

## **Blossoms -**

# **Will an Ice Cube Melt Faster in Saltwater or Freshwater v4**

[MUSIC PLAYING]

BILL ANDRAKE: Hello. I'm Bill Andrake. I'm an eighth grade science teacher at Swampscott Middle School in Swampscott, Massachusetts, which is on the North Shore of Boston. I'm standing on Fisherman's Beach in Swampscott and behind me is Massachusetts Bay, which is part of the Atlantic Ocean.

The ocean represents Earth's largest habitat, containing 99% of the living space on the planet. It is where life began and it's where at least half of Earth's living species reside today. There are thousands of species yet to be discovered. At some point in the history of our planet, life moved onto land and cells evolved the ability to live with fresh water. Like most terrestrial life, we are dependent upon fresh water, so it is familiar to us.

Yet the ocean remains Earth's defining feature. 70% of the Earth's surface is covered by this layer of salt water. In this BLOSSOMS lesson, we will take a look at the differences between salt water and fresh water. And we can begin this investigation by answering a simple question, will an ice cube melt faster in fresh water or salt water? Make a prediction as to which will melt the ice cube faster and come up with a simple experiment to answer this question. And I will join you back in my classroom.

Welcome to my classroom at Swampscott Middle School. At this time, you should have a prediction as to whether you think an ice cube will melt faster in fresh water or that it will melt faster in salt water. You should also have a plan for an experiment that would test this hypotheses.

Now most of my students over the years have always felt that the ice cube will faster in salt water.

[RUMBLING]

They base this on their experience with salt on the roads to melt ice in the winter or that locally our lakes and ponds will freeze as saltwater harbors and bays remain ice free. But you may have other ideas and it's worth discussing them in class before carrying out your experiment.

So here we have a simple set-up to test our hypothesis. I've just got two simple, clear cups here, two plastic cups. I've got one labeled fresh water. I've got one labeled salt water. They have equal amounts of water. Now the saltwater cup, I've added about two spoonfuls of Kosher salt. And I find Kosher salt dissolves very clear and it's a good salt to use for this experiment.

I've also kept the cups at the same temperature. I want the water to be at about room temperature. I don't want it to be too hot. I don't want it to be too cold.

I don't want the ice cube to melt too quickly. I don't want to melt too slowly either. I've also chosen two ice cubes that are of equal size and equal shape.

And in this way, the only variable in this experiment is we have salt water and we have fresh water. I put them into the cup at the same time, keep an eye on the clock, and then see the results of this experiment. During the experiment, pay close attention to what happens inside the cup. Pay attention to the ice cubes. Even pay attention to the cup itself. And make sure you record any observations that you see along the way. In the Activities Packet, there is a template for recording these observations. And after the experiment, I will join you again in segment three.

Welcome back. How did your experiment turn out? Clearly, the ice cube in fresh water is melting faster than the ice cube in salt water. But why?

Notice the way in which the ice cube is melting in each cup. Compare their shapes as they melt. Note the condensation patterns on the outside of each cup.

What is different between the two cups? What is this telling you?

In our experiment, the ice cube placed in fresh water clearly melted faster than the ice cube in salt water. So how might we explain these results?

Well, there are clues in the experiment to help us. One thing you can do is carefully measure the surface temperature and the bottom temperature in each cup without disturbing the set-up. Also, pay attention to the condensation patterns that develop on the outside of the cup. They also are a big part to telling us the story.

Condensation covers the outside of the freshwater cup, whereas there's a band of condensation around the saltwater cup only at the surface of the salt water. In the saltwater cup, the water at the surface is colder

than the water at the bottom. In the freshwater cup, the opposite happened, as it became cold on the bottom of the cup. Also the shape of the ice cube in salt water is a flattened V-shape, as opposed to the ice cube in fresh water, which was more of a cube shape throughout.

Now would be a good time to pause the video and brainstorm a possible explanation to explain the results that we see in this experiment.

Welcome back. Were you able to come up with some possible explanations for the results that you saw in your experiment? It appears that in salt water, the cold meltwater from the ice cube is floating on the salt water, forming a layer of cold water, thus preventing the ice cube from melting. In fresh water, the cold meltwater from the ice cube sinks to the bottom of the cup and pushes the warmer bottom water to the surface, circulating the water and melting the ice cube faster.

My students have normally come up with an idea of using dye or color ice cubes in order to visualize what's happening in the cup as the ice cubes are melting. So this time, try the experiment using ice cubes that have been dyed with food coloring. And in this way, it might help you to visualize what's happening and confirm your explanation.

Was the second experiment that you tried with colored ice helpful?

Now, I'm going to take two ice cubes that have been colored with food dye. I'm going to place them in the cups. We can see that the cold, blue water from the ice cube is sinking quickly to the bottom. This forces bottom water to the surface, creating a circulation in the cup, which melts the ice quicker. Meanwhile in the saltwater cup, we can see that the cold, blue water from the ice cube is floating on the warmer salt water, forming a layer of cold temperature that keeps the ice cube from melting.

Cold water is more dense than warmer water and sinks in the freshwater cup, creating a downward current or downwelling. And this results in the upwelling of warmer water, which helped melt the ice. However, salt water is more dense than fresh water, and therefore the cold, fresh water from the ice floats on the salt water.

We can take what we've learned from this experiment and apply it to global ocean circulation, which is very important to climate on planet Earth. Think about what you saw happen in each cup. Think about the factors that generated currents in the cup or even prevented currents from occurring in the cup and brainstorm ideas on how this type of movement might cause circulation in our oceans and affect climate.

Welcome back. Hopefully, you've come up with some good ideas.

The explanation for what we saw in this experiment can help us to understand thermohaline circulation, which is known as the Global Ocean Conveyor Belt. This is a slow moving system of currents that circulate ocean water around the planet. This thermohaline circulation, "thermal" or heat, and "haline" or salt, is driven by cold, dense, salty water sinking in polar seas and warmer, less dense water rising to the surface in warmer regions.

To help understand this circulation, I have a simple demonstration in an aquarium. In my lab, I've set up this aquarium, to which I will add colored ice cubes at one end, representing the polar region, and a lamp at the other end, representing warmer seas. We can see that cold, dense water sinks at polar regions, drawing warmer water from the tropics toward polar regions and distributing the heat, that builds up at tropical latitudes.

I've added green dye to the aquarium to visualize the warm surface water moving from the tropics to the poles. We saw this at a smaller scale in our cup with fresh water and a colored ice cube. But what if surface water at the cold end of the aquarium was prevented from sinking? The circulation wouldn't happen.

If we translate this demonstration to the saltwater ocean, the addition of fresh water in polar regions from melting sea ice and glaciers could form a layer of water at the surface with a lower density. In this scenario, polar surface water would not sink and thermohaline circulation would be disrupted. This experiment shows one type of ocean circulation, which may take as much as 1,000 years to make a complete cycle.

Now there are many others factors involved in ocean circulation as well. Winds, tides, and other features of the ocean play a large role, in a fantastic, complex system.

Remember what we saw in the cup with salt water. A fresh water ice cube resulted in layering and no circulation. Could ocean circulation be disrupted in the same manner?

About 14,500 years ago, the Earth's climate began to shift from an ice age to a warmer state. But about 1,500 years into this transition, an event happened that led to a sudden influx of fresh water into the North Atlantic, slowing thermohaline circulation and sent the Northern Hemisphere back into another cold period for another 1,400 years.

This period was named Younger Dryas, after *Dryas octopetala*, a flower that grows in cold conditions and became common in Europe during this time. With global warming, random sea ice continued to melt at increasing rates in the Arctic. And one less worry that this could, or is already, disrupting thermohaline circulation, which could lead to greater changes to Earth's climate.

I hope that you have learned that we can use simple experiments to help us to understand more complex and relevant phenomenon and that we are inextricably connected to this layer of salt water, the Earth's ocean. Thanks for watching.

Hi. I hope you get a chance to do this lesson in your classroom. I've found it pretty successful at many different levels. I have had a lot of success in getting my students engaged because of the unexpected outcome of the experiment.

Now my students experience winters with snow and ice on roads and walkways, where salt is used to prevent them from becoming icy. So they are absolutely certain that an ice cube will melt faster in salt water. In fact, they are so certain of this that they even question why we're even bothering to do this experiment.

But when they see the ice cube melting faster in fresh water, they're so surprised and they become truly engaged and really want to know how this can happen. In this way, I am able to achieve getting students interested in the study of the ocean and in salt water and to see that salt water has different physical properties than fresh water.

This lesson can serve as a springboard into concepts such as density, convection, and buoyancy. Changing the density of fluids, whether through temperature or dissolved materials, leads to dynamic changes within a system. Thus, the principles behind circulation, or lack of circulation in this lesson, can be applied to circulation patterns and other systems, such as freshwater lakes, the atmosphere, or even currents in our mantle that drive tectonic plates.

The lesson presented here introduces one aspect of ocean circulation and with follow-up investigations, can drive home its relevance to the Earth's climate, helping our students realize that whether we live near the ocean or not, we have a strong connection to it. Just a few tips though in conducting this experiment.

One is the salt solution. Make a large batch of saturated salt solution ahead of time, about two to three tablespoons per cup of tap water. And as I mentioned earlier in the activities, use Kosher salt or a lab-grade sodium chloride because you can put a lot of it in there and it'll dissolve very clear and reinforces the concept that you can't see dissolved salt in seawater.

And when you conduct the experiment, if possible, do it on a humid day, as condensation patterns on the outside of the cup will provide valuable evidence for the explanation as to why a ice cube melts slowly in salt water and faster in fresh water. During the experiment, you'll want to use solutions at room temperature. If they're too cold, the experiment might not give you the desired outcome or the ice cubes might melt too slowly. If water is hot, the ice cubes might melt too quickly.

If students don't come up with it on their own-- but they often do-- it's important to suggest doing the follow-up experiment, which repeats the experiment using dyed ice cubes. When preparing colored ice cubes for this activity though, it's important not to color the water too dark. If the cubes are too dark, it will be difficult to trace the path of the water through the cup as they melt.

So those are some of the tips. I hope you've enjoyed this activity and hope you get a chance to use it in your classroom.

[MUSIC PLAYING]