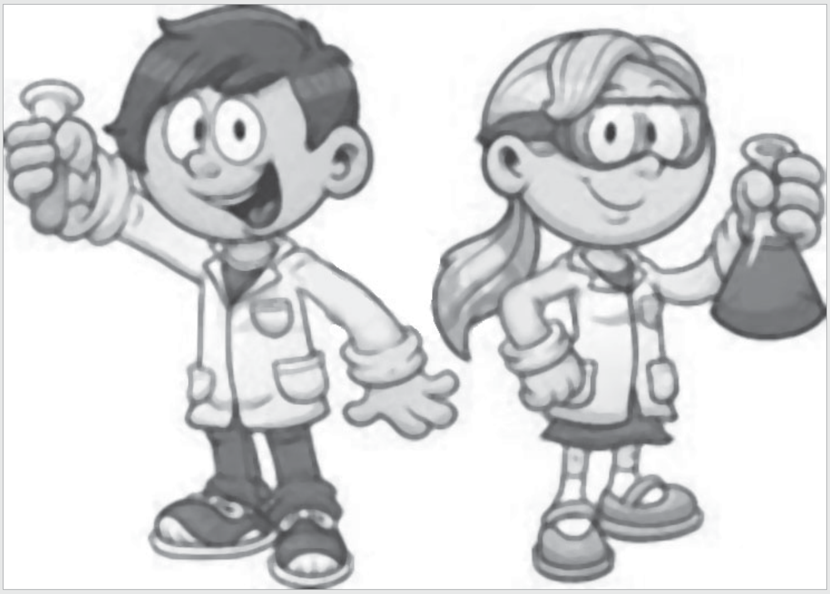
contents



Contents

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The Shocking Electric Eel!

From the article by

Roberta Kwok,

Science News for Students

The electric eel is a fascinating creature. It lives in dark, murky South American rivers, such as the Amazon. The animal can't see very well and it hunts at night. So it detects prey by emitting weak electrical pulses that act like radar. Then the eel stuns its prey with strong electrical blasts and sucks the animal into its mouth.

Sometimes an electric eel demolishes an entire school of fish this way. Once they are stunned, they all float to the surface, and the eel eats them like popcorn!

In the last two years, one scientist has published several intriguing findings about electric eels. **Ken Catania**, a biologist at Vanderbilt University in Nashville, Tennessee, discovered that these animals use their electrical bursts to freeze prey in place. These eels can even force hiding fish to reveal their position. Concludes Catania, "Everything I've seen in these animals is amazing."

A sixth sense

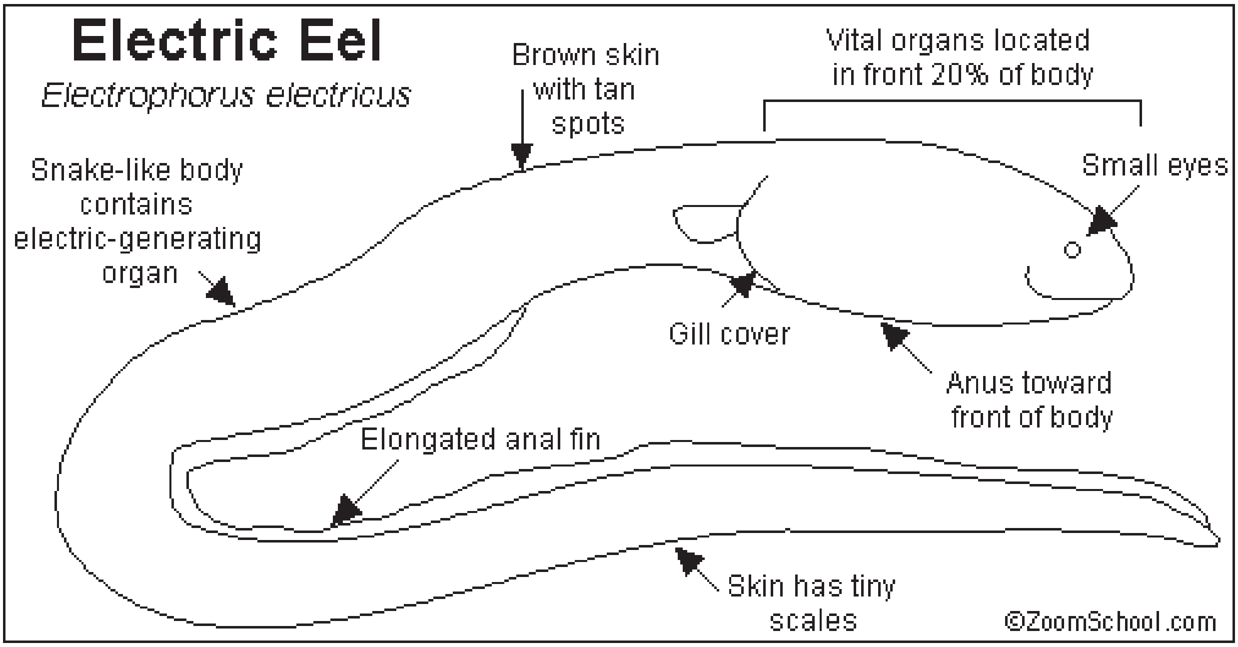
Electric eels are part of a group of animals called electric fish. All have special organs that produce electrical pulses. Some species emit only weak pulses. Others emit strong pulses. The electric eel can do both.

Electric fish generate these pulses using special cells called electrocytes. These run in rows along the length of the animals' bodies. These cells pump positively charged sodium atoms, called ions, from inside themselves to the outside. Then the cells open gates to let the sodium ions back in. The flood of ions back into the cells produces an electrical pulse. The voltages of all the electrocytes in a row add up. It's similar to how the row of batteries work to collectively power a flashlight.

An electric fish uses its weak pulses like radar. Those pulses create an electric field around its body. This acts like a bubble of electric current. When another animal enters that space, the fish detects a distortion in the electric field. That change helps it figure out the other animal's position and identity — even when the water is dark or murky: they literally have a sixth sense.

These fish get that sixth sense from organs called electroreceptors. These detect changes in the electric field. Electroreceptors look like little pits and cover the fish's entire body.

Weak pulses also help the animals communicate. Electric fish change the rhythm and strength of their pulses to send different messages. These signals tell other electric fish lots of information, including the messenger's sex, species and how



aggressive it feels.

The strong electric pulse is a weapon. During an attack, a fish may zap its prey hundreds of times. In addition to electric eels, fish such as torpedo rays and African electric catfish also can release these intense blasts.

But the electric eel's pulses are the strongest of all electric fish. "It is legendary," Catania notes.

Freeze!

People have studied electric eels for a long time. Still, many mysteries have remained.

In 2014, Catania wanted to write a book chapter about these eels. Normally, he studies the sensory systems of animals such as moles, alligators and snakes. But he was fascinated by the way these eels sense electric fields.

So Catania got some eels for his lab. "I felt like if I was going to write about this creature, I wanted to get to know it a little better," he explains.

First, he took videos of the eels hunting goldfish. He says, "I thought, what the heck: I gotta see when they attack a fish — what happens?" Electric eels attack very fast. So Catania used a high-speed camera that took 1,000 pictures per second. Then he replayed the recordings in slow motion.

What he saw surprised him. He thought the goldfish would jerk around after being zapped. Instead, the fish froze almost immediately — within three one-thousandths of a second. It was as if the eel had cast a spell that turned its prey to stone.

Catania was intrigued. "How is that possible?" he wondered.

Perhaps the eel's electrical blast acted like a *Taser*. This is a weapon used by American police that releases electrical pulses. When the pulses hit a person, they trigger nerve cells called neurons. The activated neurons make the muscles contract so that the tased person can't move.

To test his 'tasing' idea, Catania performed an experiment. He hooked up a dead goldfish to a device that recorded the animal's muscle contractions. The fish had just died, so its muscles still worked.

Catania wanted to see how the fish's muscles reacted to the eel's pulses. But he didn't want the eel to actually eat the fish, because that would mess up the muscle-contraction measurements. So he put the fish in a tank with an eel but separated the two with a barrier. Then he added some live earthworms to the eel's section of the tank. The eel zapped the worms with hundreds of strong electrical pulses. The pulses penetrated the barrier to reach the dead fish.

Just as Catania expected, the goldfish's muscles contracted as soon as the eel began releasing pulses. It looked like his hunch was correct. The electrical blast worked like a Taser: It froze the fish by making its muscles contract.

But Catania also noticed something odd. Rather than hundreds, sometimes the eel emitted just two strong pulses when swimming near the dead fish. Only afterward would it launch a full-scale barrage. That's when it attacked its prey with hundreds of pulses and tried to break through the barrier.

Nowhere to hide

Catania's first experiment showed that the eel's bombardment with strong pulses froze its prey. So why had it released an isolated pair of pulses beforehand? Hoping to find out, the scientist looked more carefully at those data on the goldfish's muscle contractions. And he realized that its body had twitched right after the eel emitted the two pulses. He wondered if the eel's little electrical burst had triggered the twitch.

The idea made sense. Imagine a small fish in a dark river at night. To avoid being eaten by an electric eel or some other predator, the fish hides in some plants. It stays very still, hoping the eel doesn't notice it.

If the eel could somehow force the fish to twitch, that movement would make the water ripple. The eel would feel the ripple and spot the hiding fish. Perhaps the eel needs this clue to the prey's location because its radar system can't always detect a fish that is motionless.

But gathering evidence for this idea was tricky. How could Catania show that the twitch allowed the eel to figure out the prey's position? Maybe the the twitch wasn't important. Those two pulses might just have been a warm-up for the full attack.

To find out, Catania devised another experiment. First, he hooked up another dead goldfish to a device called a stimulator. Through wires attached to the goldfish's body, the device transmitted an electrical pulse that forced the fish to twitch. Before Catania turned it on, he put the fish in a plastic bag. Plastic doesn't conduct electricity very well. Here, then, the bag blocked the eel's pulses.

Catania watched what happened when the stimulator was inactive and the fish stayed still. The eel gave off a pair of pulses, as usual. Since the plastic bag shielded the fish, it didn't twitch. The eel didn't attack the fish.

Then Catania used the stimulator to make the goldfish twitch after the eel's two pulses. This time, the eel did attack. The result suggested that the fish needed those twitches to detect its prey.

In a way, the eel is performing "remote control" on the fish, says Catania. The eel can make the fish move without even touching it.

Confused eels

Catania had uncovered some impressive eel strategies. But his work wasn't over yet. Each experiment just raised another question. He noticed that when the fish in the plastic bag twitched, the eel lunged toward it to attack. But it didn't end up biting the fish. It moved in the right direction, but then it gave up. "The fish is right there in front of them," says Catania. "So what's the deal there?" Was the eel missing something crucial?

The fish's twitch gave the eel a hint to its general location — like "I'm off to your right." But maybe the eel needed more information to zero in on the exact spot.

Plus, the prey might move to a new location after it twitched. Even if the eel's attack froze the fish's muscles, it could still drift through the water. And eels don't have good vision.

Catania wondered if the eel needed to track its prey using electrical pulses (which the plastic bag blocked). He knew that electric eels use their weak pulses as "radar" to detect prey. During an attack, though, the eel's pulses switch from weak to strong. The animal can't emit both types at the same time.

So Catania found himself wondering whether the eel also used its strong pulses as radar. That would be surprising. Scientists thought that eels used the strong pulse only as a weapon.

To find out, Catania repeated his experiment — but added a twist. He dropped a carbon rod into the tank. The rod would conduct electricity. Catania used the stimulator to make the goldfish in the plastic bag twitch. But this time, something weird happened. The eel lunged toward the fish, but then it changed direction and attacked the carbon rod instead!

Why? The eel was releasing strong pulses to try to freeze its prey. But those strong pulses also acted as radar. The plastic bag shielded the goldfish from the radar, but the carbon rod was not as lucky. The eel detected the rod, thought that it was the prey and attacked that, instead.

Catania did many more experiments to make sure his idea was right. He put plastic rods in the tank along with the carbon rod. Since plastic doesn't conduct electricity well, the eel's radar couldn't detect those rods. Sure enough, the eel ignored plastic ones, attacking only the carbon.

Then he put the carbon rod on a spinning disk to find out how well the eel could track a fast-moving object. The eel chased and struck the moving rod.

Catania also did the experiments in the dark, using only infrared light. The eel couldn't see anything in that type of light, yet it still behaved the same way. So vision wasn't that important in the eel's hunt.

All the experiments suggested that the electric eel relies on its strong electrical bursts to track prey. In other words, the strong pulses are both a weapon and a sensory system. "It's like having laser vision," says Catania. Think about a cartoon character that uses its eyes to see but also to shoot deadly laser beams. That's sort of what the eel is doing with its zaps.

A sophisticated hunter

Catania had put together a lot of puzzle pieces. He discovered that the electric eel first emits two pulses to make its prey twitch. Then it releases hundreds of strong pulses. The bombardment does two things at the same time: it freezes the prey's muscles and helps the eel track the prey's exact location.

These eels pull out all the stops to make sure they get their meal. "They're even more sophisticated than we thought," says Stoddard. "They're not running purely on brute force."

When Catania first brought electric eels into his lab, he never thought he would learn so much about them. He thought he might take some cool videos to show his students in class and write his book chapter. "Instead, I ended up stumbling into this thing that was just so interesting that I had to pursue it," he says. Every time he watched the eels closely, a new question arose — and he wanted to answer it.

Catania has not yet been shocked by a big electric eel, only small ones. "I'm very curious," he admits. But he has decided that he doesn't need to know first-hand what the full force of an electric eel attack feels like. That's one question he'll leave unanswered.

Adapted from: https://www.sciencenewsforstudents.org

Explaining Nuclear Energy

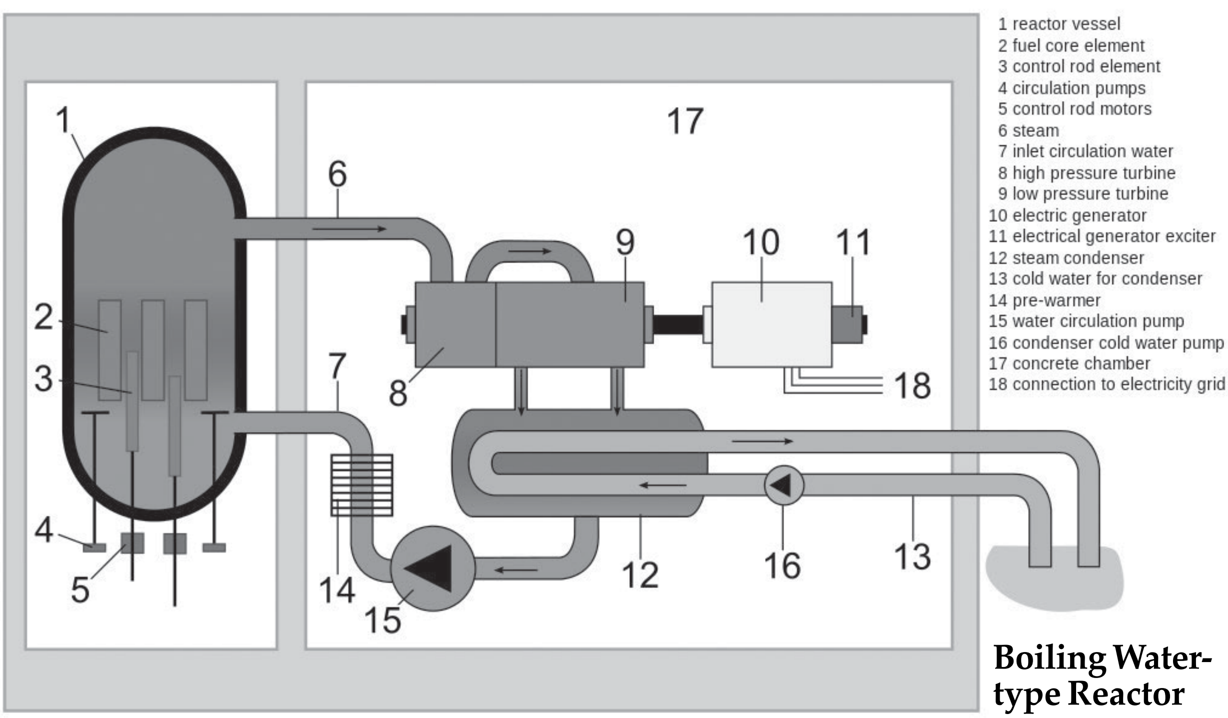
Atoms and what's inside them

The nucleus is at the centre of an atom. Atoms make up everything in the universe and are held together with great force. The nucleus contains the positively charged protons and the neutral neutrons which are held together by the **strong force**. The negatively charged electrons are outside the nucleus and are bound to the nucleus through **electric forces**.

In a process called *fission*, atoms are broken apart. Unlike chemical interactions which involve loss or gain of electrons, here the nucleus of the atom is also broken up. Since the nucleus is very tightly bound, breaking it up causes a large amount of energy to be released. For example, it is about 100,000 times more than the energy released when the electron of an atom interacts instead. The energy released can be used to generate electricity at power plants.

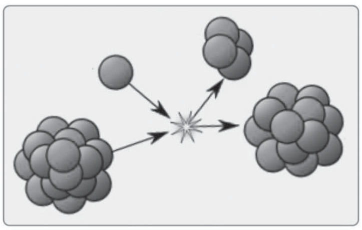
Chain Reaction

Atoms of uranium, a common element



Boiling Water-type Reactor

nuclear physics



Nuclear physics is the field of physics that studies atomic nuclei and their constituents and interactions. The most commonly known application of nuclear physics is nuclear power generation, but the research has led to applications in many fields, including nuclear medicine and magnetic resonance imaging, nuclear weapons, ion implantation in materials engineering, and radiocarbon dating in geology and ...

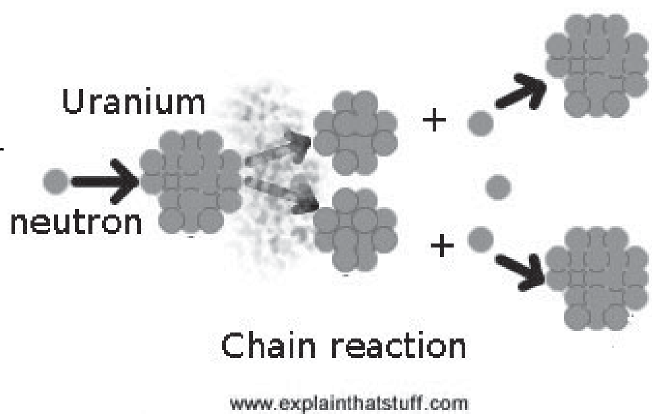
that can be mined from the Earth, are typically used in nuclear reactions. In fission, a free neutron hits a uranium atom. The atom splits, releasing more neutrons. These in turn hit more uranium atoms, breaking them up and releasing more neutrons and generating a chain reaction. That reaction releases huge amounts of energy. That energy can boil water to create steam, which in turn causes turbines to spin, generating electricity in a power plant. The last stage is the same as in any other power plant such as diesel, coal, hydro-electric, etc.

What is a nuclear reactor?

A nuclear reactor is the device in a power plant where fission takes place. Pieces of uranium about the size of your fingertip get stacked up in 12-foot-long metal tubes, called rods. Bunches of rods form the core of the reactor. It is enclosed in a giant concrete dome that's reinforced in case it explodes. In the heart of the reactor (the core), atoms split apart and release heat energy, producing neutrons and splitting other atoms in a carefully controlled nuclear reaction.

How is the reaction controlled?

The number of neutrons available (to split more uranium) decides the rate of the reaction. *Control rods* made of materials such as cadmium and boron can be raised or lowered into the reactor to soak up



neutrons and slow down or speed up the chain reaction.

How is the energy taken out?

Water is pumped through the reactor to collect the heat energy that the chain reaction produces. It constantly flows around a closed loop linking the reactor with a heat exchanger. Inside the heat exchanger, the water from the reactor gives up its energy to cooler water flowing in another closed loop, turning it into steam. Using two unconnected loops of water and the heat exchanger helps to keep water contaminated with radioactivity safely contained in one place and well away from most of the equipment in the plant. The steam from the heat exchanger is piped to a turbine. As the steam blows past the turbine's vanes, they spin around at high speed. The spinning turbine is connected to an electricity generator and makes that spin too. The generator produces electricity that flows out to the power grid—and to our homes, shops, offices, and factories.

Can a nuclear reactor explode?

One reason many people oppose nuclear power is because they think nuclear plants are like enormous nuclear bombs, just waiting to explode and wipe out civilization. It's true that nuclear plants and nuclear bombs are both based on nuclear reactions in which atoms split apart, but that's generally where the similarity begins and ends.

To start with, very different grades of uranium are used in power plants and nuclear bombs. Bombs need extremely pure (enriched) uranium-235, which is made by removing contaminants (notably another isotope of uranium, uranium-238) from

Test the speed of water molecules with food coloring

Water Molecules on the Move

This experiment is great for testing if hot water molecules really move faster than cold ones. Pour some water, drop in some food coloring and compare results.

What you'll need:

A clear glass filled with hot water
A clear glass filled with cold water
Food coloring, An eye dropper

Instructions:

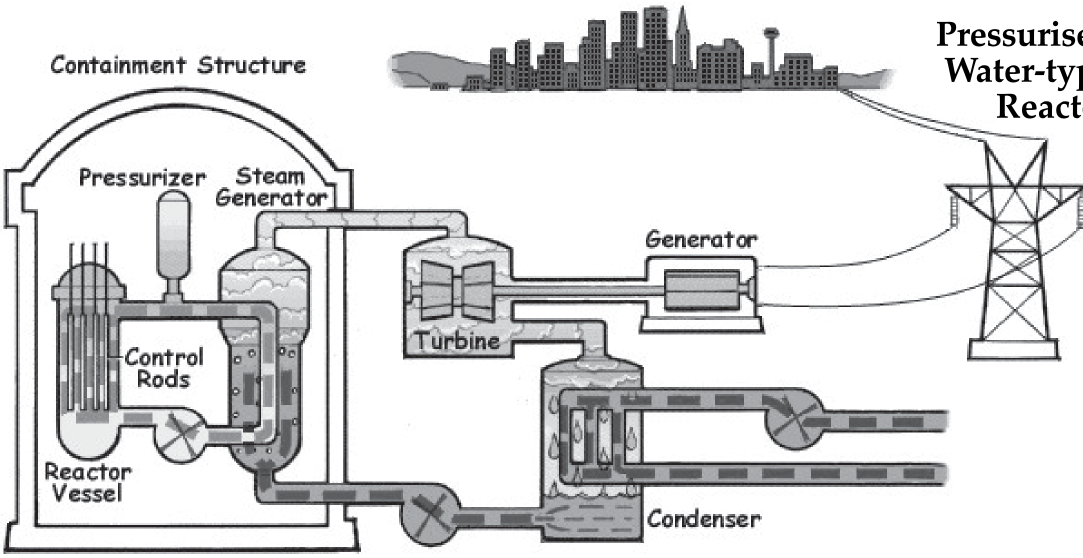
Fill the glasses with the same amount of water, one cold and one hot.

Put one drop of food coloring into both glasses as quickly as possible.

Watch what happens to the food colouring.

What's happening?

If you watch closely you will notice that the food coloring spreads faster throughout the hot water than in the cold. The molecules in the hot water move at a faster rate, spreading the food coloring faster than the cold water molecules which mover slower.



Pressurised Water-type Reactor

naturally occurring uranium. Unless the contaminants are removed, they stop a nuclear chain reaction from occurring. Power plants can work with less purified, much more ordinary uranium providing they add another substance called a *moderator*.

So what happens if the reaction inside a power plant starts to run out of control? If that happens, as it happened in 2011 in Fukushima in Japan, so much energy is released that the reactor overheats and may even explode—but in a relatively small, entirely conventional explosion, not an apocalyptic nuclear bomb. In that situation, the moderator burns or melts, the reactor is destroyed, and the nuclear reaction stops; there is no runaway chain reaction. The worst situation is called a *meltdown*: the reactor melts into a liquid, producing a hot, radioactive glob that drops deep down into the ground, potentially contaminating water supplies.

There are various other important differences that stop nuclear power plants from turning into nuclear bombs.

Advantages and Disadvantages of nuclear power

Nuclear plants can produce large amounts of power compared to coal or other plants. They also produce much lower carbon emissions than fossil fuel plants (coal, oil, and natural gas).

However, waste from nuclear plants remains dangerously radioactive for many years, so it's difficult to dispose of safely. Nuclear plants can produce long-range air pollution and water pollution. Nuclear plants aren't sustainable or renewable forms of energy, because they rely on mining limited reserves of uranium. Nuclear plants are expensive and take many years to construct, usually in the face of fierce public opposition. Since nuclear plants need huge amounts of cooling water, they're often built by the coast—but that makes them dangerously susceptible to rising sea levels and earthquake tsunamis. At the end of their life, nuclear plants are very expensive to decommission safely.

Adapted from various sources

Nuclear Facts

Nuclear Facts

- The word 'nuclear' is related to the nucleus of an atom, it is often used to describe the energy produced when a nucleus is split (fission) or joined with another (fusion).
- The nucleus is positively charged and found at the central core of an atom.
- Nuclear physics is the study of atomic nuclei and their interactions.
- Nuclear power uses fission to create heat and electricity.
- The US, France and Japan are the largest producers of nuclear power.
- Nuclear power provides around 14% of the world's electricity.
- Nuclear power plants have a relatively good safety record but there is ongoing debate into the threat they pose, especially after widely publicized accidents at Chernobyl, Three Mile Island and Fukushima.
- The radioactive waste produced by nuclear reactors can be difficult to dispose of safely.
- The military often use nuclear reactors to power their submarines and aircraft carriers.
- Nuclear weapons use the energy produced by fission or fusion to create destructive blasts.
- While many nuclear weapons have been used in testing, only 2 have been used as part of warfare.
- In August 1945, near the end of World War 2, the United States used atomic bombs on the Japanese cities of Hiroshima and Nagasaki, leading to the death of approximately 200000 people.
- Enriched uranium is a crucial element of both nuclear weapons and nuclear power production.
- The Sun creates energy through the nuclear fusion of hydrogen nuclei into helium.
- It is believed that radiation exposure led to the death of Marie Curie in 1934.

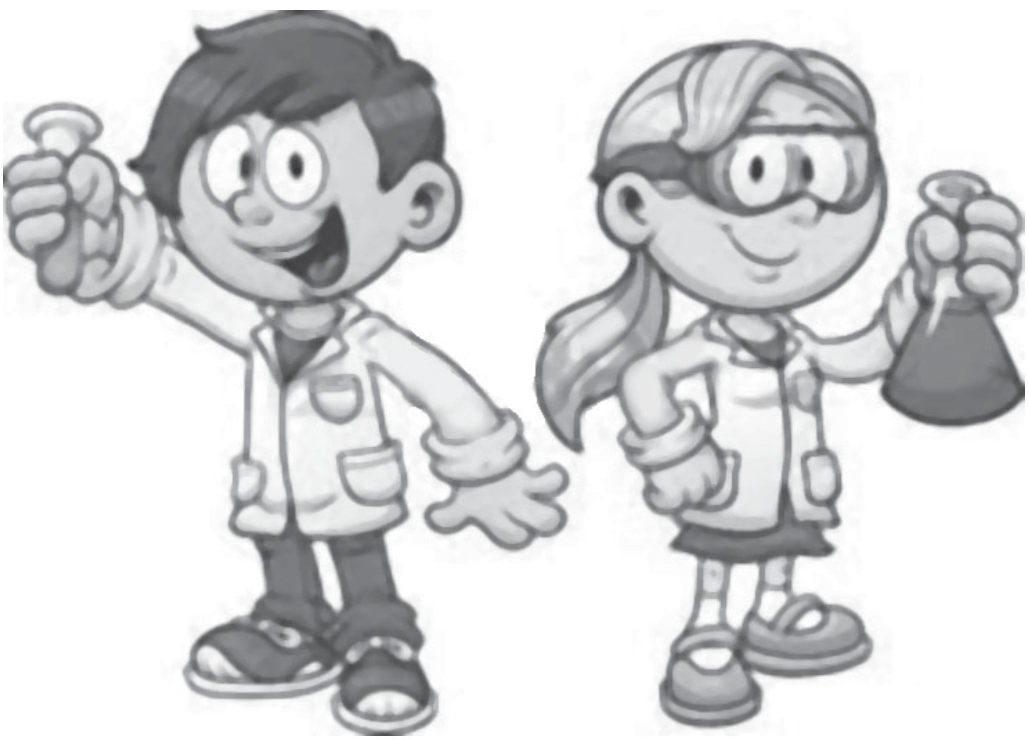
Acid & Base Activities

Learn about the differences between an acid and a base, make sherbet and experiment with universal indicator paper to see which substances are acids and which are bases. This fun lesson plan is perfect for teaching kids about chemistry.

Testing For Acids & Bases:

Use universal indicator paper to test which substances are acids and which are bases. After adding certain substances and solutions to your universal indicator paper it will change color, the color it changes to depends on how strong an acid or base it is.

Do some tests on various substances you can find such as lemon juice, ammonia, cleaning products, tap water, pure water, soft drinks and more. Record your results, were they what you expected?



Chemical Reaction:

For a fun acid and base activity that's easy to do try adding baking soda (a base) to vinegar (an acid) and see what happens. Combining the two should create an exciting chemical reaction for you to enjoy.

To understand what happens, you can use turmeric as an indicator. Make a solution of 1 spoon turmeric in 5 spoons of water. It is yellow in colour. Now take two spoonfuls of lemon juice in one bowl. In another bowl, make a soap solution with two spoons of water and some soap. Into each bowl, add a few drops of turmeric water. The soap water turns red while there is no change in the lime water. All bases (soap water contains sodium hydroxide which is a base) turn turmeric red while acids (like lemon juice) don't affect it.

Now do one more experiment. Stir the red soap water and add lemon juice drop by drop to it. After some time, the red colour gets bleached and the liquid turns yellow (turmeric colour). This is because the acid and base have neutralised each other and converted into salt and water, neither of which can change the colour of turmeric.

Sherbet Making Activity:

You may be familiar with sherbet, it's a tasty treat for kids and also great for talking about acids and bases. Why? Let's find out!

Sherbet is great because it contains both an acid and a base which react when they are together. The key is that they don't react until they reach your tongue. Why? Because this chemical reaction needs moisture to get it started. So where does this moisture come from? It comes from your mouth! That's right, there's a chemical reaction going on in your mouth when you

eat sherbet.

Try making some sherbet of your own and give it a try:

Find a bowl and make sure it's clean and dry.

Mix together the following ingredients:

1/2 teaspoon of citric acid crystals

1 teaspoon of icing sugar

1/2 teaspoon of drink crystals such as Tang

1/4 teaspoon of bicarbonate of soda (baking soda)

Stir everything together and then have a taste of your delicious sherbet! Can you tell that there's a chemical reaction happening on your tongue?

Learn About Crystals: Fun Crystal Activities

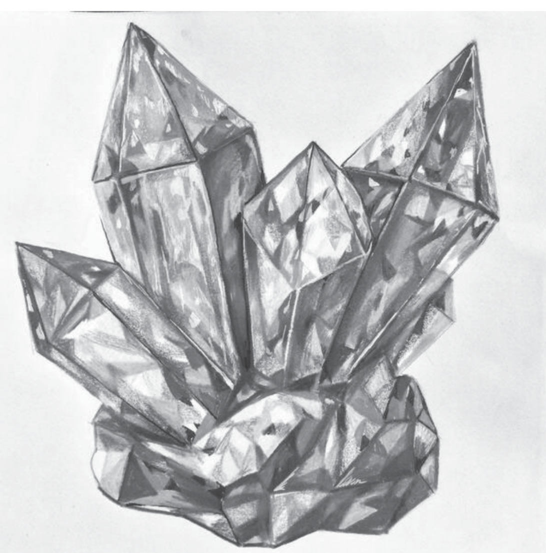
Crystals are special structures that can be used in a number of great science experiments. Try these fun crystal activities and learn about their physical properties and have fun at the same time.

Introduction:

What do you know about crystals? Perhaps you have seen jelly crystals, sugar and salt crystals in the kitchen cupboard at home.

A crystal is a regularly shaped solid with flat surfaces. The tiny particles inside the crystals are arranged side by side, and on top of each other in symmetrical patterns. This is what makes a crystal special.

No two crystals are the same and there are lots of different shapes that crystals can make, the flat surfaces of these crystals are called 'faces'.



Not all crystals you see will actually look like crystals to you, this is because they aren't perfectly formed. Sometimes there is not enough space or it's too hot or cold for the crystals to grow perfectly. When this happens you often end up with different and unusual looking crystals.

Crystals that are perfectly formed are often worn as jewelry because of their beautiful aesthetic quality.

Now that we know a little bit more about crystals, let's try some fun activities!

Crystal Activities:

Make a crystal solution and try creating your own 3D snow picture.

Create a crystal solution by mixing 2 cups of sugar (or 3 tablespoons of borax) into a cup of hot water until it is fully dissolved.

Find a piece of black card.

Dip your paintbrush into the crystal solution.

Paint your snow picture. (It will be invisible at first so you will have to imagine what you are drawing).

Hold the picture in front of a hot stove and your picture will appear like magic.

So what's happening? The liquid in the solution evaporates, leaving behind a film of delicate crystals in the shape of what you drew earlier.

Copper Sulphate Crystals

Take a clean film canister.

Put one teaspoon of copper sulfate (blue powder) into your film canister (small plastic bottle with a tight lid).

Half fill the canister with warm water (adult supervision is a good idea for this part).

Put the lid on firmly, and shake gently for around 30 seconds.

When you get home, take the lid off the canister and put it in the sun and watch as your crystals grow.

Remember to wash your hands and clean up any mess when you're finished. Don't taste the crystals! They are toxic!!

If you want to grow really big crystals, use 100 gm of copper sulfate and 100 ml of cold water. Keep dissolving the powder until no more dissolves. The solution is called super-saturated. Filter the solution to remove any excess powder using a filter paper. Leave the solution undisturbed for some time, until you see some small crystals forming. Choose just one crystal and filter out the rest. Put the single crystal back in the water and leave it undisturbed. A big crystal will form from the small seed that you started with. You need patience: it can take several weeks to a month or two to get really large crystals.

Warning: If there are very young children, use alum (potassium aluminium sulfate) instead of copper sulfate since it is not toxic.

If you are careful, you can also make nickel sulphate crystals instead. Here you can obtain two types of nickel sulphate crystal. If you heat the solution up to 30° C, you get turquoise coloured crystals, and if the solution's temperature exceeds 30° C, you get translucent green crystals. These are also toxic, so handle them with care.

Chemistry Word Search

Step up to the challenge of our chemistry word search for kids. Do you have what it akes to find the range of words related to atoms, elements and experiments?

Give it your best shot to see how many you can find and have fun with our free hemistry word find puzzle game. This teaching resource is a fun and easy activity that will eep students happy and save teachers time.

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

ACID	ATOM	BASE
CARBON	CHEMIST	COMPOUND
CRYSTAL	ELEMENT	ENERGY
EXPERIMENT	GAS	HYDROGEN
LIQUID	MOLECULE	OXYGEN
SODIUM	SOLID	STRUCTURE
SUBSTANCE	URANIUM	

Math Facts for Kids

Enjoy a wide range of fun math facts for kids. Check out some cool trivia related to the things that make mathematics such an interesting subject.

Learn about amazing numbers that are so big it's hard to even understand them. Find facts about the golden ratio, pi, geometry, prime numbers and much more. Read on and have fun learning about math!

- Mathematics is important in many different types of jobs, including engineering, business, science, medicine and more.

- It is believed that Ancient Egyptians used complex mathematics such as algebra, arithmetic and geometry as far back as 3000 BC.

- It wasn't until the 16th century that most mathematical symbols were invented. Before this time math equations were written in words, making it very time consuming.

- What comes after a million, billion and trillion? Why a quadrillion, quintillion, sextillion, septillion, octillion and nonillion of course.

- Cutting a cake into 8 pieces is possible with just 3 slices, can you work out how?

- An icosagon is a shape with 20 sides.

- A three dimensional parallelogram is called a parallelepiped.

- Trigonometry is the study of the relationship between the angles of triangles and their sides.

- The smallest ten prime numbers are: 2, 3, 5, 7, 11, 13, 17, 19, 23, 29.

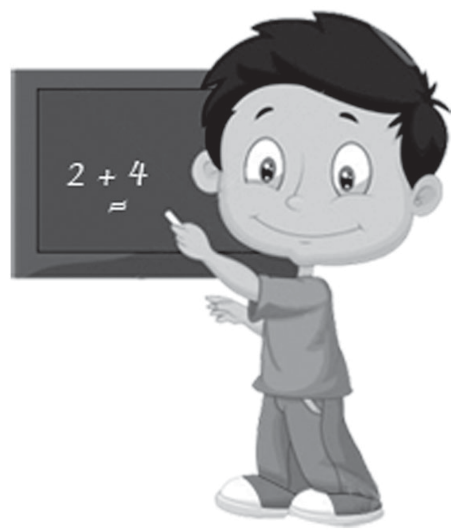
- The name of the popular search engine 'Google' came from a misspelling of the word 'googol', which is a very, very large number (the number one followed by one hundred zeros to be exact).

- A 'googolplex' is the number 1 followed by a googol zeros, this number is so big that it can't be written because there isn't enough room in the universe to fit it in! It would also take a length of time far greater than the age of the universe just to write the numbers.

- The number Pi (the ratio of the circumference to the diameter of a circle) can't be expressed as a fraction, this means it is an irrational number. When written as a decimal it never repeats and never ends.

- Here is Pi written to 50 decimal places: 3.14159265358979323846264338327950288419716939937510

- If two quantities have a ratio of approximately 1.618, they are said to be in the golden ratio. This ratio has been used throughout history to design aesthetically pleasing art works such as the Parthenon. It also appears in paintings, music, the design of books, and even in nature.



Make a parachute!

Design and Test a Parachute

Learn about air resistance while making an awesome parachute! Design one that can fall slowly to the ground before putting it to the test, making modifications as you go.

What you'll need:

A plastic bag or light material

Scissors

String

A small object to act as the weight, a little action figure would be perfect

Instructions:

Cut out a large square from your plastic bag or material.

Trim the edges so it looks like an octagon (an eight sided shape).

Cut a small whole near the edge of each side.

Attach 8 pieces of string of the same length to each of the holes.

Tie the pieces of string to the object you are using as a weight.

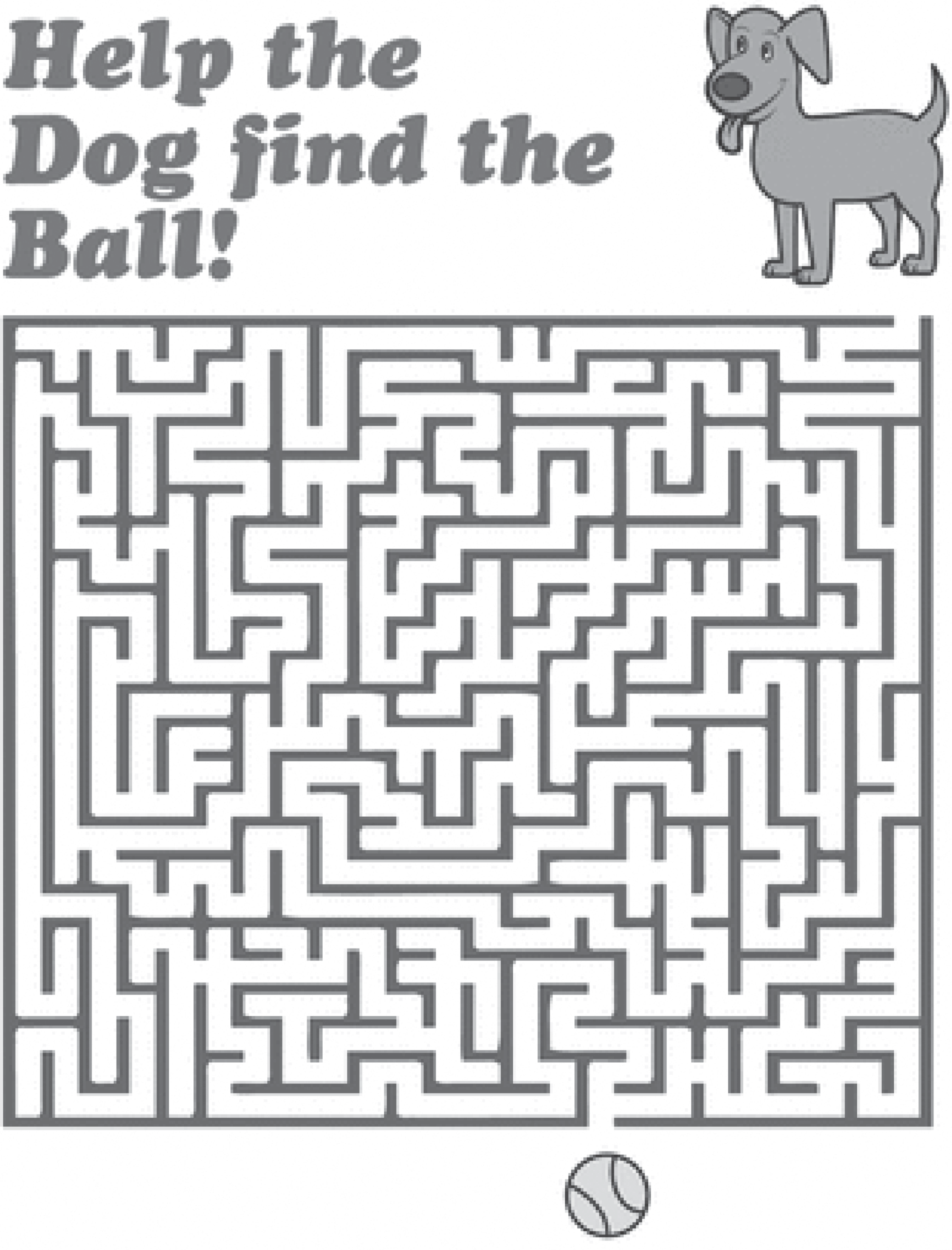
Use a chair or find a high spot to drop your parachute and test how well it worked, remember that you want it to drop as slow as possible.

What's happening?

Hopefully your parachute will descend slowly to the ground, giving your weight a comfortable landing. When you release the parachute the weight pulls down on the strings and opens up a large surface area of material that uses air resistance to slow it down. The larger the surface area the more air resistance and the slower the parachute will drop.

Cutting a small hole in the middle of the parachute will allow air to slowly pass through it rather than spilling out over one side, this should help the parachute fall straighter.

Help the Dog find the Ball!



The Intriguing History of the Indian Rupee and its Evolution

The history of Indian currency not only spans centuries but also boasts quite a fascinating past. Read on for a brief glimpse of India's – and your wallet's – financial history.

The rupee in your pocket has a mysterious past. Behind Mahatma Gandhi's smiling face lies a long history of struggle, exploration, and wealth that can be traced back to the ancient India of the 6th century BC. Let's demystify this history by bringing you the interesting stories about how Indian currency has evolved over the ages into the rupee of today.

Ancient Indians were the earliest issuers of coins in the world, along with the Chinese and Lydians (from the Middle East). The first Indian coins – punch marked coins called Puranas, Karshapanas or Pana – were minted in the 6th century BC by the Mahajanapadas (republic kingdoms) of ancient India. These included Gandhara, Kuntala, Kuru, Panchala, Shakya, Surasena, and Saurashtra.

Made of silver of a standard weight but with irregular shapes, these coins had different markings – for example, Saurashtra had a humped bull, Dakshin Panchala had a Swastika, and Magadha had several symbols.

Then came the Mauryas who punch marked their coins with a royal standard. Chanakya, prime minister to the first Mauryan emperor Chandragupta Maurya, mentions the minting of coins such as rupyarupa (silver), suvarnarupa (gold), tamararupa (copper) and sisarupa (lead) in his Arthashastra treatise.

The Indo-Greek Kushan kings who came

next introduced the Greek custom of engraving portrait heads on coins. Their example was followed for eight centuries. The extensive coinage of the Kushan empire also influenced a large number of tribes, dynasties, and kingdoms, which began issuing their own coins.

Kushan coins had the diademed, helmeted bust of the king on one side, and the king's favourite deity on the reverse.

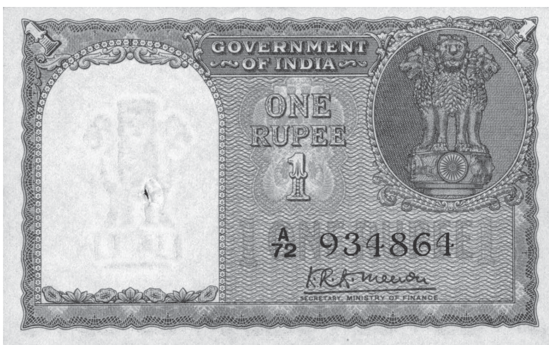
The Gupta Empire produced large numbers of gold coins depicting the Gupta kings performing various rituals. This tradition of intricately engraved coins continued till the arrival of the Turkish Sultanate in North India.

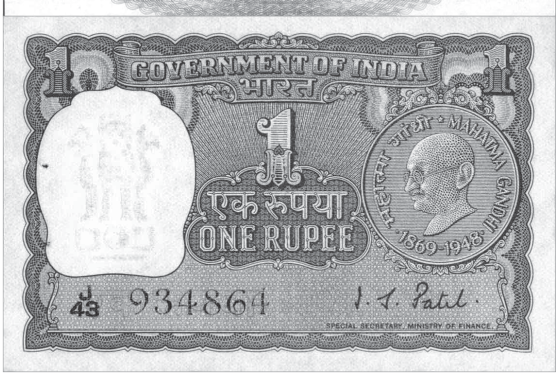
The Gupta coins, with their many varieties and inscriptions in Sanskrit, are among the finest India has produced.

By the 12th century AD, the Turkish Sultans of Delhi had replaced the royal designs of Indian kings with Islamic calligraphy. The currency – made in gold, silver and copper – was now referred to as tanka, with the lower valued coins being called jittals. The Delhi Sultanate also attempted to standardise the monetary system by issuing coins of different values.

The commencement of the Mughal Empire from 1526 AD brought forth a unified and consolidated monetary system for the entire empire.

But the defining moment in the evolution of the rupee occurred when, after defeating Humayun, Sher Shah Suri set up a new civic and military administration. He issued a coin of silver, weighing 178 grains, which was termed the rupiya and was





divided into 40 copper pieces or paisa. The silver coin remained in use during the remaining Mughal period.

By the time the British East India Company set itself up in India in the 1600s, Sher Shah's silver rupiya had already become the popular standard currency in the country. Despite many attempts to introduce the sterling pound in India, the rupaiya grew in popularity and was even exported as a currency to other British colonies.

In 1717 AD, the English obtained permission from Mughal emperor Farrukh Siyar to coin Mughal money at the Bombay Mint. The British gold coins were termed carolina, the silver coins angelina, the copper coins cupperoon, and the tin coins tinny.

Paper money was first issued in British India in the 18th century, with the Bank of Hindostan, General Bank in Bengal and the Bengal Bank becoming the first banks in India to issue paper currency.

The oldest surviving banknote in India was issued by the Bank of Bengal – a Two Hundred and Fifty Sicca Rupees note dated September 3, 1812.

After the 1857 revolt, the British made the rupee the official currency of colonial India, with the head of King George VI replacing native designs on banknotes and coins.

In 1862, the Victoria portrait series of bank notes and coins were issued in honour of Queen Victoria and later, many emperors followed suit. For security reasons, the notes of this series were cut in half; one half was sent by post and upon confirmation of receipt, the other half was sent.

The Reserve Bank of India was formally set up in 1935 and was empowered to issue Government of India notes. RBI also printed 10,000 rupee notes (the highest denomination RBI has ever printed in its history) that were later demonetised after independence.

The first paper currency issued by RBI was a 5 rupee note bearing King George VI's portrait, in January 1938.

After India became independent in 1947, India's monetary system remained unchanged for a while, with 1 rupee consisting of 64 pice. The first banknote printed by independent India was a 1 rupee note.

On August 15, 1950, the new 'anna system' was introduced – the first coinage of the Republic of India. The British King's portrait was replaced with the engraving of Ashoka's Lion Capital of Sarnath, and the tiger on the 1 rupee coin was replaced with a corn sheaf. One rupee now consisted of 16 annas.

The 1955 Indian Coinage (Amendment) Act, which came into force on April 1, 1957, introduced a 'decimal series'. The rupee was now divided into 100 paisa instead of 16 annas or 64 pice.The coins were initially called naye paise, meaning new paise, to distinguish them from the previous coins.

In order to aid the blind in the country, each coin had distinctly different shapes – the round 1 naya paisa, scalloped edge 2 naya paisa, the square 5 naya paisa, and the scalloped edge 10 naya paisa.

Also, prior to Independence, the Indian currency was pegged against silver. The silver-based rupee fluctuated according to the value of silver and had a distinct disadvantage when trading against currencies that were based on the gold standard. This was rectified post-Independence.

In 1959, a special issue of Rupees 10 and Rupees 100 notes took place for Indian Haj pilgrims so as to ease money exchange with the local currency in Saudi Arabia.

In 1969, the Mahatma Gandhi Birth Centenary Commemorative Issue was released. It was the only commemorative note issue ever by the Reserve Bank of India.

Later, in 1996, the 'Mahatma Gandhi Series' was introduced with prominent new features such as changed watermarks, windowed security threads, latent images, and intaglio features for the visually handicapped. This was replaced in 2005 by the 'MG series' notes that had some additional security features.

In 2010, India celebrated its hosting of the Commonwealth Games with commemorative 2 and 5 Rupee coins. One side of these coins features the logo of the Games while the other features the three lions from the pillar of Ashoka. In the same year, India also adopted the new symbol for the rupee ₹, with new coins bearing this symbol being launched in 2011.

Since 2010, other commemorative coins have also been issued – 60th anniversary of the Indian Parliament, 150th anniversary of Swami Vivekananda, and more recently, International Day of Yoga.

Electricity for Kids

Static Electricity

Static electricity is the build up of an electrical charge on the surface of an object. It's called "static" because the charges remain in one area for a while rather than moving or "flowing" to another area.

We see static electricity every day. It can even build up on us. For example, when we rub our feet on the carpet and then zap something when we touch it. That is static electricity that we have built up on the surface of our skin discharging onto another object. We also see it when our hair gets charged and sticks straight up or when our pant legs keep sticking to our legs no matter what we try and do.

This is all static electricity that has built up on the surface of an object. Lightning is a powerful form of static electricity.

What is static electricity?

In our study of atoms we learned that atoms are made up of neutrons, protons, and electrons. The electrons are spinning around the outside. A static charge is formed when two surfaces touch each other and the electrons move from one object to another. One object will have a positive charge and the other a negative charge. Rubbing the items quickly, like when you rub a balloon fast over something or your feet on the carpet, will build up a large charge. Items with different charges (positive and negative) will attract, while items with similar charges (positive and positive) will push away from each other. Sort of like a magnet.

Remember when you've gone down a slide and all your hair stands up straight. This is because the friction of sliding has caused a positive charge to be built up on each hair.

Since each hair has the same charge, they all try to push away from each other and end up standing up straight.

Likewise, when your skin is charged with static electricity and you touch something metal, like a door handle, the metal is very conductive and will quickly discharge the static electricity, creating a zap or small spark.

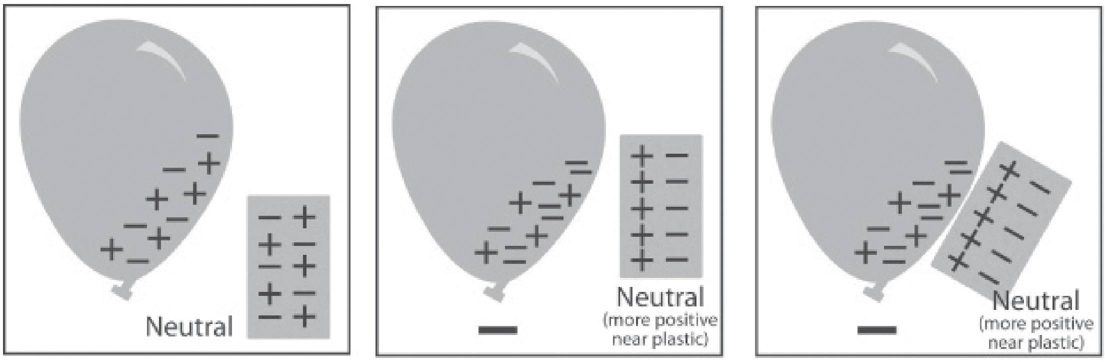
Does it have any real uses? Static electricity has several uses, also called applications, in the real world. One main use is in printers and photocopiers where static electric charges attract the ink, or toner, to the paper. Other uses include paint sprayers, air filters, and dust removal. It can damage electronics Static electricity can also cause damage. Some electronic chips, like the kind that are in computers, are very sensitive to static electricity.

There are special bags to store these in. Also, people that work with these kind of electronics wear special straps that keep them "grounded" so they won't build up charge and ruin the electronic components.

Fun facts about static electricity

A spark of static electricity can measure thousands of volts, but has very little current and lasts for a short period of time. This means it has little power or energy.

Lighting is a powerful and dangerous example of static electricity. As dangerous as lighting is, around 70% of people struck by lightning survive. Temperatures in a lightning bolt can hit 50,000 degrees F. Static electricity will be worse on a dry non-humid day.



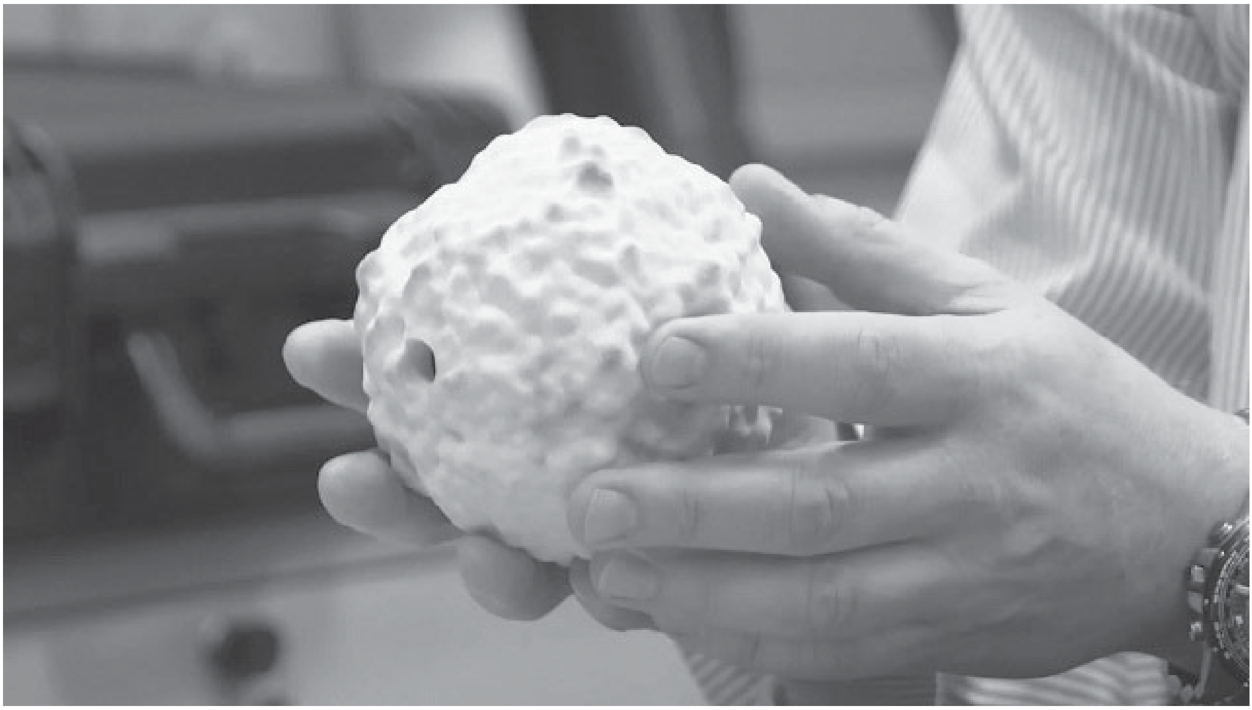
You Can 3D Print Your Own Mini Universe

Hanneke Weitering

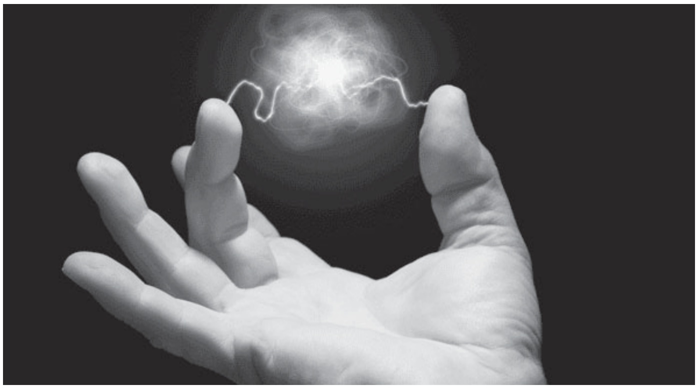
Have you ever wondered what the universe looks like in all of its entirety, or how it would feel to hold the universe in the palm of your hand? Good news: It is now possible to do both of these things — all you need is a 3D printer.

Researchers at the Imperial College London have created the blueprints for 3D printing the universe, and have provided the instructions online so anyone with access to a 3D printer can print their own miniature universe. You can see a video on the science behind the 3D-printed universe here: http://www.space.com/34579-3d-printer-puts-baby-universe-in-the-palm-of-your-hand-video.html.

The researchers' representation of the universe specifically depicts the cosmic



microwave background (CMB), or a glowing light throughout the universe that is thought to be leftover radiation from the Big Bang, when the universe was born about 13.8 billion years ago.



At first, the universe was a dense fog of plasma (a cloud of charged particles) and radiation. Once it expanded and became more transparent, the CMB was born. This happened 380,000 years after the Big Bang, the researchers said.

A 3D-printed model of the cosmic microwave background is shown on the previous page. The colours (not visible here) and texture represent temperature and density. (Photo credit: Dave Clements, Imperial College, London).

The CMB is the earliest radiation astronomers have detected in space. Although observers can't see it with the naked eye, measuring the CMB can reveal details about the structures in the universe, including temperature and density.

"The big bumps — that's where the microwave background is a little bit hotter than average, and the blue bits are where the microwave background is a little bit cooler," Dave Clements, a physicist at Imperial College and the lead researcher of the 3D-printed universe project, said in a video.

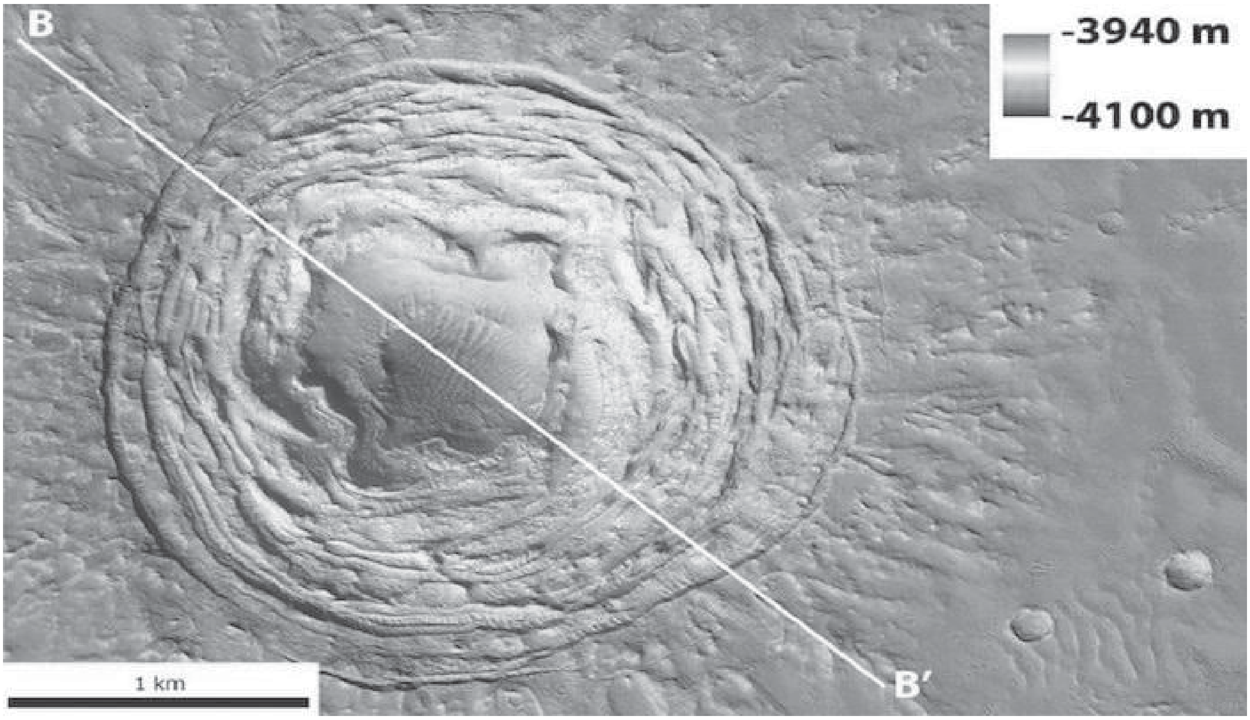
Red bits are warmer and denser than the cooler-colored regions and are "the seeds for the formation of structure," Clements explained. These areas clumped together through gravitational attraction to form the stars and galaxies seen today.

Clements and his team decided to 3D print the universe to get a better perspective of all the data about the CMB collected by the European Space Agency's Planck satellite, Clements said. Launched in 2009, the Planck satellite has been studying the early universe by measuring the CMB from orbit 930,000 miles (1.5 million kilometers) above the Earth.

Instead of sifting through intricate 2D maps of the universe, Clements and his team thought it would be easier to visualize the CMB in three dimensions, Clements said.

"Presenting the CMB in a truly 3D form that can be held in the hand and felt rather than viewed has many potential benefits for teaching and outreach work, and is especially relevant for those with a visual disability," Clements said in a statement.

A paper describing the process was published Oct. 28 in the European Journal of Physics. The files needed to print your own 3D miniature universe are free to download here.



A funnel on Mars could be a place to look for life

A strangely shaped depression on Mars could be a new place to look for signs of life on the Red Planet, according to a University of Texas at Austin-led study. The depression was probably formed by a volcano beneath a glacier and could have been a warm, chemical-rich environment well suited for microbial life.

The findings were published this month in Icarus, the International Journal of Solar System Studies.

"We were drawn to this site because it looked like it could host some of the key ingredients for habitability -- water, heat and nutrients," said lead author Joseph Levy, a research associate at the University of Texas Institute for Geophysics, a research unit of the Jackson School of Geosciences.

The depression is inside a crater perched on the rim of the Hellas basin on Mars and surrounded by ancient glacial deposits. It first caught Levy's attention in 2009, when he noticed crack-like features on pictures of depressions taken by the Mars Reconnaissance Orbiter that looked similar to "ice cauldrons" on Earth, formations found in Iceland and Greenland made by volcanos erupting under an ice sheet. Another depression in the Galaxias Fossae region of Mars had a similar appearance.

"These landforms caught our eye because they're weird looking. They're concentrically fractured so they look like a bulls-eye. That can be a very diagnostic pattern you see in Earth materials," said Levy, who was a postdoctoral researcher at Portland State University when he first saw the photos of the depressions.

But it wasn't until this year that he and his research team were able to more thoroughly analyze the depressions using stereoscopic images to investigate whether the depressions were made by underground volcanic activity that melted away surface ice or by an impact from an asteroid. Study collaborator Timothy Goudge, a postdoctoral fellow at the institute, used pairs of high-resolution images to create digital elevation models of the depressions that enabled in-depth analysis of their shape and structure in 3-D. Researchers from Brown University and Mount Holyoke College also participated in the study.

"The big contribution of the study was that we were able to measure not just their shape and appearance, but also how much material was lost to form the depressions. That 3-D view lets us test this idea of volcanic or impact," Levy said.

The analysis revealed that both depressions shared an unusual funnel shape, with a broad perimeter that gradually narrowed with depth.

"That surprised us and led to a lot of thinking about whether it meant there was melting concentrated in the center that removed ice and allowed stuff to pour in from the sides. Or if you had an impact crater, did you start with a much smaller crater in the past, and by sublimating away ice, you've expanded the apparent size of the crater," Levy said.

After testing formation scenarios for the two depressions, researchers found that they probably formed in different ways. The debris spread around the Galaxias Fossae depression suggests that it was the result of an impact -- but the known volcanic history of the area still doesn't rule out volcanic origins, Levy said. In contrast, the Hellas depression has many signs of volcanic origins. It lacks the surrounding debris of an impact and has a fracture pattern associated with concentrated removal of ice by melting or sublimation.

The interaction of lava and ice to form a depression would be an exciting find, Levy said, because it could create an environment with liquid water and chemical nutrients, both ingredients required for life on Earth. He said that the Hellas depression and, to a lesser extent, the Galaxias Fossae depression, should be kept in mind when looking for habitats on Mars.

Gro Pedersen, a volcanologist at the University of Iceland who was not involved with the study, agrees that the depressions are promising sites for future research.

"These features do really resemble ice cauldrons known from Earth, and just from that perspective they should be of great interest," Pedersen said. "Both because their existence may provide information on the properties of subsurface material -- the potential existence of ice -- and because of the potential for revealing ice-volcano interactions."

Ancient Scratched Stones: World's Earliest Maps or Magic Artifacts?

Tom Metcalfe

A set of broken stones covered with etchings of lines and squares, discovered at a 5,000-year-old sacred site in Denmark, may be some of humankind's earliest maps, according to archaeologists.

One of the 5,000-year-old "map stones" discovered on the island of Bornholm in Denmark, which may show fields, fences and crops, is shown in the picture.

The researchers think the inscribed stones are symbolic maps of local landscapes, and were perhaps used in rituals by Stone Age farmers who hoped to magically influence the sun and the fertility of their farmlands.

Fragments of 10 of the "map stones" or "landscape stones" were found in June, during excavations of a round, earth-walled enclosure at the Vasagard archaeological site on Bornholm, a Danish island in the Baltic Sea.

Excavations of the enclosure since the 1990s have found hundreds of broken flat stones inscribed with patterns of radiating straight lines, called "sun stones" or "solar stones" ("solsten"in Danish). Archaeologists have said these artifacts are likely from the rituals of a Neolithic sun-worshipping religion that existed about 5,000 years ago.

But the map stones are inscribed with squares and lines that look like fields, fences and plants, said archaeologist Flemming Kaul, the curator and senior researcher in prehistory at the National Museum of Denmark.

"There was one particular stone that seems to be rather complicated, and we all agree that it looks like some sort of a map — not a map in our modern sense, but a stylized map," Kaul told Live Science. "And I could see some similarities with rock carvings from the Alps in northern Italy, dated to the same period of time, which are interpreted as symbolic landscapes — and that is what I believe we have found now."

Archaeologists think the lines and squares on the map stones are symbolic representations of Stone Age fields and fences.

Sacred territory

The most detailed of the newly discovered map stones went on display in October at the Moesgaard Museum in Aarhus, Denmark. It measures about 2 inches (5 centimeters) across, and has been

broken into three pieces. One triangular piece has not yet been found, the researchers said.

"That is one that seems to be very complex, with different sorts of fields, and something which looks like plants, which could be a symbol for a crop like barley, and other details that look like fences," Kaul said. "And it's fascinating that even though it's so small, you can certainly see that these patterns have been very deliberately made."

Kaul said the stone was probably crushed during an ancient ritual, like what the researchers saw with many sun stones also found at the site. The pieces were then deposited in the rings of ditches that surround the sacred enclosure sometime between 2900 B.C. and 2700 B.C., according to the archaeologists.

"Often when ritual objects have had a certain life cycle, then they are deposited at a sacred place, perhaps also to enhance the magic of the ritual which has just been performed with them," Kaul said. "And of course, when they are broken, then they are not working more in the human world — but they are still working in another [spirit] world, by being placed in the ditches of these sacred sites."

Kaul thinks the map stones and sun stones from Bornholm were used together in ceremonies to influence the effects of the sun on the fertility of a particular piece of land.

"[T]hey could have passed the sun images over the small field images in order to enhance some magic, which could give the sun more light, for example, such as in the spring, when the sun should give more light so that crops can grow," he added.

Here comes the sun

Kaul sees a link between the evidence for solar rituals at Bornholm and evidence of similar beliefs elsewhere in Neolithic Europe, a time of transition from nomadic hunter-gatherer groups to settled farming communities.

"Sun images must have something to do with a solar cult — and we have many other European indications of that, such as Stonehenge in England from about the same time, and passage graves in Ireland that are oriented towards the midwinter sunrise. And now we have these early pictures of the sun in Denmark," he said.

He also noted the similarities between

the map stones from Denmark and rock carvings in the Val Camonica and other Alpine regions of northern Italy and France, which have been interpreted by archaeologists as symbolic farm landscapes used in Neolithic rituals.

"The Italian archaeologists give these square features that they interpret as fields the name of 'topographical elements' — so it is not a map in our modern sense, but it is somehow a rendering of fields and field systems," Kaul said. "And so it is very interesting to find these topographical elements here in Scandinavia, and in this minute form."

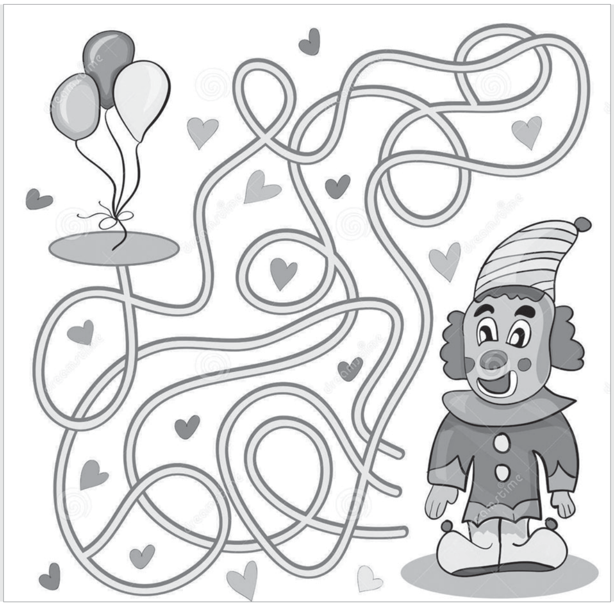
The similarities are not evidence of direct contact throughout Europe 5,000 years ago, but they could reflect common ideas among Neolithic farming peoples about the sun and the fertility of their lands, he said.

"When you also look at the Italian material, then it gives you a feeling that these map stones are not just isolated phenomenon — but that we are looking at a trend of a general European development here, and also in a religious or spiritual sense," Kaul added.

An article about the map stones from the Vasagaard enclosure on Bornholm, written by archaeologists Jens Andresen of Aarhus University and Michael Thorsen of the Bornholm Museum, was published in October in the Danish archaeological magazine Skalk.

Kaul accepts that the interpretation of the map stones could be controversial: "About 20 years ago, after the first solar stones were found, I wrote about it for Skalk – and even the editor of the magazine didn't believe it," he said. "And now, after 20 years, we have found more than 200 solar stones, and they are one the most important things from Bornholm … so let's wait a couple of years to see if there are more map stones to come."

Original article on Live Science



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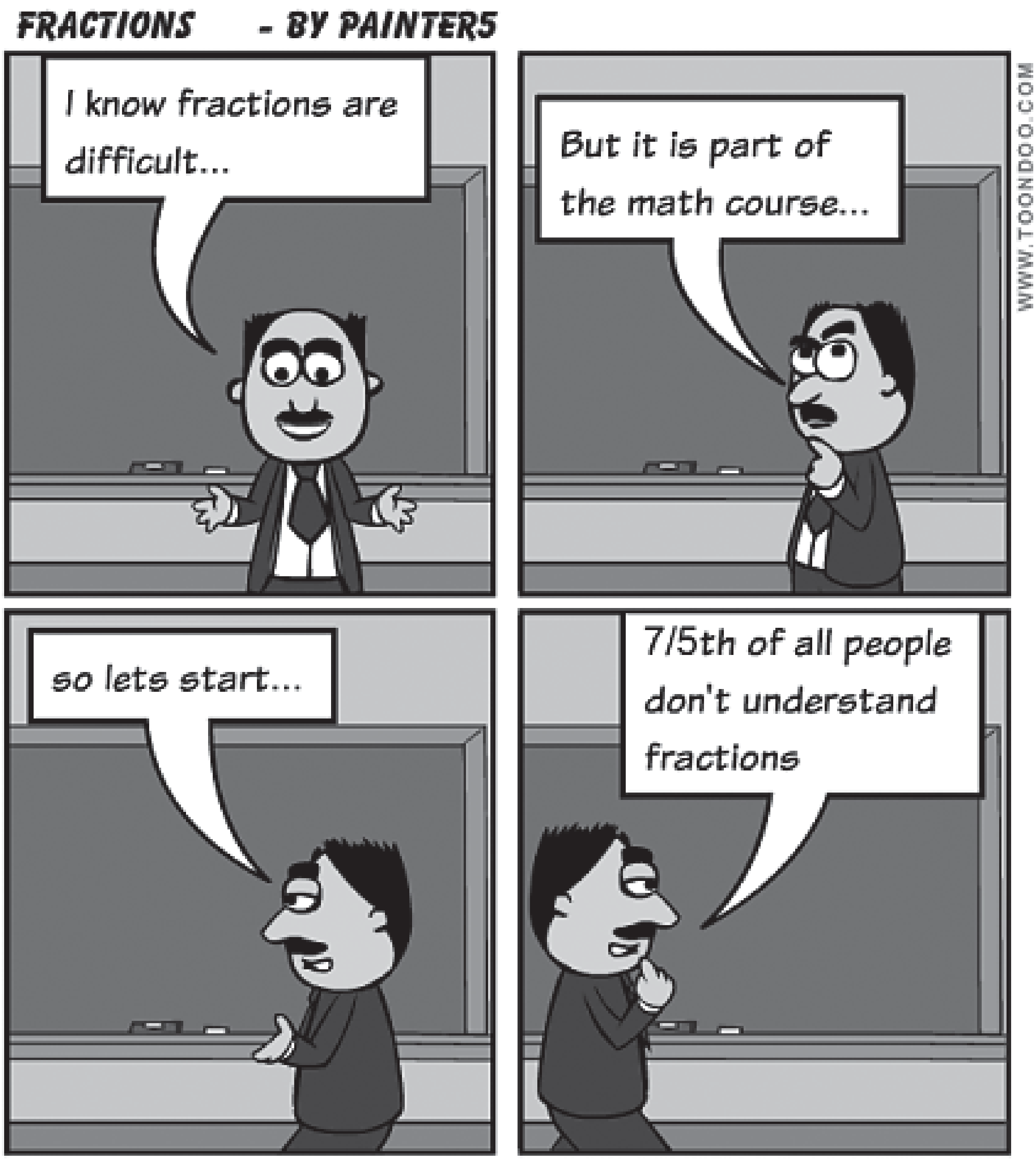
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