchers also measured the clouds' area across Neptune's surface.

The sun's light intensity is known to rise and fall every 11 to 13 years. Neptune's cloudiness also seemed to vary over this timescale, suggesting that it's linked to the solar cycle. The researchers shared their findings in *Icarus*.

Chavez and their colleagues suspect sunlight triggers cloud-forming chemical reactions in Neptune's atmosphere. The atmosphere contains molecules made of only carbon and hydrogen known as hydrocarbons. Methane is one example. Ultraviolet light from the sun can break methane gas apart, freeing its atoms to form other hydrocarbons. These heavier hydrocarbons can sink to cooler spots in the atmosphere, become liquid droplets and form clouds.

But sunlight didn't explain some blips observed in the planet's cloud activity. So there's still more to learn about Neptune's clouds.
— *Carolyn Wilke*

Neptune Weather Report

Researchers looked at images of Neptune taken by the Hubble Space Telescope and the Keck and Lick Observatories from 1994 to 2022. In some years, the planet had more clouds (brighter spots in images). In the figure below, vertical lines connect each image of Neptune with the year it was taken. Researchers investigated how Neptune's clouds may have been linked to ultraviolet, or UV, radiation from the sun (data plotted in white).

DATA DIVE

1. Look at the data plotted in white. What is the trend in these data? How does the sun's ultraviolet, or UV, radiation change from 1994 to 2004?

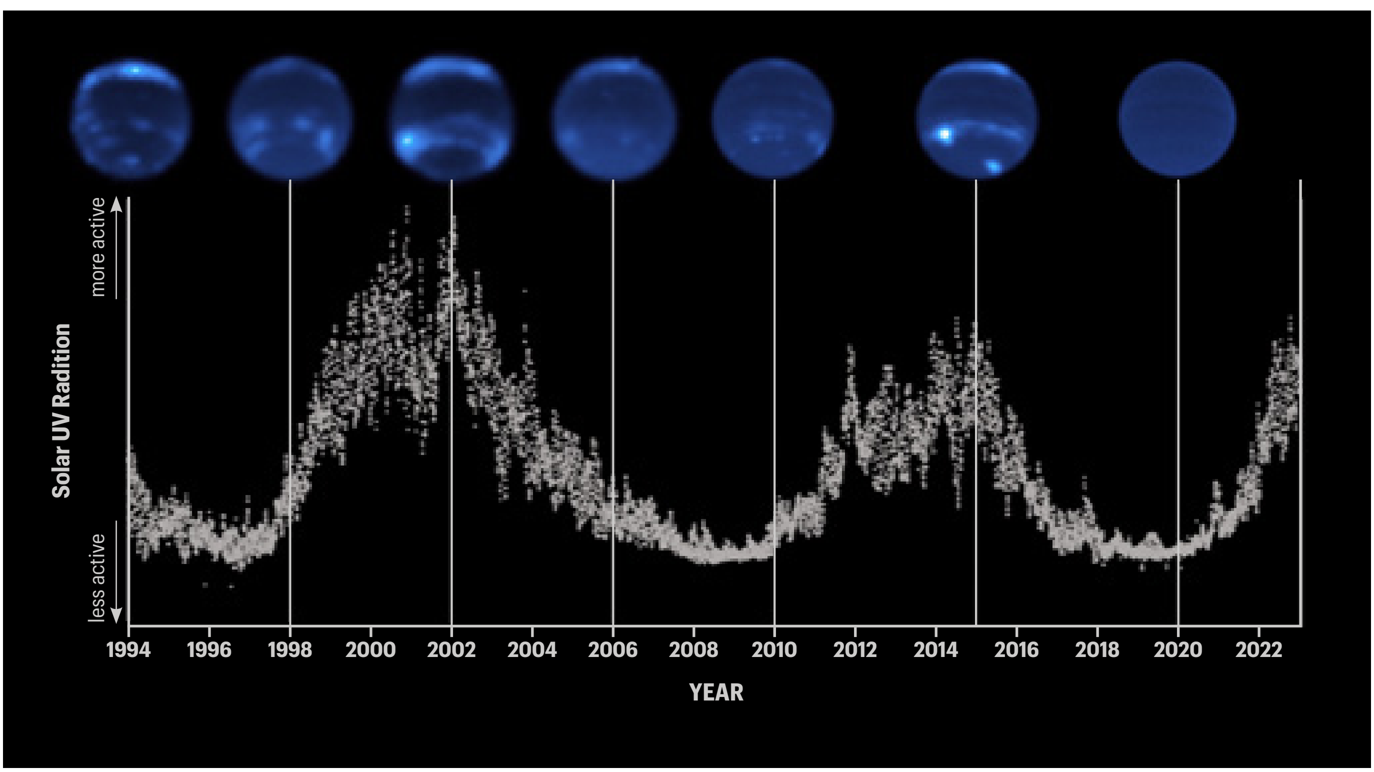
2. In what years is solar UV radiation highest? What is the length of time between these years?

3. Look at the pictures of Neptune. In what years does Neptune have the most clouds?

4. In what years does Neptune have the least cloud cover? How does the amount of cloud cover relate to the level of solar radiation?

5. Why did the researchers need decades of data to spot this link? (Hint: What do the data look like over shorter periods of time? For instance, within a two-year period?)

Hubble Space Telescope | Observations of Neptune (1994–2020)
Cloud features plotted against solar UV radiation



NASA, ESA, LASP, ERANDI CHAVEZ (UC BERKELEY), IMKE DE PATER (UC BERKELEY)

ANSWER

The sun shines brightest in South America's Atacama Desert

Solar rays in this high-altitude desert at times rival the light intensity on Venus

A researcher in the Andes Mountains of Chile sets up an instrument (inset, a closer view) to measure sunlight.

R. CORDERO; HPEREIRA.SI/SHUTTERSTOCK

Craving lots of sun? Head to South America's Atacama Desert. It gets the most intense sunlight on Earth.

A research team determined this with a pyranometer. This palm-sized instrument measures solar energy.

The Altiplano is a high-altitude plateau in the Atacama. It straddles parts of Chile, Bolivia, Peru and Argentina. Satellite data had suggested sunlight there is the most intense on Earth. But it's important to check such claims with on-the-ground data, says Raúl Cordero. A physicist, he works at the University of Santiago in Chile. His team wanted to know: "How good are these [satellite] estimates?"

On average, some 308 watts of solar energy hit each square meter (about 11 square feet) of land in the Altiplano. This matches the satellite estimates. The team shared its findings in the *Bulletin of the American Meteorological Society*.

Some bursts of sunlight, most lasting just a few seconds or minutes, were especially intense. This probably happens when thin clouds scatter light toward the ground. One event in January 2017 blasted the site with a whopping 2,177 watts per square meter! This rivals the intensity of sunlight that reaches Venus, which is much closer to the sun than Earth is.

— *Katherine Kornei*

INSIDE THE MIND OF A YOUNG SCIENTIST

A Thermo Fisher Scientific Junior Innovators Challenge winner answers three questions about her science

Science competitions can be fun and rewarding. But what goes on in the mind of one of these young scientists? **Ellie Lou Olvera**, a prize winner at the 2023 Thermo Fisher Scientific Junior Innovators Challenge, shares her experience.

Q What inspired your project?

A "Periods are a big topic for conversation in a 12-year-old girl's life," Ellie Lou says. She learned about period poverty and thought about how to help. She decided to sew menstrual pads and donate them to people in need. "I discovered that there was not a consensus as to which natural fabric was best" to use in these pads.

Q Did you encounter any unexpected obstacles?

A "When I was pitching my idea to a group of peers, one of my classmates asked, 'Is menstruation a disease?'" Ellie Lou says. "That's when I realized that I had a lot of work ahead of me. … Because if they did not understand menstruation, how would they understand period poverty? And … how would they be able to put my project into context?"

Q What was your favorite part of this project?

A "I loved my testing, because each fabric reacted so differently," Ellie Lou says. "Even if it was the same exact material just woven or put together in a different way, it had a crazy different reaction." She was especially surprised to find that pads made from reused fabrics were more absorbent than new fabrics. It meant surplus fabrics "could be redirected into solving a humanitarian crisis."

Robert Wood Johnson Foundation Award for Health Advancement

Ellie Lou Olvera

Ellie Lou, 13, wanted to help solve the global problem of period poverty. This is a lack of access to menstrual products, ways to hygienically use them or education about how to use them. Surveys suggest that more than half of people with periods worldwide don't have access to proper menstrual products. Ellie Lou showed that fabrics made with cotton and hemp were most absorbent and best for making affordable, reusable menstrual pads. Ellie Lou is in the seventh grade at Santa Barbara Charter School HomeBased Partnership in Goleta, Calif.