New England Aquarium

Protecting the blue planet

Salt & Ice Activities

Summary: Water will freeze and become solid ice when temperatures drop. However, when salt is added, the properties of the ice will change. Here are three activities to explore how salt mixed with water can alter ice formation.

Goals & Objectives: Person(s) will explore and observe how (1) fresh water and salt water freeze differently, (2) salt can be used in effective ways to disrupt ice formation on streets and sidewalks, (3) and how density of water can be affected by the addition of salt.

Grades: 2nd-7th

Materials:

- Cups
- Popsicle sticks or spoons
- Salt (Coarse & Fine if available)
- Ice Cubes
- Trays or Plates
- Ice pack or ice cubes in a sealed plastic bag
- Food Coloring-Dark Color
- Various paper/wraps/fabric from around your house (described below)

Activity 1: Compare & Contrast Frozen Freshwater and Frozen Saltwater

(***this activity requires 24 hours to prep)***

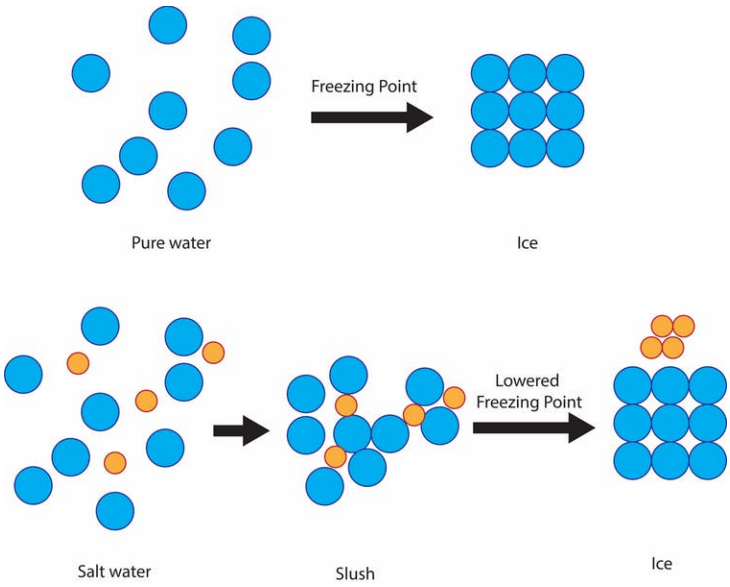
1. Fill one cup with plain tap water, and fill another cup with tap water but add in salt.
2. Put in freezer overnight.
3. When the cups turn into ice, dump them separately onto different plates or trays.
4. Use Popsicle sticks or spoons to explore and describe the texture of the ice.

Discussion:

- Which cup is fresh water? Which cup is salt water? How can you tell?
- Why do you think the cups did not freeze the same way?
- Have you seen this before somewhere?

Background:

Why salt will make water freeze slower than the normal water? Salt lowers the freezing temperature of water. Water freezes less readily because it requires even colder temperatures in order to freeze. The easiest way to think of this is that the salt interferes with the ice forming a crystal. The salt likes (or at least is very energetically stable) being mixed with the water. **To freeze water with salt, it's actually kind of a two-step process: getting the salt out of the way, and then forming the structure of the crystal.** So, it takes extra "coldness" to force the salt out of the way to form crystals. This image should help explain it:



http://scienceline.ucsb.edu/getkey.php?key=4968

http://theconversation.com/salt-doesnt-melt-ice-heres-how-it-actually-makes-winter-streets-safe-110870

Can the ocean freeze?

Ocean water freezes just like freshwater, but at a lower temperature. Fresh water freezes at 32° F (0° C), but seawater freezes at about 28.4º F (-2º C) because of the salt in it. When seawater freezes, however, the ice contains very little salt because only the water part freezes. It can be melted down to use as drinking water. At least 15% of the ocean is covered by sea ice some part of the year. On average, sea ice covers almost 10 million square miles of the Earth. Sea water becomes more and more dense as it becomes colder, right down to its freezing point. Fresh water, on the other hand, is most dense while still at 39.2° F, well above the freezing point. The average temperature of all ocean water is about 38.3° F.

https://oceanservice.noaa.gov/facts/oceanfreeze.html

Activity 2: Ice Cubes vs Salt

1. Create two or three separate areas on a tray that will be used to sprinkle experimental salt and then place ice cubes on top. One area that is the "control" with no salt addition, a second area that has fine salt covering the surface, and a third area that has coarse salt covering the surface.
    a. *Note: this activity can be modified if only one type of salt is available.*
2. Ask students to make a prediction before placing ice cubes.
    a. ASK: "What do you think will happen? Which area will melt the ice cubes the fastest? Why"
3. Place 3-4 ice cubes on surfaces.
4. Students can compare directly what is happening and ice melts.

Discussion:

- Which salt melted the ice faster?
- Where have you seen salt used before to cover a surface to melt ice?
- Does it work better to put the salt down before the ice or after the ice is already there?

Background:

› Fine salt vs coarse salt: Table salt is more finely grounded than rock salt. The finer something is, the more surface area it has. As a consequence, table salt will melt ice faster than rock salt simply because it has more surface area and so touches more of the ice at once. In this sense, table salt is better than rock salt for melting ice. It works better. However, rock salt is the most widely used because it is readily available and the most inexpensive. In this sense, rock salt is better for melting ice in that it works and is cheaper. (https://www.atlaslandscapesky.com/2018/01/17/rock-salt-vs-table-salt-for-melting-ice/)

› Salt underneath ice: It's important to note that the salt must be in a solution with liquid water in order for this principle to be obeyed. That's why many cities spray a salt solution before any ice forms. Pre-treating with solid salt relies on the warmer road surface to initially melt any snow or freezing rain so that it can properly mix with the salt.

› Salt on top of ice: Salt that's dumped on top of ice relies on the sun or the friction of car tires driving over it to initially melt the ice to a slush that can mix with the salt and then won't refreeze

› Sand instead of salt on roads? An alternative strategy used at these lower temperatures is putting sand on the ice. Sand doesn't change the melting temperature; it just provides a rough surface for your tires to prevent slipping and sliding.

› http://theconversation.com/salt-doesnt-melt-ice-heres-how-it-actually-makes-winter-streets-safe-110870

Activity 3: Cold Insulators and Conductors

1. Gather materials from around your house that you could wrap around an ice pack. Some ideas include: aluminum foil, bubble wrap, different kinds of fabric, paper bags, plastic wrap, etc.
2. Get an ice pack (or a few ice cubes in a plastic bag) from the freezer.
3. One at a time, wrap a material around the ice pack and hold it in your hand for 5 seconds. Does your hand feel cold, or is it staying warm? Test all of your materials in the same manner.
4. On a whiteboard or piece of paper, rate your materials on a scale from Good Insulator to Good Conductor.

Vocabulary:

- **Insulator**: A material that does not carry heat from one side to another. An insulator will keep your hands from getting cold while holding an ice pack.
- **Conductor**: A material that does carry heat from one side to another. A conductor will make your hands cold while holding an ice pack.

Discussion:

- If you wanted to build a shelter from the cold, which of these materials would work best?
- What happens if you layer some of the materials?

Background:

- Thermal conductivity is the term used by physicists to describe how well a material transmits heat. When you are holding a cold item, it is the heat from your hand that is being transmitted – not the cold from the ice pack!
- Generally speaking, metals are good conductors of heat, and fabrics, plastics, wood, and air are poor conductors of heat. If you have an insulated water bottle or travel mug, it most likely has a layer of vacuum or air between two layers of metal. The metals will conduct heat, but the vacuum in between will not.
- If you have double-paned windows in your house, the space between the panes is most likely filled with a gas that is a poor conductor, such as argon. This keeps the heat inside your house during the winter, conserving energy.

Activity 4: Ice Melt in Fresh vs Salt Water

Set up:

1. Using two equal size (~12oz) clear cups, fill each of with room temperature fresh water to the same level.
2. Label one of these cups fresh water, and set aside.
3. In the other cup add 1 tablespoon of Kosher Salt, stir and allow the solution to sit until the water is clear. Label this one Salt water.
4. Add 1 large ice cube or 2 small ice cubes to each cup.
5. Now do not move, touch or stir the cups, just watch.

Predict

- Will ice cubes melt faster in fresh water or salt water? Why?
- Think about the experiment. Share out or write down your prediction and why you think that?

Observe (10 minutes)

- What do you notice happening in the cups?
- Do they look the same or different?

Gather more Evidence

- After the ice has melted for 10 minutes, add one drop of a food coloring to each cup (dark colors, blue/green work best).
- How do these new observations with the food coloring help answer our question?

Discuss

- Which ice cubes melted the fastest? Why do you think that was happening?
- What is your explanation now for why the ice cubes melted faster in the fresh water?

Scientific Background/Explanation

Ice melts faster in fresh water than in salt water. It's all about density!

1. What happens when ice melts in fresh water at room temperature?

- Water from melting ice is cold and fresh. It is denser than fresh water at room temperature. (Liquid water's density decreases as temperature increases.)
- The denser cold water from the melting ice sinks to the bottom of the cup. That's why you saw the food coloring sink to the bottom of the cup.
- When the dense cold water sinks to the bottom of the cup, it displaces (pushes away) water at the bottom of the cup. The room-temperature water at the bottom of the cup has to go somewhere, so it moves from the bottom of the cup to the surface. When you saw that the food coloring eventually mixed throughout the cup, that was a result of dense cold water sinking and room-temperature water being displaced in a circulatory process (convection current).
- The result of this mixing process in fresh water is that the ice is always being surrounded by new room-temperature water as the dense cold water sinks and less dense room-temperature water is pushed upward. This is what makes the ice melt faster in fresh water.

2. What happens when ice melts in salt water at room temperature?

- Water from melting ice is cold and fresh. Fresh water is always less dense than the surrounding salt water no matter what the water temperature is. (Water density decreases as salinity decreases.)
- Since the cold water from the melting ice is less dense than the salt water in the cup, it floats on the top of the salt water. That's why you saw the food coloring form a distinct layer at the top of the cup.
- Since the layer of cold water from the melting ice remains captive above the salt water, it "insulates" the ice. In other words, the cold, fresh water from the melting ice stays around the ice cube, keeping the ice cold. This is why the ice melts more slowly in salt water.

Share out

Share your favorite activities with friends and family. We would love to see your photos from these activities—share your results/creations with us!