But Why: A Podcast for Curious Kids

Ice, Ice, Baby: Why is Ice Slippery?
November 22, 2019

[00:00:21] [Jane] This is But Why: A Podcast for Curious Kids from Vermont Public Radio. I'm Jane Lindholm. On this podcast [00:00:28] we take questions from kids just like you from all over the world and we find answers. [00:00:34] Maybe you've even had a question answered on one of our many episodes. [00:00:38] What are you curious about? If you've never sent us a question, we'd love to hear it.

Today (brrrrrrrrrr!), we're talking about ice.

[child's voice] Why does ice float?

[child's voice] How are icicles made? [00:00:49]

[child's voice] Why was there an ice age?

[00:00:51] [Jane] We'll get answers to all of those questions. And we'll take a trip to the world's largest skating rink. But first, let's start with the basics.

[00:01:00] [Molina] My name's Molina, I'm four years old, I live in California. My question is "How does water make ice?"

[Rowan] Hello, I'm six and a half years old, my name is Rowan and I live in Texas and my question is [00:01:11] "Why is ice very cold?".

[00:01:17] [Jane] How does water make ice and why is it cold? Okay, so you probably know that ice is what happens when water freezes. But what is water exactly? And why does it go from liquid to solid when it gets cold? We're going to back way up for just a minute and do a little chemistry. Everything on earth is made of atoms. Atoms are the smallest component of matter of stuff. If you could break something down into smaller and smaller and smaller and smaller and smaller units, the

smallest you could get would be a single atom. But a bunch of atoms just floating around don't really make a thing. When you combine or bond atoms together in different arrangements, you get molecules and molecules are the smallest particle that is essentially that thing. The smallest piece or particle of water would be a water molecule. Water is made out of two hydrogen atoms and one oxygen atom bonded together, kind of tightly connected together. Maybe you've heard people call water H2O. That's the way you describe the water molecule. H2 is two hydrogen and O is one oxygen. So, H2O, that's water. You can't see a molecule with your own eye. Molecules are minuscule, teeny teeny tiny. But put a bunch of water molecules all together and you get something you can see: water. If you're interested in molecules and atoms and how they bond and break and how all the stuff in the world becomes the stuff in the world, you might be interested in becoming a chemist or studying chemistry. We're not going to go super in-depth about the chemistry of water. So if the adults in your life know a lot about this, they might want to pause this episode and tell you more. But we're just going to summarize so you understand what ice is and how it's formed and then we can go from there. Because molecules have energy, they're constantly moving around. That's how you feel when you have a lot of energy, right? Like you're just bouncing off the walls, you're vibrating. That's the same thing that happens to molecules. They have a lot of energy and that's what makes water liquid. There's enough energy that the molecules are slipping all around each other. If they get a lot more energy, like by absorbing heat from the air or from the burner on your stove, they start moving very fast, even faster than when they're water and they eventually turn into a gas and evaporate because they're moving too fast to stay in that liquid form. That's called boiling. But if the atmosphere around the water is colder than the water, those molecules lose energy. Their energy is absorbed into the atmosphere. And so the water molecules are losing energy in the form of heat and their movement slows waaaay, waaaay down and the water gets colder and colder. And as the molecules slow down, they can't slip around each other the way they do when they're in water. And eventually the water hits the freezing point where it goes from a liquid to a solid, and that's ice. Isn't that amazing? You know what else is amazing? Those molecules in ice are still moving. They're just moving much more slowly than they were when the

water was liquid. And we can't see the molecules moving because molecules, remember, are super, super small, but they're still moving even in solid matter. So why is ice cold? Well, again, to simplify, it's because heat has more energy. [00:05:05] So when something has more energy, like those molecules are moving around, the water is warmer. It's a liquid. When the water molecules lose energy and have less energy, they have less heat. They get cold. And that's when they turn into a solid, into ice. So it's all about the energy and the molecules that determine the temperature of how you feel the water. Now, different substances have different freezing and melting points. Water turns to ice at zero degrees Celsius, 32 degrees Fahrenheit. So now that we know a little bit about ice, let's tackle a few of your specific questions about this cold solid.

[00:05:44] [Aiden] My name is Aiden, I live in Edmonton, my age is six and I want to know “Why are icebergs mostly underwater?”.

[00:05:50] [Jane] Icebergs are very large chunks of ice floating in the water. And to explain why icebergs are mostly actually under the water, not above it, is Celeste Labedz. You might remember her from our episode about earthquakes. She is a cryoseismologist. That's someone who studies earthquakes in ice. And she works at the California Institute of Technology.

[00:06:15] [Celeste] Great question, Aiden. You've probably heard the figure of speech “tip of the iceberg”, which means that there's way more than you can see at first. This figure of speech is pretty accurate because real icebergs are mostly underwater, but with a little tiny bit sticking up above the surface. The reason that happens is because of their density. Density is how much mass is in a volume of space. So if you have a rock and a piece of styrofoam that are the exact same size, the rock is gonna be much heavier because it has a higher density. If you put something in water that's more dense than the water, like a rock or some metal, it will just sink right to the bottom. But if you put something in that’s less dense than the water, like styrofoam or a basketball, it will float at the surface. Icebergs float with only a little bit above the surface because they're only a little bit less dense than the water. The reason for that little difference is that the H2O molecules in water and ice take up just a tiny bit more

space as a solid crystal, that's the ice, then they do as a flowing liquid. This density difference means that any piece of ice in water will have about 90 percent of its volume below the surface and 10 percent above. Since it's all about the density, and not about the size, an ice cube in a glass of water has the same fraction of its ice sticking above the surface as a humungous iceberg. So when you want to chill out a drink, you basically have a mini iceberg right there.

[00:07:47] [Jane] Ice cubes are just mini icebergs! That's something to think about the next time you have a cold glass of water. Here are two more ice questions.

[00:07:56] [Noah] Hi, my name is Noah. I live in California and I'm five years old. My question is, "Why is ice very sticky?".

[00:08:06] [Adam] Hi, my name is Adam. I'm four years old. I live in Albany, New York. [00:08:13] Why is ice slippery?

[Jane] Why is ice sticky and why is it slippery? Let's tackle slippery first. Scientists haven't really agreed on what makes ice slippery, but there are a lot of theories or ideas that can be tested. The slipperiness is caused by the fact that there's often a very thin layer of liquid water on top of the ice, so it's a little bit warmer than the ice and that's slippery. But why is the top of the ice turning into water? Well, that's the part that's unclear. The theory that seems most promising right now is that the molecules on the outside of the ice are weakly bonded to the rest of the ice, and it's easier for them to turn into water even if it's cold outside. Now, when it comes to sticky, the sticky ice comes from a difference in temperature, too. This is not something I would advise you to do, but if you've ever stuck your tongue to an ice cube and had your tongue stick, that's because your warm tongue is melting the outer layer of the ice. But then when the heat is gone from your tongue, the ice will refreeze and the moisture on your tongue freezes and the ice sticks to your rapidly cooling tongue. Here's a question from Nina.

[00:09:24] [Nina] I live in Vermont, and I'm 7 years old, and my question is "How are icicles made?".

[00:09:32] [Jane] Icicles are formed on days when it's cold, but sunny. The warmth from the sun will start to melt the snow on a roof of a building, say. That water will begin to drip down. But as it does, the freezing temperature in the air refreezes the water. Icicles start with a small number of water droplets. But if the process continues, an icicle keeps growing and it'll eventually usually start to have a long carrot-like shape as more water goes down the sides and freezes in the cold air. [00:10:01] Here's a question about the Ice Age.

I'm almost eight. I live in Montreal, Quebec and my question is "What was the Ice Age?"

[00:10:14] [Mike] My name is Mike and I live in Indianapolis and I'm four years old. My question is "Why was there an Ice Age?"

[00:10:22] [Jane] Here's Celeste Labedz again.

[00:10:24] [Celeste] Ice ages are super interesting times in our planet's history. The amount of ice on Earth has changed a lot many times over the history of the planet. But the most recent Ice Age, which is usually what people mean when they say the Ice Age, started about 100,000 years ago and ended about 15,000 years ago. During this time, there was a lot more ice on earth than there is today. The whole world was cooler, so there were huge ice sheets covering basically all of Canada and into the northern USA, as well as the United Kingdom and Scandinavia. So if you were at the place where Montreal is, but back in the Ice Age, it would look a lot like Antarctica does now. The most recent Ice Age isn't the only one, though. Over the last eight hundred thousand years, there have been eight different ice ages, all lasting about the same amount of time with warmer periods in between. And there have been other ice ages even further back in the past, too. For example, 700 million years ago! Basically, the entire planet was covered in ice in an era we call Snowball Earth. Now, why there was an Ice Age is a really interesting question that scientists are still trying to figure out the complete answer to. For the Ice Age cycles in the last million years, one major reason that we suspect is Earth's orbital cycles. When you picture the earth going around the sun,

you probably think about its orbit as a circle. But this isn't quite exactly the case. Earth's orbit is an ellipse, which is like a slightly squished circle. And its eccentricity, which is how much or how little the ellipse is squished, varies in a cycle that lasts about one hundred thousand years. The tilt of Earth's axis, which affects how much sunlight different parts of the earth get in different seasons, also varies on cycles that lasts about forty thousand years. When you put effects like those together, you can get variations and climate factors like how strong the seasons are. They can make ice sheets more likely to grow or shrink. It's important to keep in mind that these changes happen over pretty long timescales unlike modern human caused climate change, which is a lot faster.

[00:12:34] [Jane] Coming up, we'll learn about some of the fun things you can do on ice.

(station identification break)

00:12:54] [Jane] This is But Why: A Podcast for Curious Kids. I'm Jane Lindholm. [00:13:03] (sound of skaters on ice) That’s the sound of ice skating. If you live in a part of the world where there's winter or if there's a rink nearby, it may be something that's a pretty familiar sound to you. And maybe you like skating, too. In Ottawa, the capital of Canada, about 20,000 people every day head onto the ice on the Rideau Canal. A canal is like a river, but it's not natural. It was built to connect two waterways. The Rideau Canal becomes the world's largest skating rink when it freezes over in winter. On a busy day, you’ll see families skating, people walking or pushing kids, some adults in sleighs on the ice. Some people may even commute to work or school along the canal on ice skates and machines go by with big brushes to keep the ice clean. [00:13:56] It's like a carnival. There are even places you can play games and listen to music and eat pastries called Beaver Tails. [00:14:05] We found someone on the Rideau Canal who could help us answer a few questions you have sent us about ice. (happy, bouncy background music)

[Bruce] I’m Bruce Devine, a senior manager for the Rideau Canals Gateway, working for the National Capital Commission. While the Rideau Canal [is open] for the wintertime, the National Capital Commission has

the mandate to manage the ice rink. It is the largest skating rink in the world on a natural ice, floating ice surface; there is water moving underneath. It's a UNESCO World Heritage site, since 2007. This is our 47th year. It started around the 70's where you had actually a crew to shovel five kilometers and it was so much of a success, so it started to build up and build up, and now we're 7.8 kilometers long. We average about 20,000 visits a day. So a regular season of 50 - 52 days, [00:15:08] it's about 1.2 million visits that we have during the season.

[Ben] My name is Ben. [00:15:14] I am five and a half. I live in Philadelphia. My question is "Why does ice float?".

[00:15:22] [Tom] Hi, my name is Tom. I'm eight years old. I'm from Medfield, Massachusetts and my question is, "Why does ice float?".

[00:15:31] [Bruce] The water, it's made of many molecules, like imagine small bingo balls all tied up together. [00:15:38] So it's very, very tight, so it has some kind of a weight. But when it freezes, those bingo balls, they separate. So they separate so much that they become less dense. So it's lighter and now it begins to float.

[00:15:56] [Jane] I like that picture. Lots of bingo balls or say tennis balls, all hugging tightly together when the water is liquid and then those balls or molecules spread out when they get colder and turn into ice. That makes the ice less dense. It makes it lighter because it's not so many balls packed into that same space. There are fewer of those balls in that same square. So it's lighter. So that makes the ice lighter than the water and the lighter ice floats on top of the heavier water. Here's a question we got about the clarity and color of ice.

[00:16:36] [Caleb] Hi, my name is Caleb and I live in Amherst, Mass and I'm 7 years old. And my question is "Why is the some ice clear and some ice not?".

[00:16:44] [Bruce] What we've seen in pictures, or some have seen it in life, the icebergs are blue, sort of. So, those are all old ice blocks and the sunshine goes through and it absorbs every color of the sun except the

blue and it reflects it. So that's why we sort of see it like a kind of blue. Whereas here we have two types of colors because it's not an old ice, it just forms quickly and then it disappears when it gets warmer. So we've got clear ice. So this is the natural water underneath that has no snow on it. There's no dirt on it. So it's very clear, we can see it through. Since we are processed now, when it snows before we open the season, to accelerate the thickness of it, to twelve inches, for instance, we water all the snow on it. So it becomes…it acts like a sponge and absorbs all the water and because it's very, very tight like this one in my hand, we call it the white ice. You see all the bubbles in there? So those are air bubbles. When you look you can see how tight they are, so it's all squished together. So this becomes very, very solid as normal ice. The tighter it is, the less bubble there is, the safer it is to be.

[00:18:06] [Jane] Did you catch all that? An oversimplified answer about the color of the ice, is that clear ice is usually ice that froze slowly enough for bubbles and impurities to have a chance to rise to the surface and escape before they were frozen in. Bruce mentioned blue icebergs were made from old ice. Now, because those icebergs were formed so long ago, they have been compressed over time, kind of squeezed together, and the ice has been pushed more and more and more together. And all of the air gets squeezed out as that ice gets pushed together. When light hits this iceberg, it's absorbed instead of reflected because there's not as much oxygen or air in the ice. So we see it as blue and not white. Bruce also mentioned that the ice on the Rideau Canal is 12 inches thick. That's pretty solid. Still, there are people who monitor the ice there to make sure it's safe. But how do you know if natural ice that you find on a river or, say, a pond near your house is thick enough to skate on?

[00:19:07] [Bruce] You want to make sure that you've got at least, if you're just skating, six inches, five inches of ice. And, especially if it's a river, well, you should wait. Well, you shouldn't venture on the river if there's a large current, because the water underneath eats the ice from underneath and becomes weaker. So but just a lake here, four inches. You should be fine if it's all tight. (sound of walking/skating on the ice)

[00:19:38] [Jane] It’s always best to check with an adult before you go out on any ice. All right, let's get back to skating and see if we can find some more music. (bouncy music starts up) By the way, if you ever skate indoors on a hockey rink, [00:19:50] that ice is layered onto a hard surface and it's painted. One of the layers of ice is painted usually white or pale blue. And then there are lines painted on top of that for center ice or around the nets if you're thinking about a hockey game. And then there's more ice layered on top of that. And one of my favorite things is called the Zamboni. That's a machine that puts a very thin layer of water on top of the ice after it's been scratched up by skaters. That water freezes on top of the ice, creating a nice, clean, smooth surface. And remember how we said the ice on the Rideau Canal is usually about 12 inches thick? Well, the ice in a hockey rink is usually just an inch and a half thick.

[00:20:36] That's it for today. Now, if you have a question on any topic that you're wondering about, we'd love to hear what you're thinking. [00:20:43] Have an adult record your question or your comments on a smartphone and send the file to “Questions” at butwhykids.org. [00:20:51] Don't forget to tell us your first name and maybe how old you are and where you live.

[00:20:55] But Why is produced by Melody Bodette and me, Jane Lindholm for Vermont Public Radio. Our theme music is by Luke Reynolds. We'll be back in two weeks with an all new episode. Until then, stay curious.