Freezing Point Experiment & Homemade Ice-Cream

Age: 11-15

Education Blurb:

Animals that live in the arctic often deal with water temperatures that are below zero and have evolved adaptations to make living in sub-zero temperatures possible. This experiment will look at the chemistry of freezing points and how this effects life in the arctic. A substances **Freezing Point** is exactly how it sounds: the temperature at which the substance changes from a liquid to a solid form or "freezes". For example, the freezing point of pure water is 0° Celsius (C). But in arctic waters the ocean can drop below 0° without freezing. This is because of something called **Freezing Point Depression.**

Freezing Point Depression allows substances to stay in liquid form after their temperature drops below the freezing point. You can cause freezing point depression by adding different substances to water to change its composition. Water may freeze at 0° C, but water mixed with salt freezes at less than 0° C.

Because the salt content, the freezing point of Sea Water is about -1.9 ° C. (NOAA, 2016). This means that arctic fishes and mammals may be swimming in waters that are at least a degree below zero. Once the water hits -1.9 ° C it will freeze into sea ice. One of the coolest adaptations for sub-zero temperatures is found in arctic fishes, such as the **Arctic Char**. They can create **Antifreeze Proteins** in their blood which stops ice crystals from forming inside them, keeping them alive in the frigid temperatures. (NOAA, 2016) Other adaptations include thick blubber or fur that allows the animals to withstand the temperatures.

Key Definitions:

Freezing Point: the temperature at which a liquid turns into a solid when cooled

Melting Point: the temperature at which a given solid will melt

Freezing Point Depression: the decrease of the freezing point of a solvent on the addition of a solute

Arctic Char: A cold-water fish native to alpine lakes an arctic/subarctic coastal waters. Closely related to salmon and lake trout

Antifreeze Proteins: proteins produced by some animals, plants, fungi and bacteria that bind to ice crystals to stop their growth

Solution: a liquid mixture in which the minor component (the solute) is uniformly distributed within the major component (the solvent)
Solute: the part of a solution that is dissolved

Solvent: the part of a solution that is able to dissolve other substances

Steps and materials

You can experiment with the freezing point of water in your own home! By adding different substances to ice or ice water and taking the temperature you can see how they affect the freezing point. Try salt, sugar, sand/dirt, or whatever other solutes you have lying around the house. Use a thermometer to take their temperatures to see which is the coldest.

Part 1: The Freezing Point

Materials:

- 3-4 Glasses
- Ice (crushed)
- Thermometer
- Salt
- Sugar
- Dirt
- Clock

Procedure:

1. Fill three glasses with ice
2. Add approx. 3 spoons of salt to glass 1 to make solution
3. Add approx. 3 spoons of sugar to glass 2 to make solution
4. Add approx. 3 spoons of sand/dirt to glass 3 to make solution
5. Add nothing to glass 4 (this is your control)
6. Take the temperature of all three glasses and mark them in Chart 1
7. You can leave the glasses on the counter or put them in the fridge if you have time. (This experiment has clearer results when left to melt slowly in the fridge, but if you're short for time should work at room temperature as well.
8. Take the temperatures of each glass at 5 minutes, 10 minutes, and 15 minutes – mark changes in chart

CHART 1

	Control	Glass 1 (Salt)	Glass 2 (Sugar)	Glass 3 (Sand)
0 minutes				
5 mintues				
10 minutes				
15 minutes				

Results:

Which substance allowed the water to get the coldest? This experiment shows the effect salt has on the freezing point of water.

If you wanted a solution to have the lowest

Part 2: Ice Cream or Sorbet

Now that we know that that salt can allow water temperatures below the normal freezing point of water, we can use this chemistry trick to make some homemade ice cream or sorbet! The temperature of a salt/ice mixture can drop below zero, which makes it possible to freeze our sorbet/ice cream mixture quickly. The same principle is used in the wintertime, trucks spread salt on the streets which lowers the freezing point meaning that ice will melt even when the weather is below the normal freezing point of water.

Materials (Ice- Cream)

- 1 Tbsp sugar
- ½ cup whipping cream (or milk or half-and-half)
- 4 cups ice
- ½ cup salt (Rock salt works best, but regular salt will do)
- Two bags (1 large, 1 small)

Materials (Sorbet)

- 1 cup fruit juice
- 2 cups ice
- 1 cup salt
- 1 cup water
- 2 bags (1 large, 1 small)

Procedure:

Sorbet:

1. Pour the juice into a plastic baggie that has a zipper. Close the bag.
2. Add the ice, salt, and water to a much larger bag.
3. Place the bag of juice inside the baggie containing the ice, salt, and water.
4. Shake, shake, shake the bag until the sorbet is the consistency you want. Remove the inner bag, scoop out your frozen treat and enjoy!

Ice Cream:

1. Prepare your ice cream mix by adding 1 tablespoon of sugar, ½ cup of half-and-half (or milk or heavy whipping cream), and ¼ teaspoon of vanilla extract to a small sealable baggie.
2. Add 4 cups of ice cubes or crushed ice to a large, gallon-sized baggie. The ice in this baggie is used to freeze your prepared ice cream mix as fast as possible. Add ½ cup salt to the ice cubes for the best freezing results. *Note:* Remember, that you want this ice-salt mixture to be as cold as possible for the best and creamiest ice cream results.
3. Once you have added the salt or sugar to the large baggie, put the small baggie with the prepared ice cream mixture into the large baggie with the ice cubes. Be sure both baggies are sealed shut.
4. Put on oven mitts or wrap the baggie in a small towel and then shake the bag for 5 minutes. Every couple of minutes, feel the smaller baggie and take a quick peek at it.
5. When you are done shaking, carefully open the large baggie and remove the small baggie with the ice cream mix. Did the mixture turn into delicious, creamy ice cream? If so, enjoy it now as a tasty reward for your chemistry challenge! *Note:* You can also try to modify this procedure to make even creamier ice cream or to create different ice cream flavors.

For the advanced chemist:

Salt (Sodium Chloride, NaCl) when added to water will dissociated into sodium and chlorine ions. These impurities in the water are what act to lower its freezing point. Energy is absorbed from the environment around the ice (in this case the ice cream) as the ice melts and changes its state from solid to liquid which causes the inside bag to keep getting colder as more ice melts and absorbs more energy in the form of heat.

This experiment was adapted from Science Buddies experiments. Learn more at www.sciencebuddies.org.

Olson, Andrew, Terik Daly, and Svenja Lohner. "Chemistry of Ice-Cream Making: Lowering the Freezing Point of Water." *Science Buddies*, 13 Mar. 2020, https://www.sciencebuddies.org/science-fair-projects/project-ideas/FoodSci_p013/cooking-food-science/chemistry-of-ice-cream-making. Accessed 24 Mar. 2020.

Science Buddies Staff. "What Makes Ice Melt Fastest?" *Science Buddies*, 12 Jan. 2020, https://www.sciencebuddies.org/science-fair-projects/project-ideas/Chem_p049/chemistry/what-makes-ice-melt-fastest. Accessed 24 Mar. 2020.

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