Growing Floaters and Shrinking Sinkers
by Stephen Whitt

Grab an ice cube from the freezer and drop it into your favorite after-school drink. What happens? You probably saw your cube sink a bit, then bob up to the surface and just stay there, floating like a cork or a bath toy. Big deal, right? Wrong! What you’ve just experienced is one of the oddest and most important events on Earth. Ice floats in water, and that makes water weird!

Ice is of course just solid water. Hold an ice cube in your hand and you quickly get a wet hand, because your body heat changes the ice from a solid to a liquid. Heat changes other substances (like iron, for instance) from solid to liquid, too. But there’s a big difference.

For most substances, the solid form sinks in the liquid form. Imagine a vat of molten iron. Toss in a chunk of solid iron, and it sinks like a stone. Solid iron sinks in molten iron because as solid iron forms, it shrinks.

Shrinking Iron

Think about what really happens when something shrinks. Everything around us is made of atoms. The atoms that make up molten iron are moving fast! They are bouncing off each other at high speed. As the molten iron cools, the atoms slow down a little. The slower atoms don’t bounce off each other quite so forcefully, and so the atoms end up closer together. Eventually, the atoms are so slow that they get locked into place, in a shape called a crystal.

You might think of crystals as beautiful, shiny jewels. When scientists talk about crystals, though, they’re talking about something else. A crystal is just an ordered arrangement of atoms. When molten iron cools, it forms crystals. If it cools slowly, it forms one large crystal. If it cools quickly, it forms lots of little crystals. Either way, the atoms in the crystal solid are closer together than the atoms in the liquid. This is why the solid iron sinks in the molten iron.

That’s true for almost every material you can think of. The atoms in the solid are closer together than in the liquid. The solid shrinks, and it sinks in the liquid. But that’s not true for water. Something weird happens as water gets colder and changes to ice.
Growing Ice

But what happens when water turns to ice? The best way to understand is to build your own water molecule. To build this model, you’ll need gumdrops, small marshmallows, and toothpicks.

Every water molecule is made of one atom of oxygen and two atoms of hydrogen. Let’s use gumdrops for the oxygen atoms. The marshmallows will be the hydrogen atoms. The toothpicks will hold the atoms together.

First stick two toothpicks into a gumdrop. But don’t stick the toothpicks straight across from one another! A water molecule is bent a little. It looks something like this:

Now stick a marshmallow on the ends of each of the toothpicks. There’s your water molecule.

Let’s think about that liquid water for a minute. Imagine a whole sea of the water molecules floating past one another. Their shape lets them get pretty close to each other without touching. As the temperature drops, they move slower and slower. The slower they move, the closer they can get to each other.

That’s when something strange happens. Just like cooling iron, the cooling water starts to form crystals. But these crystals have a very special shape.
Why? It has to do with the atoms. It turns out the hydrogen atoms can get close to oxygen atoms. But they can’t get close to other hydrogen atoms. In your model, this means that the marshmallows can get close to the gumdrops, but not to the other marshmallows. This causes the water molecules to line up something like this:

In this picture, each blue dot is an oxygen atom, or a gumdrop. Each red dot is a hydrogen atom, or a marshmallow. Do you notice how much space there is between the water molecules? That extra space is what makes ice float!

When water cools down, its molecules get closer together. The molecules start to form these wide-open crystals. More and more crystals form until the water has turned to ice. The wide-open crystal structure means that the freezing water didn’t shrink. It grew!

**Pop, Potholes, and Polar Bears**

If you’ve ever left a bottle or can of pop in a freezer, you know how powerful this growing ice can be. It can even break glass! The ice inside pushes harder and harder on the container’s walls until the container gives way, sometimes in an explosion. The same thing makes potholes in roads. First, water seeps into small cracks in the road. Then the
water freezes. The freezing water grows, and the cracks get bigger. More water creeps in, freezes, and grows, starting the whole thing all over again.

Growing water isn’t all bad, however. In fact, without water’s weird way of growing as it freezes, the world would be a very different place. Imagine if ice sank to the bottom of lakes, or even the ocean. Once there, the ice would likely never melt again. Much of the world’s water would be trapped forever far below the surface of lakes and the ocean.

If lakes froze from the bottom up, fish could never survive the winter. And what if ice didn’t float on seawater? Polar bears, seals, and many other creatures would need to find a new way of life. They depend on the floating ice of the Arctic.

The next time you cool off your favorite drink with a bit of solid water, consider what an amazing event you’ve just witnessed. Ice floats, and that’s weird!

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Glossary

atom – small particles that make up everything around us
molecule – several atoms joined together
molten – melted or liquid