But Why: A Podcast for Curious Kids

How is Glass Made?

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[Jane] This is “But Why: a Podcast for Curious Kids.” I'm Jane Lindholm.

On this show we invite you to be the leaders. You tell us what you want to hear about--what makes you curious --and we find interesting people to help answer the questions you send us.

We love hearing every single one of your questions. So, thanks to everyone who has sent one in. We'll tell you how to do it at the end of the episode.

OK. Do you like to take field trips? I do. For this episode we went to two different places to answer some of your questions and learn new things. Let's get right to it. Here.

[Child] Hello. My name is Isabelle. I live in Brazil and I have seven years old. And my question is: How do you make glass?

[Karin] my name is Karin and I am five years old from San Jose, California. My question is: how does glass get made?

[Madeleine] My name is Madeleine. I am 6 years old. I live in Scottsdale, Arizona. I want to know how glass is made.

[Yael] My name is Yael and I live in Cambodia and I'm 7 1/2. And I’m going to ask my question in French and English. Comment fait du verre? So, how do you make glass. Thank you. I hope you can hear my question and answer it too.

[Jane] I love hearing a question in French and English. You guys come from all over the world—Brazil, California, Arizona, and Cambodia—and all of you want to know the same thing. How is glass made? Well to find out, I took a field trip over to a place called Simon Pierce in Windsor, Vermont. Simon Pierce is a place where they make some really beautiful glass things like bowls and vases and fragile cups—the kinds the adults in your life might tell you “Don't touch”.

[Mike] My name is Mike Cushing. I've been a glassblower here at Simon-Pierce for a little over twenty years.

[Jane] Maybe first you could tell us what glass is made out of.

[Mike] Glass is basically made from silica sand.

[Jane] That's right. Sand glass is made out of sand. This special sand is shipped to Simon Pierce where it's put into a great big furnace or oven—a very hot oven.

[Mike] About 2400 degrees Fahrenheit. The furnace runs all of the time and stays at a temperature 24 hours a day, 365 days a year, without ever cooling down.

[Jane] To give you some idea of how hot that is, your oven at home probably only goes up to about 500 degrees or so Fahrenheit or 260 degrees Celsius. Now the center of the sun is 27 million degrees Fahrenheit. So, we're not talking about that kind of heat, but still way hotter than anything you have in your home.

[Jane] So if I went to the beach and I picked up a bucket of sand and took it home and I put it in my oven, would it turn into glass?

[Mike] No. They search all over for a specific kind of sand-- silica sand-- to make glass. In theory, if you took beach sand and you heated up enough it would melt into glass. However, your oven at home would not even become close to hot enough to make that happen.

[Jane] And the sand at the beach, I imagine, has a lot of other things in it besides pure silica. It has little pieces of shells and bones and other kinds of substances that would probably make that glass not pure and clear, right?

[Mike] Correct. There's a lot of minerals and other items in sand that's filtered out for our process. A fun fact about glass is all glass is clear. If you see a piece of glass that's green or blue, they simply change the color of that by adding a metal to the process. When you melt the silica sand, if you add copper to that mix, a very small amount will turn your glass to blue.

[Jane] You can add sulphur or lead to turn your glass yellow, nickel oxide for violet, iron for brown. And there are other chemicals that can be added to take color out of glass if the silica sand is not quite pure. So, you take this sand and you melt it in the hot, hot oven and then you've got liquid or molten glass clear and very, very hot and it moves around like lava, sort of.

So how does it get from a liquid to all the different things we make out of glass—windows, cups, car windshields, casserole dishes, bottles.

Most glass is poured into molds to make the glass a different shape. Like the bottles you might see drinks in, the hot liquid molten glass is poured into a mold of the shape and then it cools down and voila,.it's a jar. Things like windows that are very flat and straight are poured onto a flat surface and they melt in that shape. It's kind of like how, if you pour water onto a plate and put it in the freezer it would come out as a frozen sheet of ice. But there's another way that people make shapes in glass. And it's called blowing glass or glassblowing.

[Mike] For us at Simon Pierce, our process is very similar now to the way they made glass a thousand years ago. The glass, actually, when it's hot will adhere to a metal rod.

[Jane] “Adhere” is a verb that means to attach or stick to something. So, the kind of melty glob glass sticks to a metal rod that someone has stuck into the oven.

[Mike] We use hollow metal rods to gather the liquid glass from the furnace. It's very similar to honey when you're gathering it out of the furnace. It's a similar texture. And you take that glass from the furnace and we use various tools to shape that to a shape we'd like and all of our pieces have a wooden mold. So, when you get the glass to a temperature that's solid enough you can actually put that glass into the mold and you blow through the hollow pipe and it takes the shape of the piece you're trying to make.

[Jane] So, people may have heard of this called glassblowing and that's actually what you're doing. You're actually blowing with your breath through this hollow metal rod to shape that glass sort of from the inside out?

[Mike] Correct.

[Jane] So it's the right shape but it's still attached to that metal rod. Mike Cushing says they use a special tool to cut the glass to get it off the rod.

[Mike] Glass wants to break in its easiest location so we have tools that will make a sharp line in the glass. So, when you tap that metal pipe the glass will want to break in that location every time.

[Jane] Then using heat, they finish the top of, say, a drinking glass so it's nice and smooth and won't cut your mouth when you put it up to your lips. And they finish the bottom using heat as well.

What kind of safety precautions do you have to take if you're working with glass?

[Mike] The biggest safety concern that we have here is that glass gets what's called glass stress and it has to be cooled very, very slowly. If it does not cool at the right speed it can actually explode into millions of small pieces.

So while you're working there's always some old glass that hasn't been annealed around the shop that can explode. So, it's very important to make sure that you have safety glasses on to protect your eyes, to make sure that you have good shoes on to protect your feet when you're walking. And, also, the right clothing to make sure that you don't get any burns on your skin from the glass while you're working with that.

[Jane] Not all glass is blown glass. What you do is pretty special and pretty specific and in many ways what you do is an art form. But a lot of glass is really utilitarian it just serves a very businesslike purpose. The glass that we might use to have spaghetti sauce in when you buy from a store is probably not blown by hand by somebody like you. So how is other glass made?

[Mike] It's a very similar process. If you look at different bottling companies that make jars for spaghetti sauce or bottles for soda, the process is very similar. However, it's made very quickly by machine and it's a much lower quality of glass that's more prone to break, is less clear and less brilliant than the glass that we make here.

[Jane] And, so, as you said it's made by machine, so machines are shaping that liquid glass into the form.

[Mike] It's very similar. All of those places that make mass quantities of a glass item have molds that are similar to what we have. Theirs are probably made from steel and the glass pours into a vessel and the machine forces air in to make that piece.

[David] Hi my name is David. I live in Australia. I’m five years old. And my question is: why does glass break?

[Mike] Well, that's a hard one for me to answer.

[Jane] Why, you've worked with glass for 20 years!

[Mike] I'm really not sure how to how to answer that question, I guess. It's just the consistency of glass. It's a hard object that's fragile and so if you if you drop it, it will break.

[Jane] OK, let me jump in here and help out. Glass is really interesting because it's very, very strong but it can also break and shatter into a million pieces. What gives? It's complicated, but basically the molecular structure--the makeup of glass-- means that it doesn't have a way to bend or stretch if it gets stressed or pushed upon-- like if you bump it against something or hit it with a hammer. So, it breaks instead of bending and it breaks in random ways, shattering. You can also break a glass if you pour something into it that's a very different temperature than the glass itself like a cold glass and very hot water. That's because where the hot water hits the glass it causes the glass to expand, reacting to that temperature change. But glass isn't very good at spreading out that heat. So, the outside of the glass is cool while the inside of the glass is hot and expanding. So, there's a difference between the outside and the inside. And remember glass doesn't bend or stretch very easily. So, it breaks. It's called thermal shock.

Now if you have a car or ride in a bus or a taxi or a train to get around, there's a lot of glass in those windows, right? That glass is made in a special way to break more safely than a vase you would put flowers in or a cup for water. A windshield is usually something called safety glass which is actually a glass plastic sandwich-- two pieces of glass with a very thin piece of vinyl plastic in between them. When something hits the windshield, usually it's only the outer pane of glass that breaks so it doesn't shatter on you. If something hits the windshield really hard, the whole windshield might shatter but the glass is more likely to adhere to the vinyl. Remember what “adhere” means? It means to stick to. So, the glass kind of sticks to the plastic instead of falling all over you, usually.

Now the side windows in your car do shatter but they're designed to shatter into small pieces like a bunch of little rocks or rock salt, not jagged edges. Scientists and engineers and designers have learned many, many different ways to work with glass to make it do amazing things for us -- from being in telescopes to cars to medical equipment to the screen on a cell phone to the glasses that you drink out of to the glasses that you wear on your face. Glass is pretty cool.

Stay with us we're going to explore something else that's really cool. Coming right up.

This is “But Why: a Podcast for curious kids.” I’m Jane Lindholm. And now we’re switching to something else clear and breakable or maybe pop-able. I traveled to a place here in Vermont and met up with this guy.

[Marcos] I'm Marcos Stafne, executive director of the Montshire Museum of Science in Norwich Vermont.

[Jane] So Marcos, we're here in the bubble exhibit at the Montshire. What happens in the bubble exhibit?

[Marcos] Well all throughout the exhibition we have different stations where families can get together and make bubbles. They can make large bubbles, small bubbles, get inside of a bubble and then experiment with foam. They can blow smoke in a bubble. Anything you want to do with a bubble, you can do here in our bubble exhibition.

[Jane] What's a bubble?

[Marcos] Well a bubble is basically some soap and some water. That's the easy answer. But I did think of a bubble as a soap sandwich. So, we eat sandwiches, right? And it's usually two pieces of bread and a piece of meat on the inside, but a soap sandwich would be two pieces of soap with some water on the inside. So, if you think about it, it's a layer of soap, then a layer of water, then a layer of soap. And that's what's helping to create a bubble.

[Jane] Are Bubbles always circles?

[Marcos] Well, the real shift that we call a bubble is a sphere, and a sphere is a naturally occurring shape in nature. Nature always likes to take the path of least resistance so it makes the easiest shape it can make. So, when we see a bubble made of soap and water, that is always going to be a sphere. Now sometimes the materials can be joined together and create different types of shapes. We can actually make a square inside of a bubble because the material is taking the shape of the path of least resistance.

[Jane] Or, if you're making a bubble and it lands on a wet table, it might be kind of like a half circle and then there's a flat bottom to it because it just sticks to the table.

[Marcos] That's right. It's taking the shape of a dome. So, it's trying to spread out all of its molecules which are these little tiny things that make up everything in the entire world, and it's making sure that those molecules are spread out so they can take up the least amount of energy. So, you have a dome on the top and you might have a flat bottom.

[Myra] My name is Myra, and I live in Oakland, California and I’m six years do. And my question is: why do bubbles pop?

[Marcos] Well Myra, if we're talking about soap bubbles, soap bubbles are made up of soap and water. So, the first reason that they can pop is because your hands if you're touching them are dry. Bubbles like things to be wet. And if you're touching it with your dry finger, it's going to pop because it's breaking up that perfect bond of soap and water. Now lots of things like dust or dry materials can pop a bubble; so dryness or just being dry is really the enemy of the bubble--that bubbles don't want to be dry. They want to be wet.

[Jane] So, a bubble in the air if you're blowing bubbles and it goes off into the air and then it. Pops. That's because it's in too much dry air..

[Marcos] Well, so there are a couple of different ways a bubble can pop. So you can touch it with your dry finger.

But remember the soap sandwich that I talked about. So, inside a soap bubble is a layer of water, and water does something called dehydrate over time. So, dehydration is a pretty long term for just drying up. If you've ever dropped water on the ground and watched it for like a really long time. You’ll notice that water disappears and that's because it's slowly drying over time.

So when a bubble is floating in the air in that soap sandwich, the water layer starts to dehydrate or dry up. And then when the two soap areas touch each other, it pops. So, a bubble will naturally pop over time, but some bubbles can last for a really long time.

[Jane] And a gum bubble pops because you… we're forcing too much air into it and that gum is getting thinner and thinner and thinner and thinner and then it just [00:17:21] can't take it anymore?

[Marcos] That's right. So a gum bubble, when you're blowing into it, the surface or the area around the air that you're expanding and expanding and expanding you're stretching out that material to the point where its little molecules can't hold on anymore and then it just goes pop.

[Jane] All right. So, our next question is from Oscar who lives in Brattleboro. Vermont.

[Oscar] I am five years old. And my question is: what's it like inside a bubble?

[Marcos] All right, Oscar. Well to learn more about what it's like inside of bubble, we're going to walk over to our bubble dome exhibition where you can make a dome and see what looks like smoke on the inside of a bubble.

[Jane] Can we actually get in the bubble.

[Marcos] Well it's not that big.

[Jane] All right, so here we are in the bubble dome area and you've got two bubble dome tables and over by one are a couple of kids and they're holding hoses and making bubbles and when the bubble pops some smoke is coming out. What is happening?

[Marcos] Well, the smoke helps us to see that air is what gets trapped inside of a bubble. So, air for the most part you can't see. It's all around us. We need it, but it's invisible. So, it's pretty cool. Now when you add smoke, it's kind of like air, but it's tinted in a way that you can see it. So, what we have are machines that help to pour a little bit of smoke inside of that bubble. Instead of you blowing into a bubble wand or making a bubble with your fingers or just having a bubble fall from the air you're actually taking a tube, putting it into the bubble solution, and then sort of grabbing and forming that bubble solution around the air that's being blown through the tube. And what you get is a really cool dome or a bubble that's filled with mist or smoke.

[Jane] All right. Can we can we do it?

[Marcos] Of course. OK. So, what I did was I took a tube and I dipped into the bubble solution. Because the tube is wet, I was able to make sure that it grasped the glycerin water around it to create a bubble.

[Jane] That bubble was really big.

[Marcos] Yup. Here you go. So, the trick with any type of bubble wand or bubble tube or anything that you're using, even your hands to blow a bubble is to make sure that it's wet. So you can get fancy Bubble Wands but you can also just use your hands and just making sure that they're wet and then you can blow through a circle that you make with your hands and you're making an OK symbol with your hands and then you can actually create a bubble.

[Jane] So there's this smoke inside the bubble. And what does that tell us about what it feels like inside the bubble.

[Marcos] Well, you know that you're going to be under a lot of pressure because there's air inside of it. Now a lot of structures today have air inside. Often, we go into domes. I play tennis inside a large dome that's compressed with air and the air is helping that dome to stay up and that's a lot like a bubble. So, architects and engineers often use bubbles to help model what they want to create to make beautiful structures.

[Jane] If I was inside of a bubble, would I be able to breathe?

[Marcos] Well, if you're inside of the dome filled with air and that dome was big enough for you to get inside, you'd be able to breathe for a while. And if that bubble dome that you were inside was made out of soap and water, you'd breathe for a while; but then what would happen was that that bubble would eventually start to dehydrate that water layer on the inside and eventually would pop. So, you'd be able to breathe. So that's if you were inside a big soap bubble.

[Jane] So, there's no... It's not like there's a different air pressure between the air inside the bubble and the air outside of the bubble.

[Marcos] You know I've never been trapped inside of a bubble so I can't tell you personally whether or not you feel a real difference. And bubbles are fleeting-- or they don't last for very long-- so bubbles that I actually have been inside that are really small pop really fast so I couldn't tell you from personal experience. We have a special bubble booth at the Montshire that lets anyone be able to at least be surrounded by three sides of a bubble. So, it was really important to us to make sure that, if you a person who uses a wheelchair or if you had a hard time stepping up onto a step, that you'd be able to at least see what it would be like to be inside of a bubble. But some museums also have areas where you can get onto a platform and then with a loop and a string pool, pull a bubble all the way on top of you and eventually have that bubble seal off to where you're in the bubble. Now, I'v,e never seen anyone be inside one of those bubbles for more than two or three seconds. So, generally, if you're taking that big gasp of air, your air that you might exhale will actually pop the bubble.

[Jane] All right we're inside the bubble booth. You have a rope that you're going to pull in. this rope is attached inside this soapy water. Look, there's a bubble all around us.

[Marcos] We are surrounded on three sides of a bubble.

[Jane] But it feels like the bubble is trying to come in and touch us. It's like sinking in on ice instead of usually you think of a bubble as puffing out.

[Marcos] Well, the bubble's moving and changing shapes and colors because the air inside this little bubble film is moving all around and is dehydrating or … Oop. There we go. The bubble just popped. So, you can make a very large bubble sheets. You can see that often. When you are doing dishes, you might get a big bubble sheet. Or when you're washing your car, whenever you have a big bucket of bubbles that you're moving your hands in and out of. You can get a big flat plane of soap film which ultimately is what this is. Now soap film that we're looking at… And water… And it moves because I'm stretching it. So, we're actually expanding the bubble as it goes up, so its molecules don't quite know what to do. So that's why they move all around.

[Jane] Now you're blowing bubbles into the bubble.

[Marcos] Yep. Let’s see if we can get a bubble. There you go.

[Jane] So when you see a bubble in your bread or you're chewing gum and you make a bubble, is that the same thing? There's no soap in that.

[Marcos] it’s a little bit different. So, what those things are are surfaces that have air inside of them that expand. So, when you're chewing gum, you're taking a surface that's malleable--- or a surface that's easy to move around-- and you're blowing air into it. It's like a balloon. So a balloon in a bubble. You have the same shape. They do a lot of the same things but they're made up of different materials. A balloon,s made out of rubber whereas the bubble that you get from soap and water is made out of something we called glycerin or soap and water.

Bubbles are really amazing for everybody to experience. That's why so many people like to study them or play with them. That is beautiful things that have a large shape that seem to float on the air. And because they float, they feel very whimsical or fun to experience. And that's why kids and adults alike love bubbles.

[Jane] Thank you for showing us the bubbles. I appreciate it.

[Marcos] Oh I've loved having you and thanks so much for those great questions about bubbles.

[Jane] Before I left, I wandered around the bubble exhibit to see what some young experimenters were doing.

[Matthew] My name is Matthew. I'm 8 years old. And I live in Oxford Massachusetts.

[Jane] So, you got your hands in the bubbles. What does it feel like?

[Matthew] It feels soapy and weird. Very, very weird.

[Jane] I agree. Kind of slippery.

[Matthew] Bubbles can be made in a tub by soap and water, so you can make your own at home.

[Jane] Yeah, I like making bubbles and bubble baths and I really like it here because you can make huge bubbles. What are you making now?

[Matthew] We’re trying…my dad’s trying to put a bubble of cage around me.

[Jane] So close. What do you think it feels like inside a bubble?

[Matthew] It would probably feel really weird.

[Connor] My name's Connor. And. I'm 11.

[Jane] And you guys are playing with the bubbles and you're playing with the smoke that’s inside the bubbles. Tell me what's happening?

[Connor] Well. The smoke's filling up the bubbles. So that it expands until it pops and lets out a big yes. Yes, smoke.

I’m the bubble king.

[Jane] That's it for today's episode. If you want to make your own bubbles, we have a simple recipe on the But Why Kids Facebook page and at ButWhyKids.org.

Do you like our show? Could you do us a big favor? Have an adult help you write a review wherever you listen to your podcasts. It helps other families find us. Or you could just tell other families about us. That's called word of mouth and it's a great way to learn about new things and share things you really enjoy. Like “But Why” And if you want to send us a question or a suggestion for things you'd like us to do better or differently, please do. You can record your questions using a smartphone. Try the memo function, and then send the file to Questions@ButWhyKids.org. Be sure to tell us your first name where you live and how old you are.

And that e-mail address questions@ButWhyKids.org is also where to send your pictures of the great bubbles you've made, your thoughts for us, criticisms, praise, anything you want us to know. “But Why?” is produced at Vermont Public Radio by Melody Bodette and me, Jane Lindholm. Our theme music is by Luke Reynolds. We'll be back in two weeks with an all new episode.

Until then, stay curious.