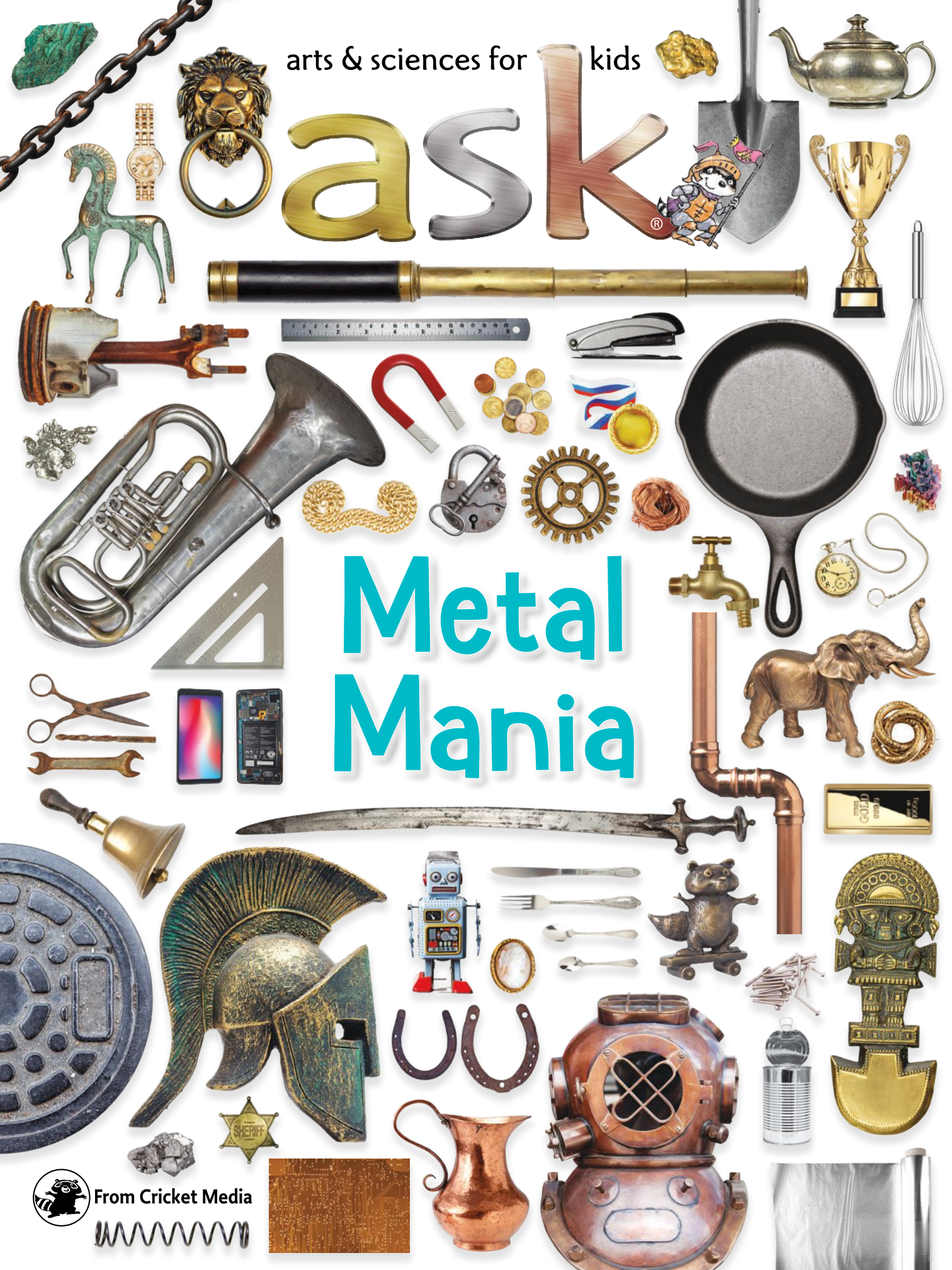
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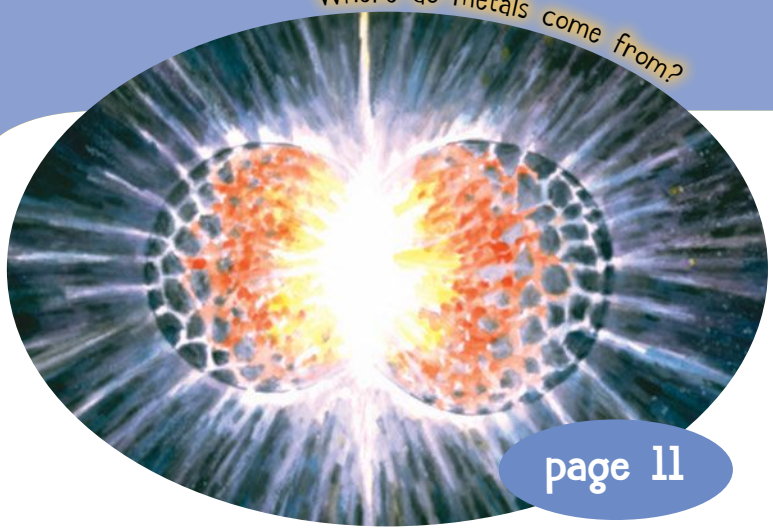

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Know Your Metals

Short name
Two-letter code for an element. Sometimes these come from the Latin name. So gold is "Au," for *aurum*.

Melting point
Temperature at which the metal turns liquid

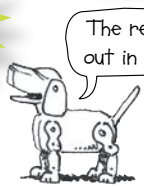
Name

Crystal structure
Metal atoms arrange themselves in regular patterns called crystals.

Atomic number
Size of its atoms (measured by the number of protons)

Source
Metals mix with other elements to make rocks.

Collect all 92!



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Nosy News

by Elizabeth Preston

MONKEYS ALWAYS BRUSH

Do you floss your teeth after a meal? These monkeys do.

Nicobar long-tailed macaques are medium-sized monkeys that live on islands in the Indian Ocean. Scientists have spotted these monkeys using lots of tools. When the macaques want to eat a fuzzy or thorny plant, they sometimes use a leaf or a twig to rub the food smooth. Or they might use a piece of trash such as paper or cloth. They use these tools to clean mud off their food too. The researchers also saw the macaques flossing after

A small dino said with a cluck,
"Alas! It is just my bad luck.
T. rex terrifies
With its teeth and huge size—
But me? I just look like a duck."

New Dino Was an Odd Duck

In a fossil from Mongolia, scientists have found a brand-new dinosaur species. But the creature looked more like a duck than a dino.

The new species is named *Halszkaraptor escuilliei*. It walked on two long legs and had front limbs shaped like flippers. Its neck was long, like a swan's. Scientists think the dinosaur spent a lot of time in the water. It could have used its flipper-like limbs to paddle and its long neck to hunt fish.

H. escuilliei lived more than 70 million years ago. But a bird-shaped dino is no surprise. Birds and extinct dinosaurs are so closely related that scientists say today's birds actually are a kind of dinosaur.

This is an artist's idea of what the duck dino might have looked like.

eating. The animals used grass, feathers, threads, or bits of wire to remove food stuck between their teeth.

Other kinds of macaques use tools in similar ways. Those monkeys deserve a sticker from the dentist!

Fantastic Beasts and Where Not to Find Them

Some monsters are no monsters at all. That's what scientists found when they studied hair, bones, and other "evidence" that supposedly came from yetis.

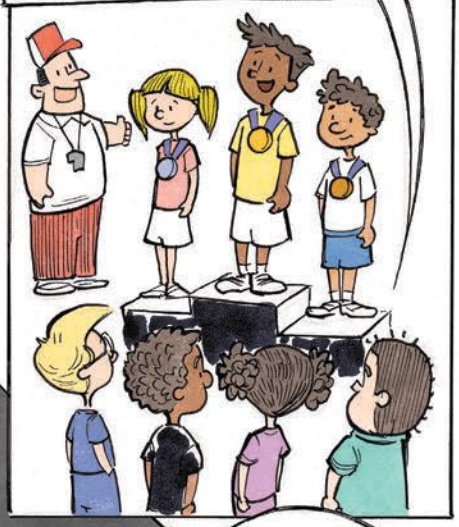
The yeti is a mythical creature—or, some people say, a real creature—from the Himalaya Mountains in Asia. Believers say it's large and hairy and lives in snow. Some people and museums have collected old pieces of bone, teeth, hair, skin, and even poop that they say comes from yetis.

Scientists studied the DNA in nine of these samples. They found that eight "yetis" were actually bears. The ninth was a dog.

NESTOR'S DOCK

by Jeffrey Ebbeler

I wish there were more medals.



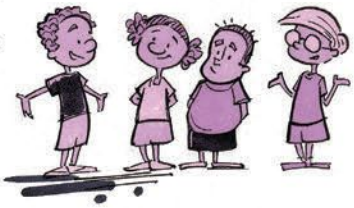
And gold isn't the most rare or valuable metal.

Bronze isn't even a pure metal. It's a mix of copper and tin.

Who wants a tin medal?

Why are the medals gold, silver, and bronze anyway?

There are lots of different metals out there, so there's plenty to choose from.



I can think of a few metals they shouldn't use.

I think the top medals should be the strongest metals, like tungsten and titanium.

Rhodium and platinum are worth more.


Iron
Rusts
Copper
Turns green
Mercury
Kind of messy
Magnesium
Catches on fire
Arsenic
Poisonous
Uranium
Radioactive
Look, my medal glows!
4th
2nd
1st
3rd
5th
6th
Congratulations!
I've got to lock this up in a safe place!
I wouldn't worry. It's only painted plastic.

by Galadriel Watson, art by Marnie Galloway

Great Mome

Long, Long Ago Shiny Rocks

No one knows who picked up the first nugget of gold or copper from a river. But it was long, long ago. People learned to hammer the shiny lumps into jewelry and tools. They found metal to be strong, waterproof, and beautiful. And if a metal object broke, they could re-shape the metal into something else.

5000 BCE Melting Rocks

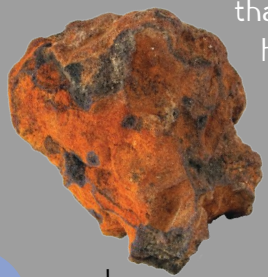
Eventually, someone (maybe a potter baking clay pots) noticed that certain green rocks oozed shiny metal when they got very hot. That metal was copper. Soon, people were collecting rocks and melting them to get more metal. They had invented smelting.

4000 BCE Mixing Metals

Mixing copper with tin made a new metal: bronze. Bronze was shaped by pouring the molten metal into sand or clay molds. This Chinese bowl was made around 1200 BCE.

1500 BCE The Iron Age

Iron is not hard to find. But it takes a very hot fire to get it out of rocks. Eventually, people invented tall furnaces that got hot enough. Then smiths hammered the hot iron to drive out the last bits of rock. Iron made even better tools than bronze.



nts in Metal

600 BCE Metal Money

Metal makes great money. Coins are easy to carry and last a long time. People in China and Greece started using metal money around the same time.

Stamping coins with a royal seal guaranteed that the metal was good.

Not all coins were round. This Chinese coin is shaped like a spade.

300 BCE A Sharper Edge

In southern India, smiths discovered how to make steel by heating iron with charcoal. Steel is more brittle than iron, but can hold a very sharp edge. Crafty smiths combined tough iron and sharp steel to make even better swords and tools.

200 BCE Spinning Spoons

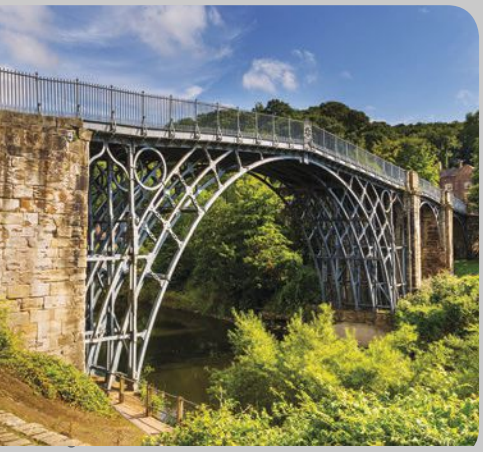
Some iron is naturally magnetic. Ancient Chinese noticed that spoons made from this iron always pointed north-south when spun on a table. They used these south-pointing spoons as compasses. Later, they learned how to magnetize any bit of iron.

1100 CE Alchemy

Alchemists were early scientists. They spent a lot of time trying to turn other metals into gold. They had some funny ideas—they thought metals grew in the earth like plants. They never succeeded in making gold (only stars can do that), but they did learn a lot about metals.

1450 Metal Books

When Johannes Gutenberg invented the printing press, he made his movable letters from a mix of lead, tin, and antimony. This metal is easy to mold and strong enough to stand up to many printings.



1781 Iron Bridge

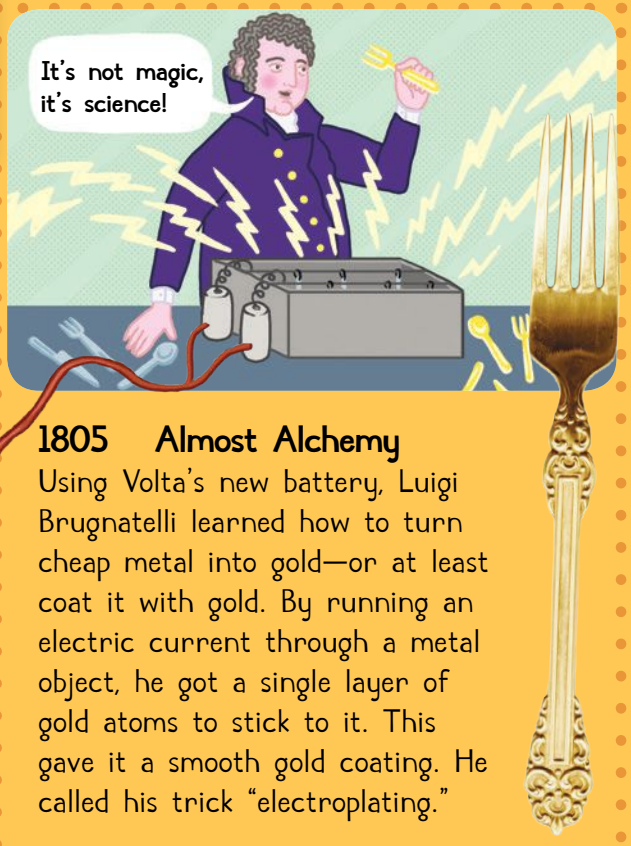
When the first metal bridge was built in England, many doubted it would stay up. They thought an iron bridge would be way too heavy. But it is still standing! Now it's rare to see a bridge *not* made of metal.

1800 Coin Battery

Alessandro Volta invented the first battery by stacking up copper and zinc disks, with bits of felt soaked in saltwater in between. The metals pull electrons from the saltwater to make an electric current.

1556 Big Book of Metal

One book printed on the new press was *De Re Metallica* (*All Things Metal*). This illustrated encyclopedia of metals gave instructions on everything from mining to making nails. It was an instant best-seller.

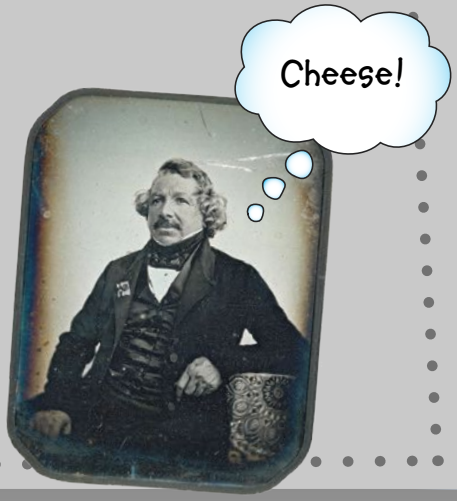


1805 Almost Alchemy

Using Volta's new battery, Luigi Brugnatelli learned how to turn cheap metal into gold—or at least coat it with gold. By running an electric current through a metal object, he got a single layer of gold atoms to stick to it. This gave it a smooth gold coating. He called his trick "electroplating."

1839 Capturing Light

French inventor Louis Daguerre discovered that a silver plate would darken to capture an image if he treated it with chemicals. He had invented the photograph. The first selfie followed soon after!

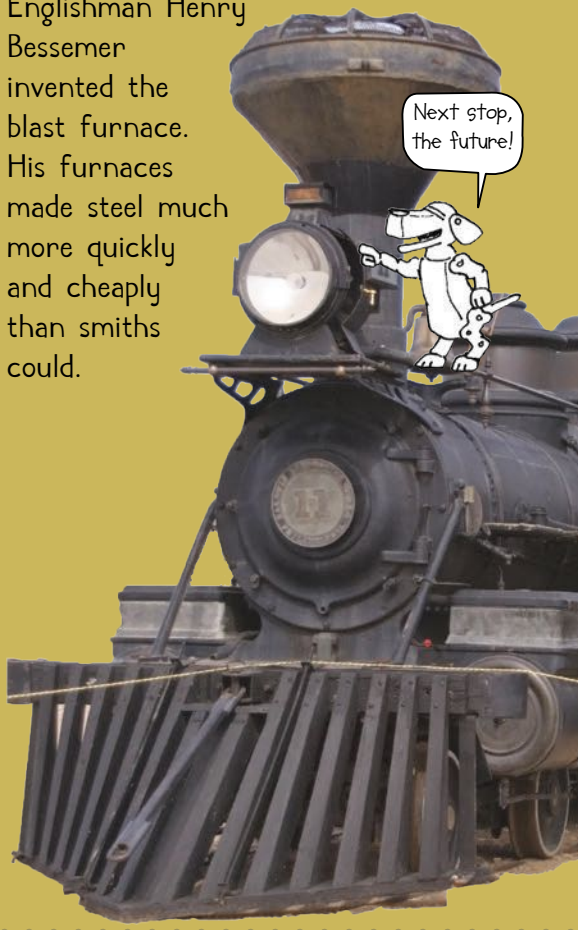


1885 Metal Towers

To build a really tall building, you need a strong skeleton inside to hold its weight. You need—metal! The world's first skyscraper—the Home Insurance Building in Chicago—used a steel frame to support its record-setting 10 floors. Since then, it's been up and up.

1856 Age of Steel

The modern age of steel factory machines, steam engines, and skyscrapers took off when Englishman Henry Bessemer invented the blast furnace. His furnaces made steel much more quickly and cheaply than smiths could.

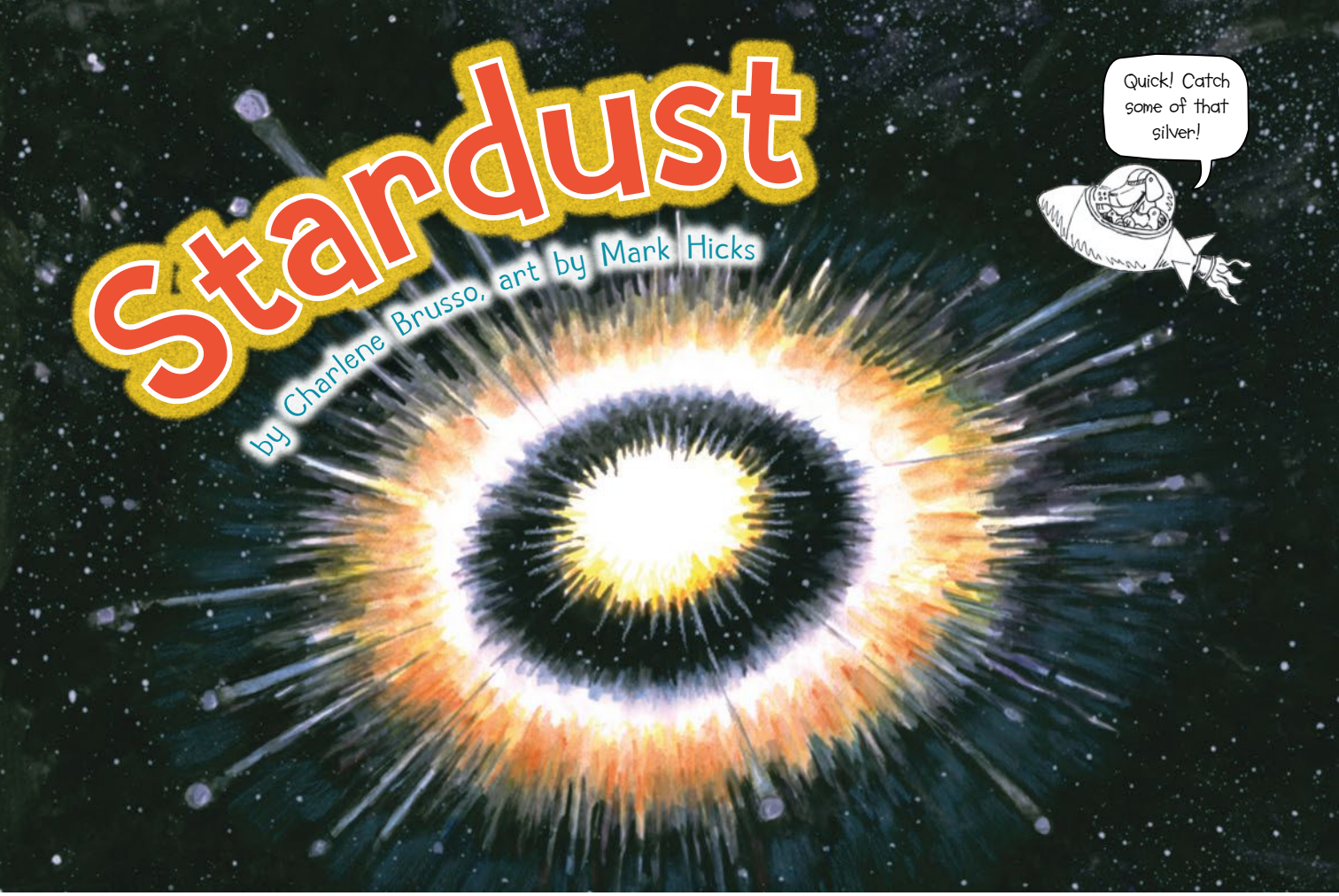


Future Metals

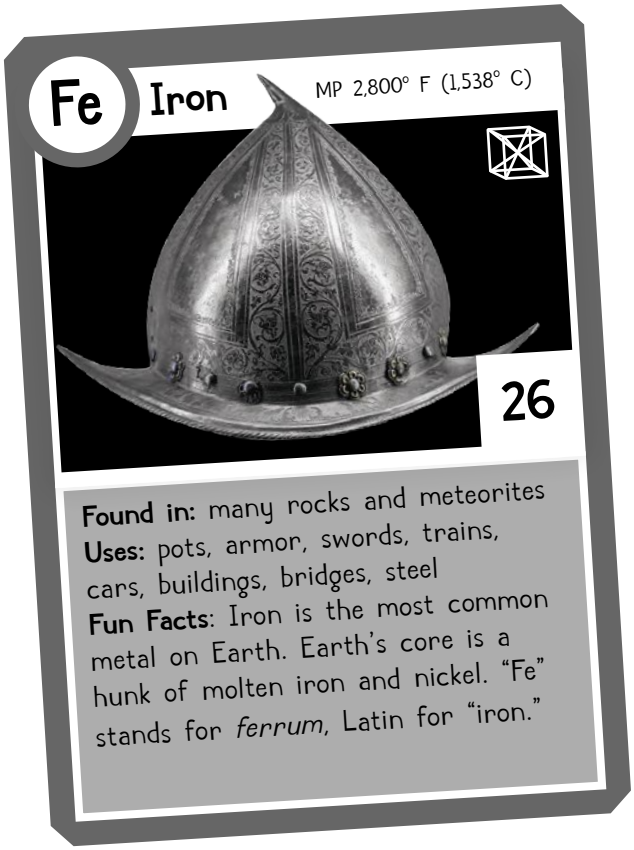
Engineers are always looking for new ways to make metals better. Metal foam is one amazing new invention. This metal is filled with tiny bubbles, making it super light but still strong. Shape-memory alloys are another futuristic metal. These metals can be bent again and again, then return to their original shape when heated. What's next?

Stardust

by Charlene Brusso, art by Mark Hicks



Where do metals come from? They were all made by stars!

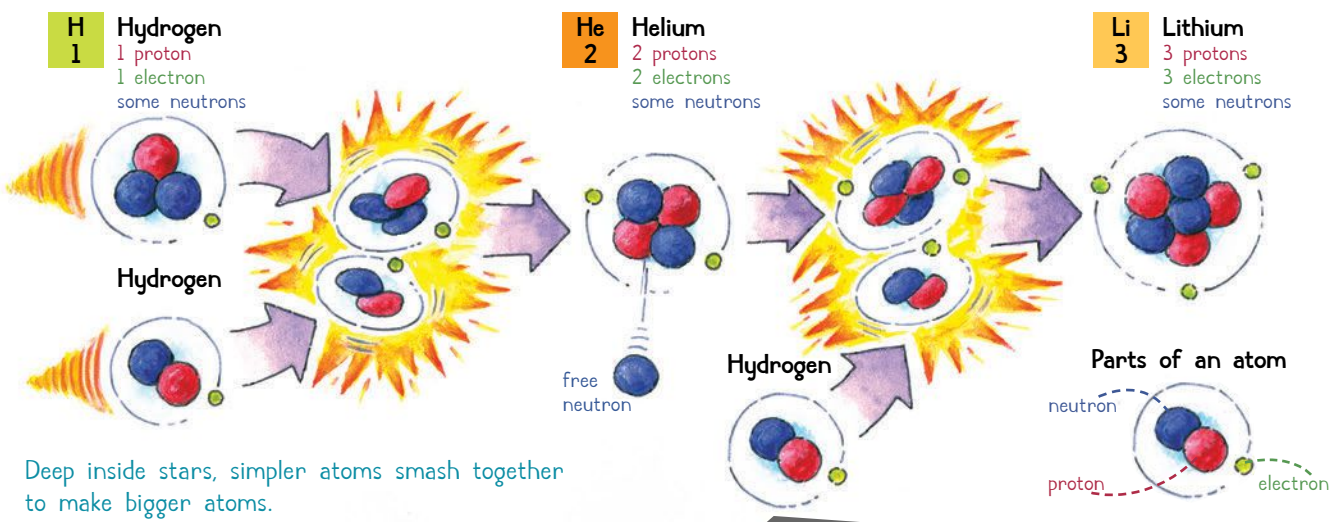


We dig metals out of the earth. But how did the metal get in there? The story of Earth's many metals starts way back at the very beginning of the universe, nearly 14 billion years ago.

The universe began with a huge explosion called the Big Bang. At first, there was just hydrogen and helium gas. Gradually, big clouds of gas formed. Some got so huge that they lit up—and became stars.

Star Factories

Inside stars, the gravity is intense. The centers get so hot that atoms sometimes smash into each other at colossal speeds. They mush together to make whole new atoms. This is called fusion. When atoms fuse, they also release a lot of heat and light, making stars shine.



Deep inside stars, simpler atoms smash together to make bigger atoms.

In the fiery hearts of stars, simple hydrogen atoms (size 1) smash together to make helium atoms (size 2). Helium and hydrogen fuse to make lithium (size 3). And so on. Each size of atom is a different element. All this fusing releases energy, which makes the star hotter, which makes more atoms fuse. This cycle can keep a star shining for billions of years.

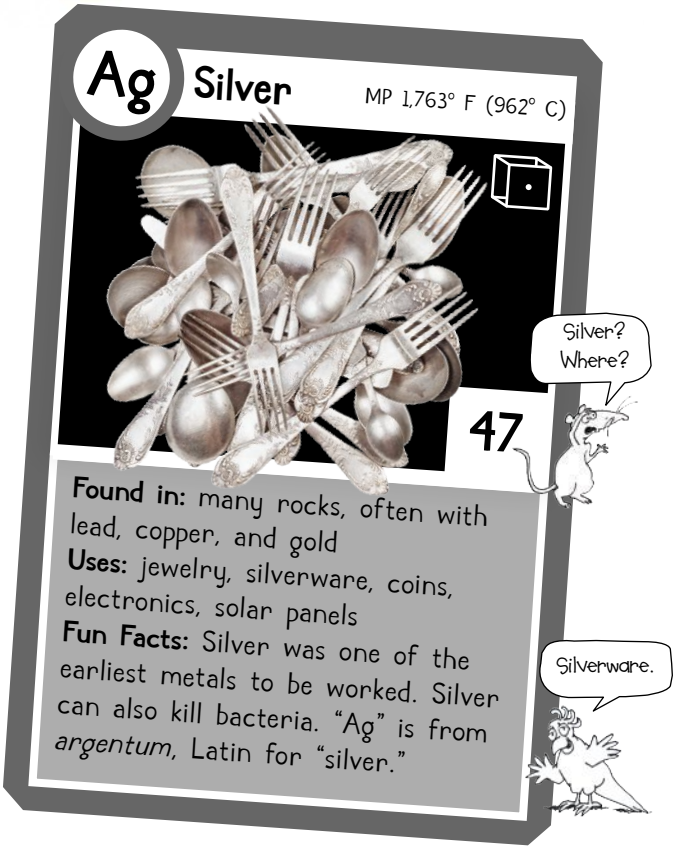
But it takes more energy to mash bigger atoms together. Stars make bigger and bigger elements until they get to iron (size 26). After iron, it takes too much energy. So they stop.

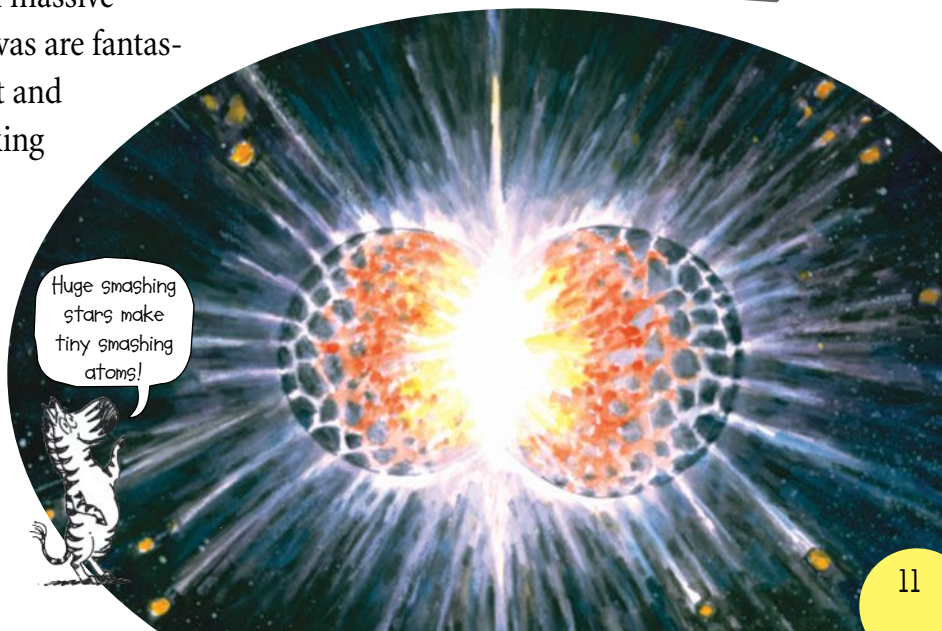
Gold with a Bang

But the story isn't over yet. When stars stop fusing, they can't stay as hot. Smaller stars just cool down and go dark. But big stars explode in massive fireballs called supernovas. Supernovas are fantastically powerful. In their intense heat and pressure, even big atoms fuse—making heavier metals like silver (size 47).

And to make the very heaviest metals, like gold, it takes an even more extreme explosion.

When especially huge stars run out of fuel, they collapse into





When massive neutron stars collide, they make heavy elements like gold and platinum.

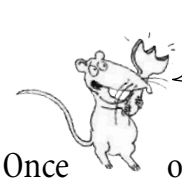
How the Solar System Formed (and Got Its Metals)

A huge cloud of dust and gas swirls in space. Some of the dust is metal flung out by distant exploding stars.

Gravity pulls the cloud together. The hot center becomes the sun.

Colliding particles stick together.

They become planets and moons. All have a bit of metal inside.



super-dense lumps called neutron stars. Once in a while, two neutron stars collide. That makes an explosion even bigger than a supernova. Heavier metals like platinum, gold, and lead are born in these explosions.

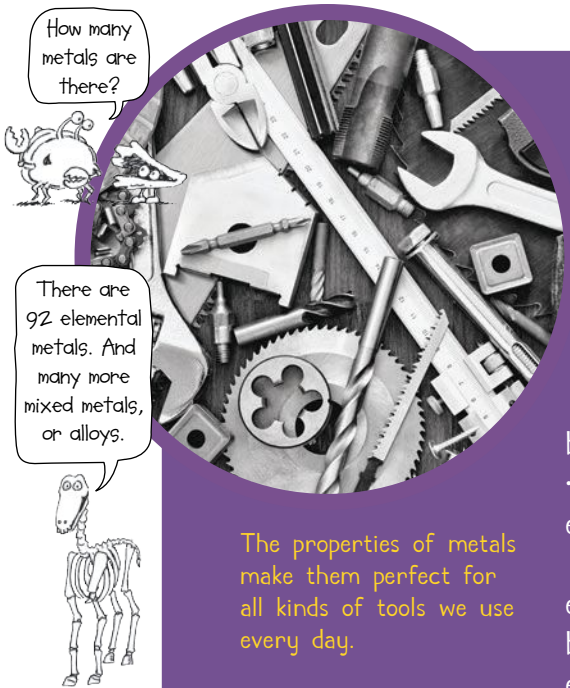
New Planets from Old Stars

When supernovas and neutron stars explode, they fling their metals out into the galaxy at top speed. Eventually, some of these atoms find their way to a new spot and begin to clump together to form a new star . . . and planets.

Our own solar system formed this way, from a cloud of swirling gas and recycled dust from old stars. Some of this dust was metal, flung out by long-ago supernovas and neutron star explosions. And some of that metal got clumped into the new planet, Earth.

So there's the surprising truth—every bit of metal on Earth was made in ancient stars that exploded! Iron and nickel sank to Earth's center, giving our planet a hefty metal core. Other metals mixed with oxygen and hydrogen to make rock. In Earth's early days, meteorites from space brought even more metals.

So the next time you want to visit the stars—just pick up a tin can, or a coin, or a nail. Stardust is all around.



The properties of metals make them perfect for all kinds of tools we use every day.

What Is Metal?

Metals are a group of materials that are alike in some ways. Metals are:

- Hard and shiny.
- Maleable, meaning they can be shaped into objects.
- Ductile, meaning they can be pulled out into wire.
- Metals carry heat and electricity well.

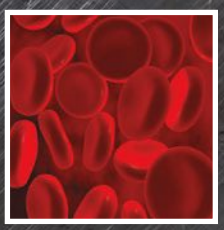
Many metals are also elements, the basic building blocks of all matter. A pure element has only one kind of atom in it. Pure gold has only gold atoms. Pure tin has only tin atoms.

Pure metals can blend to make many different alloys:

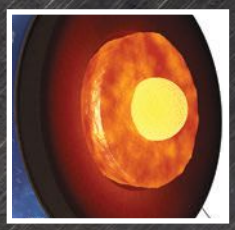
copper + tin = bronze
copper + zinc = brass
silver + gold = electrum
tin + copper + antimony + lead = pewter

Metals combine with other elements to make minerals, or rocks. Ore is rock with a lot of one kind of metal in it.

Surprise! It's Metal



Blood
is full of iron. Red blood cells use iron to carry oxygen around your body.



Earth's core
is a big hunk of iron and nickel.

Seawater
is full of dissolved metals—even gold. Ocean algae need iron to make energy from sunlight.

Food
gives you small amounts of many metals that your body needs.

Paint
is often colored with metal powder. Metals also make it not see-through.

Colored glass
is made by adding powdered metals to molten glass. Ancient Egyptians first learned this trick.

Birds' eyes
contain tiny bits of metal that may act like a built-in compass.

Eat Your Iron

If you look closely at a cereal box, you might see iron listed as an ingredient. Are you really eating the stuff nails are made of? Yep. Here's a fun way to *see* the metal you eat.

What You'll Need:

- Breakfast cereal—look for a kind with lots of iron (like Total or Formula 19).
- Plastic bag or blender
- Plastic bucket or mixing bowl
- Strong magnet
- Water
- Wooden or plastic spoon
- Piece of white paper

What to Do:

1. Crush the cereal into powder in a blender or by pounding it inside a tightly sealed plastic bag. Get it as powdery as you can.
2. Pour the crushed cereal into a plastic bucket or bowl. Add plenty of water. Drop in the magnet and stir it up. (If you like, tie a string around your magnet to pull it out with.)
3. Let the mixture sit until the cereal gets soggy and settles to the bottom.
4. Carefully take out the magnet. Hold it by the middle, not the ends.
5. Look for the spiky black fuzz at the ends of the magnet. Scrape some off onto the paper. There's your iron!

So why are you munching on metal every morning? Your blood cells use iron to carry oxygen through your body. You don't need much iron, but some gets pooped out, so you need to get more in food. So eat up your cereal, or have some spinach!

Good as

by Meg Moss

What makes gold the queen of metals?

This quartz rock hides a golden secret.

In 1972, archaeologists in Varna, Bulgaria, dug up some of the oldest gold objects ever found. The bracelets, necklaces, and headbands are 6,500 years old. Fresh from the dirt, they looked as if they'd just been polished. The ancient people who lived in these settlements didn't have writing or iron tools. But it's clear that like us, they loved gold.

The Lure of Gold

Gold is magical stuff. It's so soft you can cut it with a stone knife. It's easy to shape. It can be pounded into sheets thinner than tissue paper and stretched into slender wire. It's beautiful. Sometimes you can find it just lying on the ground.

2500 BCE Goldsmiths in ancient Sumer (Iraq) made this elegant gold cup by hammering gold flat, then shaping it.

Gold

The ancient Varna people were buried with their favorite things. Especially gold.

Au Gold

MP 1,948° F (1,064° C)

79

Found in: lumps on the ground or quartz rock, often with copper and lead
Uses: jewelry, electrical connections, space helmets, telescopes, medical devices
Fun Facts: Gold is soft, easy to work, and doesn't rust. All the gold ever mined would fill four large swimming pools. There are about 1,000 tons of gold dissolved in the world's oceans.

And gold never rusts or tarnishes. It looks great forever.

Gold is born in space, when huge old stars collide. Long ago, meteorites rained down on the new planet Earth. Those space rocks scattered gold on Earth's surface. Today, scientists think that about one atom in every billion atoms of rock is gold. That's not much!

Gold often collects in quartz rocks. Over time, as the rock is worn away by wind and water, the gold washes down into rivers. Ancient gold-hunters soon learned that where they found some gold, more was likely hiding.

1800 BCE
This gold necklace from ancient Greece is in the shape of two bees with drops of honey.

1323 BCE
In ancient Egypt, some mummies wore gold sandals.

This Inca mask from Peru depicts the sun god.

Richest Man Ever?

This old map shows king Mansa Musa of Mali, possibly the world's richest man, ever.

The continent of Africa has always been rich in gold. Ancient Egyptians worked gold mines throughout their kingdom to supply royalty with jewelry, ornaments, coffins, and even sandals.

Other African kingdoms also mined gold. They hammered it into beautiful objects and traded it for goods from far away. In the 14th century, King Mansa Musa of Mali amassed so much gold that he may have been the richest man in the world, ever. When he made a pilgrimage to Mecca in 1324, his enormous caravan included 80 camels, each loaded with 300 pounds (136 kg) of gold. He spread so much gold around that it lost much of its worth. It took 10 years for gold to become valuable again.

Sweat of the Sun, Poop of the Gods

The ancient Inca people of South America also loved gold. They called it the sweat of the sun. In Mexico, the Aztecs amassed great collections of gold jewelry, dishware, ornaments, and idols. The Aztec name for gold was *teocuitlatl*: poop of the gods. A fine substance indeed!

When Spanish explorers arrived in South America in the 1500s, the gold objects of the Incas and Aztecs

1323 BCE
Thin sheets of gold cover the wooden burial mask of the Egyptian pharaoh Tutankhamun.

900 CE
Vikings often melted their captured gold into arm rings so they could wear their wealth.

Since ancient times, people have used gold to fill, fix, and decorate their teeth. Gold is sturdy and won't react with food.

Spanish explorers seized Inca gold and melted it down into coins.

dazzled them. They greedily stole the gold from the native people, killing many and destroying the great empires.

The Spanish enslaved native people to dig more gold from the ground. They shipped tons of gold and silver back to Spain, making it the richest country in Europe.

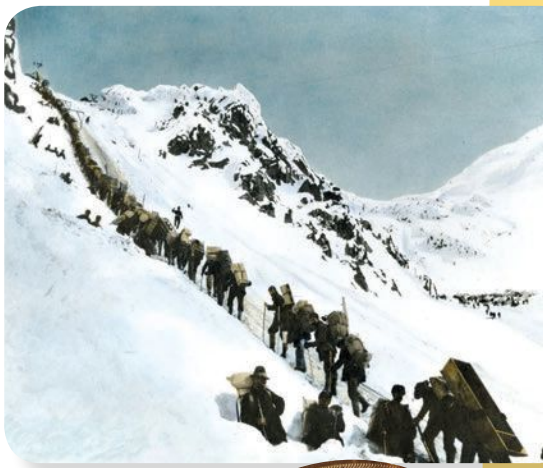
Some of that stolen gold never made it to Spain. Spanish treasure ships sometimes fell prey to pirates. Stormy weather sunk more. One of these was the *Nuestra Señora de Atocha*, which sank in a hurricane off Florida in 1622. When the wreck was discovered in the 1980s, it held over 40 tons of gold and silver.

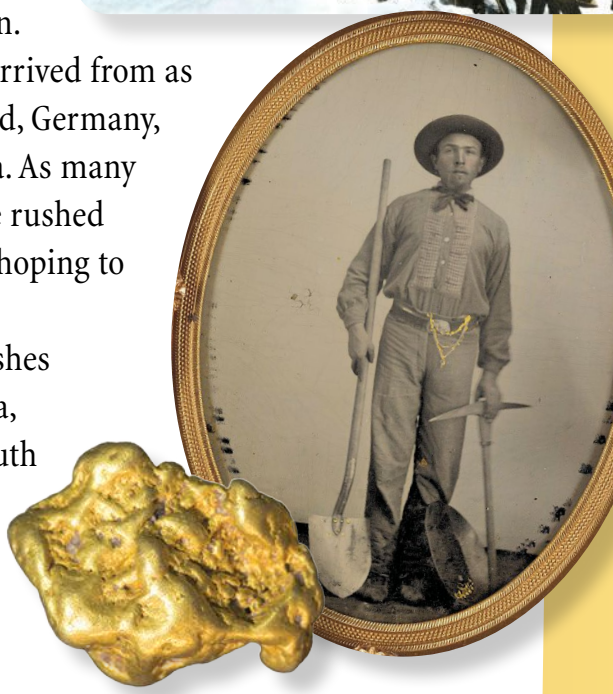
Gold Rush

Wherever gold is found, people follow. In 1848, the western part of America was largely unsettled by Europeans. Then John Marshall picked up a nugget of gold in the mountains of California. As the news got out, people from all over raced to California to search for gold. The "gold rush" was on. Fortune seekers arrived from as far away as Ireland, Germany, Turkey, and China. As many as 300,000 people rushed to the gold fields hoping to get rich.

Other gold rushes followed in Alaska, Australia, and South Africa. The Klondike gold rush of 1897 lured fortune

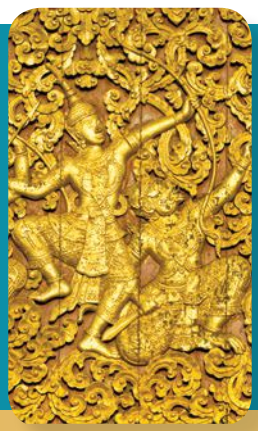
During the Klondike gold rush, miners traveled thousands of miles through harsh conditions in the hope of striking gold. Most didn't find much.





Gold can be hammered into very thin sheets. These can be used to cover just about anything.

1550
This fancy temple door in Laos was made by pressing thin sheets of gold onto carved wood.



1595
And of course, kings and queens need gold crowns. This one belonged to the king of Denmark.

hunters to the frozen wilderness of northern Canada. But only 1 in 3 completed the difficult journey. Some returned home. Others headed for Alaska, where new gold had been found.

Experts guess that in all of human history, around 200,000 tons of gold have been mined. That would fill four large swimming pools. Today, China and Australia produce the most gold.

The James Webb Space Telescope is coated in a thin layer of gold to catch the light of distant galaxies.

Back to Space

What do people do with gold today? Most is made into jewelry. Some is used in cellphones and other electronics. Gold also makes great heat shields on satellites and space helmets.

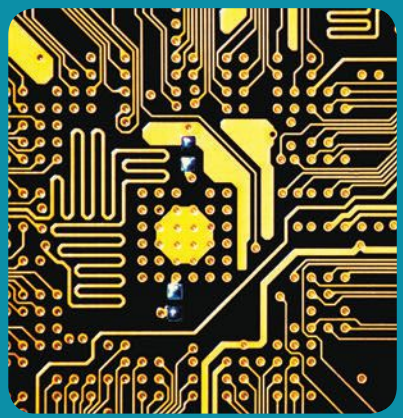
And NASA's newest telescope will be gold-plated. The James Webb Space Telescope has 18 big mirrors coated with a very thin layer of gold. Gold reflects the dim red light from distant galaxies better than any other material.

The Webb Telescope is aiming to launch in 2020. So some of the gold that rained down on the baby Earth may soon be back up in space—maybe snapping pictures of its distant home.

Hg Mercury MP -38° F (-39° C)

80

Found in: cinnabar rock
Uses: fluorescent light bulbs, thermostats, switches, getting gold out of rock
Fun Facts: Mercury is the only metal that is liquid at room temperature. It can be very toxic. Gold and silver dissolve in mercury, so mercury was once used to pull these metals from crushed rock.

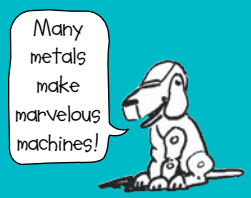


The tiny circuits on many computer chips are made of gold.

A thin coating of gold on space helmets acts like sunglasses, shielding astronauts from the strong sunlight in space. It's thin enough to see through.

Calling All Metals

An ordinary cellphone may hide more than 60 different metals inside. Some are common, like aluminum and copper. Some are rare, like indium and neodymium. Each metal has a special job to do inside the phone.



Speakers, microphone, and vibration motor
Tiny magnets of **neodymium**, **iron**, **boron**, **praseodymium**, and **dysprosium** make sounds and vibrations.

Circuit board
There's **silicon**, **arsenic**, **antimony**, **indium**, **gallium**, and **boron** in the circuit board, the phone's brain. **Tantalum** stores energy.

Frame
A **magnesium** frame sits behind the screen.

Battery
Most phone batteries are made of **lithium** and **cobalt**, with **copper** wiring and an **aluminum** casing.

Case
Aluminum, **magnesium**, and **nickel** (or plastic)

Touchscreen
A grid of very thin wires made of **indium** and **tin** sense where you touch the screen. The glass itself is **silicon** and **aluminum**.

Solder
Tiny metal parts are joined together by melting blobs of **tin**, **copper**, or **silver**. This metal glue is called solder.

Wires, antennas, and connectors
Copper, **silver**, **gold**, **iron**, and **tungsten**

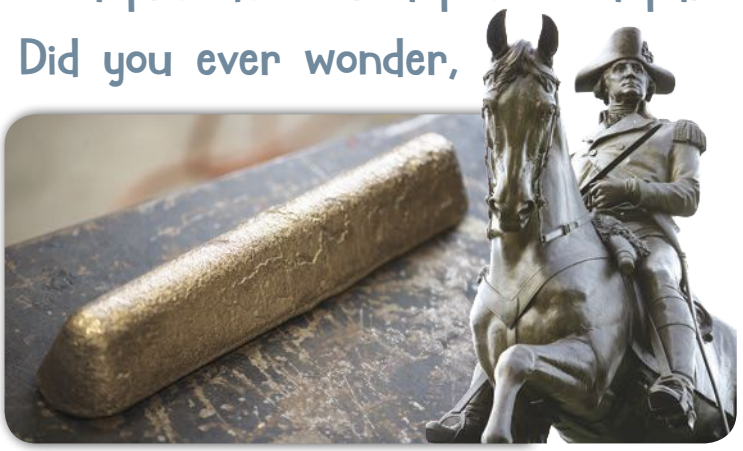
Color display
Rare elements like **neodymium**, **praseodymium**, **terbium**, **yttrium**, **lanthanum**, and **gadolinium** make colors on the screen.

Recycling
All of these valuable metals can be re-used. But separating each metal out from old phones can be tricky.

photos by Michael Burke

Bronze Me

Have you ever seen a bronze statue of a president or a poet in a park? Did you ever wonder,



How does this... turn into this?

Bronze is shaped by melting it and pouring it into a mold. It takes several weeks, and quite a few steps...

Make a clay statue (solid) → Silicone mold (hollow) → Wax statue (solid) → Ceramic mold (hollow) → Bronze statue (solid)

To see how it's done, we thought we'd ask bronze artist Marshall Svendsen to make us our very own bronze statue. Marshall has been sculpting since he was a kid. He's been working in metal for about 15 years. He makes his own sculptures and also casts other people's art in bronze.

Cu Copper

MP 1,985° F (1,084° C)

29

Found in: malachite and azurite rocks
Uses: electrical wire, water pipes, cookware, bronze, killing germs
Fun Facts: Cuttlefish and crabs have copper in their blood instead of iron. It makes their blood blue. Bronze is a mix of copper and tin.

Bronze is a mix of copper and tin. It's mixed at a foundry before it gets to the art studio.

Sn Tin

MP 449° F (232° C)

50

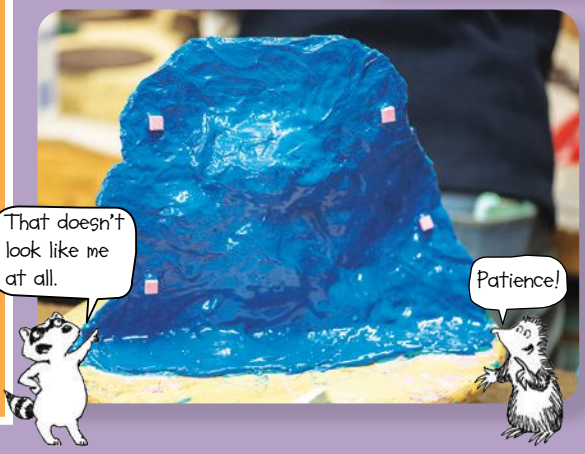
Found in: cassiterite rock
Uses: solder, electronics, pewter, bronze, making plate glass
Fun Facts: Sheet glass is made by floating hot glass on molten tin. If you bend a bar of pure tin, it will make a weird crackling sound like crunching sugar.

Clay Model

1 First, our friend Karen made a clay sculpture of our local hero. The model for a bronze can be sculpted from any stiff material—clay, wood, plaster. You can even 3D print it out of plastic.

Silicone Mold

2 Marshall paints the clay model all over with layers of silicone. This dries to a rubbery mold.



3 He sticks playing cards around the edges before painting on the last silicone layer. The cards keep the two halves of the mold separate. Marshall colors the layers pink and blue so he can tell if he's missed a spot.

4 The last layer is a hard shell of fiberglass epoxy. This is like glue with long fibers in it.

5 When it's dry, the hard shell pops off.

Then Marshall peels off the silicone and takes out the playing cards.

6 Marshall cleans out the mold and sprays the inside with slippery stuff. Then he bolts the halves together.

Wax Model

7 For the next step, Marshall heats up a big pot of wax.

8 When the wax hardens, he carefully peels off the silicone. Now we have a wax copy of our statue!

Add tubes for bronze

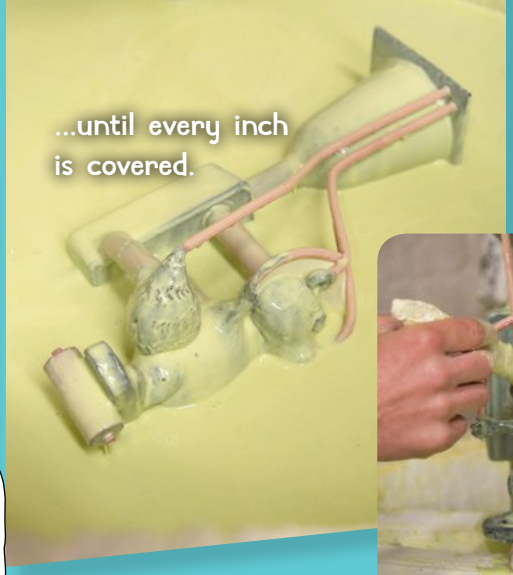
9 Next, Marshall adds wax tubes to the wax model. In the final mold, these will make a path for the hot metal to flow through.

The cup on top is where the hot bronze goes in. The bronze will flow through the red tubes into the statue's body.

Then Marshall adds some smaller tubes to let air escape, so there are no bubbles in the final statue.

Ceramic Mold

10 The next step is to make a ceramic mold for the bronze. Marshall dips the wax model in liquid ceramic, a watery mix of clay and silicon.



Brush off the drips.

11 Then he dusts the wet ceramic with tough silica sand.

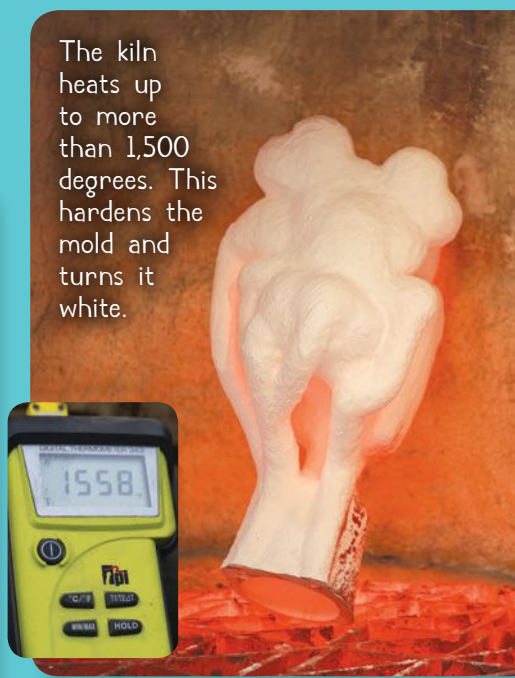
The statue gets 8 or 9 rounds of ceramic and sand, drying in between. This builds up a strong mold that can take hot metal.

Melt out the wax

12 When the mold is dry, Marshall cuts the top off the cup.

13 Then it goes upside-down into a hot kiln. All the wax melts out! It runs down into a pan.

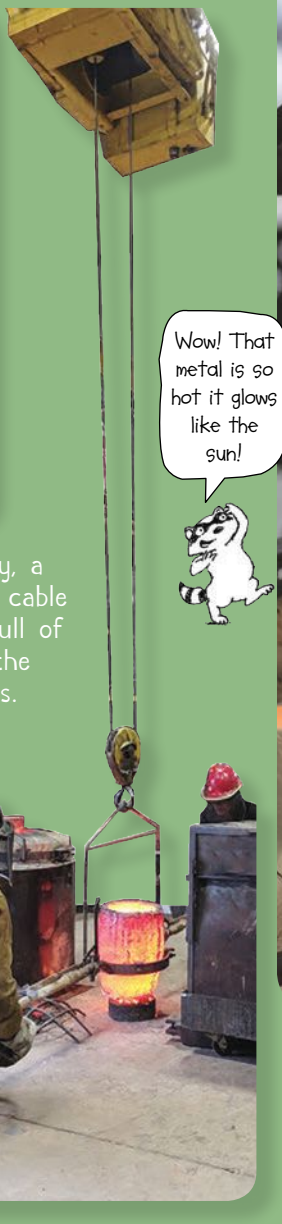
Marshall made the kiln himself, out of an old boiler. He wears a fireproof suit because it's very hot.



Now, at last, it's time for BRONZE!

14 This small furnace heats the bronze until it melts. It's extremely hot!

15 The molds wait in a fireproof box. Marshall is casting several statues today. One is Marvin! Burners heat the molds so they won't crack when the hot metal goes in.



16 When the bronze is ready, a bridge crane with a long cable lifts out the inner container full of hot metal. The crane carries the molten metal over to the molds.

17 Marshall and an assistant use a long-handled frame to guide and tip the pot.

18 In goes the hot metal! Marshall carefully tips the pot to fill each mold. Any bronze left over gets made back into ingots.

Finishing

19 After the metal cools, Marshall uses a hammer, chisel, and drill to chip off the hard white shell.

Everything that was wax is now bronze.

Marshall cuts off the extra bits of bronze.

20 Next, he polishes down all the rough bits and cleans the bronze.

Finally, he darkens the metal with sulfur for a rich brown gleam. And gives it a wax polish.

And that's how it's done!

Print your own Marvin!
Download code to 3D print a plastic copy of this statue at ireadcricketmags.com/3dmarvin.

More Precious than Gold

by Tracy Vonder Brink, art by Rupert van Wyk

Once upon a time, there was a metal that was even more valuable than gold. Now, we use it to wrap sandwiches. What happened?

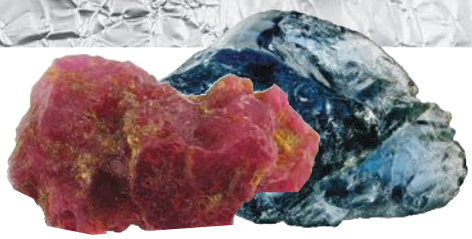
In the 1800s, rich ladies showed off by wearing jewelry made of a rare silvery metal—aluminum. The stuff was so exotic that most people had never even heard of it. French emperor Napoleon III served his extra-special guests on aluminum plates. Less important visitors had to use gold.

Aluminum is part of most rocks on Earth. Bauxite has a lot of aluminum in it.

The Shy Metal

Aluminum is not rare. In fact, it's the most common metal in Earth's crust. But it's never found by itself, in pure form. That means you'll never stumble across an aluminum nugget the way a lucky miner might find a lump of gold. And for a long time, no one knew how to get it out of rocks.

As far back as the 1700s, scientists suspected a rock called bauxite held



Aluminum gems? Yes! Rubies and sapphires are chunks of aluminum oxide (also called corundum). This mineral is almost as hard as diamond. They get their colors from traces of other metals mixed in.

metal. But they didn't know what kind. They tried heating the rock to different temperatures. They dissolved it with acids and salts. But no luck.

Finally, in 1825 they managed to get a little metal-rich powder. It took another 20 years to get the pure metal—and then the blobs were only the size of pinheads! Extracting aluminum was difficult. It took lots of chemicals and intense heat. Because it was so hard to make, it was rare and precious. For a while, it was more expensive than gold.

Aluminum for Everyone

In 1884, an American named Charles Hall was in chemistry class when his teacher handed around a piece of aluminum. He told the students that whoever could invent a cheaper way to make it could change the world and get rich. Hall decided he wanted to be that person.

Hall set up a lab in the woodshed behind his parents' house. And in 1886, he found a way.

The main challenge was how to separate the aluminum from oxygen.

Aluminum really, really likes oxygen. Aluminum and oxygen will stick together even at very high heat.

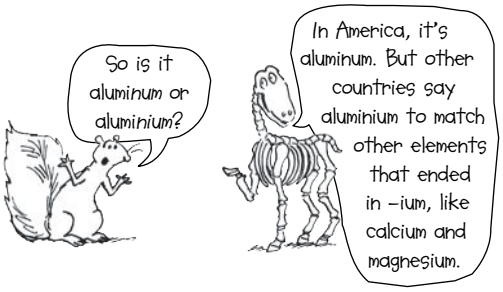
Hall's trick was to dissolve powdered aluminum ore in liquid cryolite (another mineral). Then he zapped the mixture with a lot of electricity. The electricity knocks oxygen and aluminum atoms apart. And pure aluminum sinks to the bottom.

Meanwhile, in France, chemist Paul Héroult was also working on the aluminum problem. He had exactly the same idea! They shared credit for the discovery. The Hall-Héroult Process is still used today. And Hall's aluminum company became the largest in the world.

New Cans for Old

Soon there was cheap aluminum for all. Engineers loved it. Aluminum is light, strong, and doesn't rust. Blending aluminum into other metals can make them lighter and tougher. Today, aluminum is all around us, in cars, airplanes, buildings, bikes, computers, cooking pots, soda cans, and much more.

Aluminum is also easy to recycle. Melting down old aluminum uses 90% less energy than making new aluminum. It's much cheaper and creates less pollution. In fact, thanks to recycling, 75% of all aluminum ever produced is still in use! So the next time you see an old soda can, don't think of it as trash. Think of it as one of Earth's most valuable metals, even if it doesn't cost as much as gold.



The Washington Monument in Washington, D.C., is covered in white stone. But the very top is capped with a 9 inch (23 cm) pyramid of pure aluminum. It anchors the lightning rods that prevent damage during storms. In 1884, when the monument was built, one ounce of aluminum cost as much as a full day's pay for an average worker. At the time, the 6 pound spike was the largest piece of aluminum ever cast. It could have paid a day's wages for 96 men!

The tippy top is aluminum!

Ask Ask

WITH SAGE AND BRIAR

TEXT BY ellen R. BRAAF
ART BY MARNIE GALLOWAY

Hey, Sage! Robert V. in California wants to know, why does plastic of any color (even clear) turn white when you bend it?

Hey, what do you know, it does!

So what's going on in there?

Plastic is made of long molecules—strings of atoms linked together. The kind of molecules and how they're arranged make the color.

POLYMER CHAIN

I know about color! It's bouncing light. A red block looks red because it bounces red light back to your eyes. Blue things look blue because they bounce blue light. And if light goes right through, it's clear!

White light—from the sun or a lamp—is really a mix of many colors: red, orange, yellow, green, blue, indigo, violet. All this light hits objects, but only some colors bounce. That's the color we see. So white objects are really reflecting ALL the colors of light.

And that's the key to the puzzle. Ordinary plastic has a mix of tangled molecules and straighter ones, plus bits of pigment (or color). When you bend plastic, it pulls on molecules and changes the way they are arranged. That makes them bounce many different colors of light.

Bending also makes tiny cracks and bubbles that bounce light. So with all that bouncing light. . .

Bent places look white!

Mind bending!

ASK US ANYTHING!

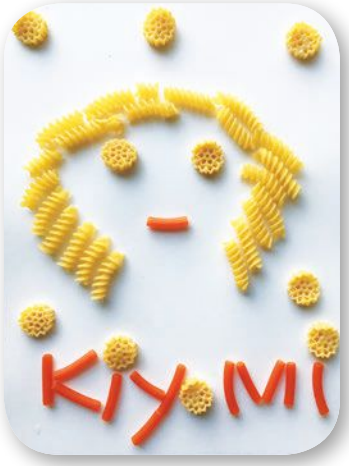
WRITE TO US AT:
ASK
70 EAST LAKE STREET
SUITE 800
CHICAGO, IL 60601

OR HAVE YOUR PARENT EMAIL
ASK@CRICKETMEDIA.COM

Contest and Letters

Send your letters to Ask *Mail, 70 East Lake St., Suite 800, Chicago, IL 60601, or have your parent/guardian email us at ask@cricketmedia.com.*

In our January issue we asked you to send us a portrait made entirely of pasta. Thanks to all you amazing portrait chefs for sharing your creations!

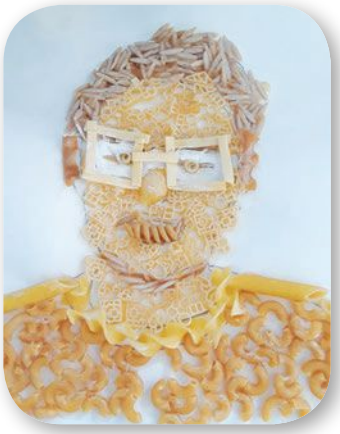


Kiyomi D., age 8, California

Hazel S., age 10, Oregon

Emma W., age 9, California

Anastasia, by email



Xavier H., age 10, by email

and all your talented siblings! Hannah, Eva, Desmond, and Isaac

Dear Whatson,
I like reading books and listening to them. I also write poetry. Here is one of my poems:

It's the end of May
Let's go out and play.
Are you done with school?
Let's jump in the pool.
Let's have some fun,
Summer's just begun.

Bye for now,
Flannery B., age 7, Texas

Dear Flannery,
Thanks for sharing your lovely poem! It perfectly captures the feeling of a fine May morning. Time to poke my nose up and see some flowers!
Regards,
Whatson

Dear *Ask*,
I'm really into volcanic eruptions and other natural disasters. Could you please make an *Ask* about natural disasters? I know two cool facts you could use. Fact #1: If there is a natural disaster and it leaves a dead area, in about a year it will be beautiful again. Fact #2: There

Lark K.,
age 8, Florida

Lula and Opal, by email

Peneolpe D.,
age 10, Michigan

Yehudis B.,
age 11,
New York

Giovanni G.,
age 7,
Florida

Cynthia L.,
age 9,
Florida

Lily R.,
age 8, Guam

is a place called the Painted Hills. Some volcanic eruptions made it super colorful. Thanks!

Sincerely,
Ela V., age 8, Ohio

Dear Ela,
If we do, we'll definitely give you a call! Thanks for sharing those interesting leads—I always love a good rock story. Volcanic ash falling in layers certainly can make some amazing stripes!

Geologically yours,
Bone Pony

Hey Ratz,
What's your favorite way to make chicken? I don't like it and I'm looking for ways to improve it.

Thanks,
Sevan, age 7, California

Dear Sevan,
I often find that chickens improve if you read them stories and teach them to dance, and stop trying to make them do homework.

Hope that helps!
Ratz

More Metal

There are lots of metals out there. But you'll never find kryptonite or anti-gravity iron—these metals are imaginary, made up for stories and comic books. Why not try it yourself? For this month's contest, make your own metal card, either for a real metal that we've left out, or for a fantasy metal of your own invention. What properties would it have? Where is it from? What could you do with it? We'll post a deck of the most metal in an upcoming issue of *Ask*.

Contest Rules:

1. Your contest entry must be your very own work. Ideas and words should not be copied.
2. Be sure to include your name, age, and address on your entry.
3. Only one entry per person, please.
4. If you want your work returned, enclose a self-addressed, stamped envelope.
5. Your entry must be signed or emailed by a parent or legal guardian, saying it's your own work and that no one helped you, and that *Ask* has permission to publish it in print an online.
6. For information on the Children's Online Privacy Protection Act, see the Privacy Policy page at cricketmedia.com.
7. Email scanned artwork to ask@cricketmedia.com, or mail to: *Ask*, 70 East Lake St., Suite 800, Chicago, IL 60601. Entries must be postmarked or emailed by June 30, 2018.
8. We will publish the winning entries in an upcoming issue of *Ask*.

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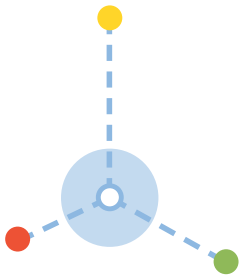
Bot's Mighty Math

A Soapy Short Cut

by Ivars Peterson

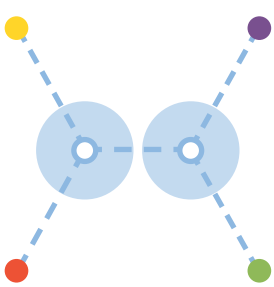
Say you want to build a brick path in a playground. It needs to join the swings, sandbox, and seesaw. But to save bricks, you want to keep the total length of the path as short as possible.



What would you do? You could make a path connecting them up in the shape of a triangle. But that isn't the shortest amount of path. Can you do better?

Try putting a new dot in the middle of the playground. Standing at this point, you can go straight to any of the three places.

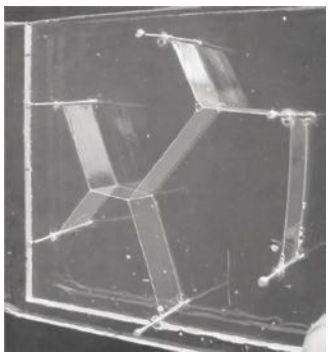
Move this new dot around and measure how much path you need. You will find that the shortest path has a special central spot. This spot is where the three paths meet at equal angles. An angle measures how wide apart lines are. The shortest paths meet where they would cut a circle into three exactly equal pieces.



What if the field also has a water fountain, so your path now has to connect four places? Or more?

One way to find the answer is to let nature do the work. With bubbles!

Put pegs for your playground places between two plastic panes. Then dip the whole thing into soapy water. When you pull it out, soap film links the pegs. Soap film will always stretch along the shortest possible path, so it does the work for you. You'll see that these paths also join up in threes, with equal angles between them. The angles will always be equal, even if the paths are different lengths. In fact, this will be true for any number of pegs! The shortest amount of path joining them will form a pattern that meets in threes, with equal slices.



You can learn a lot about math from nature.

text and art by Thor Wickstrom

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