Ice and Salt Slushies

Demonstration

Explore the freezing point of water with these delicious slushies! This demonstration uses salt to lower the freezing point of ice and turn one's favorite fruit juice into a delicious slushy.

Figure 1. Demonstration final product.

Number of Participants: 3-5

Audience: Elementary (ages 5-10) and up

Duration: 10-20 mins

Difficulty: Level 2

Materials Required:

- Gallon sized plastic bag
- Quart sized plastic bag
- Large towel
- 4 cups ice
- ¼ cup table salt (NaCl or equivalent)
- Fruit Juice
- Water (H_2O)

Setup:

1. Open a gallon sized bag and fill with 4 cups of ice and ¼ cup of table salt. Place the filled gallon sized bag to the side.
2. Open a quart sized plastic bag and fill with your choice of juice to approximately ½ of the way full. Seal the quart sized bag.
3. Place the sealed quart sized plastic bag into the gallon sized plastic bag containing table salt and ice. Seal the gallon sized bag.
4. Wrap the sealed gallon sized bag with a large towel for protection and to keep the ice and salt mixture cold. Shake the bag until the juice becomes a mixture of ice and liquid (approximately 5-10 minutes). **Take turns shaking the bag if you are in a group!**

Presenter Brief:

Be familiar with the freezing point of water and how it increases when ice is combined with salt. Know how to describe the concept of a freezing point to participants, especially a younger audience. Understand why the juice turns into a slushy when shaken over the ice and salt mixture. Be able to explain why the salt makes the ice and salt mixture colder.

Figure 2. Slushy Demonstration Set Up

Vocabulary:

- Freezing point – the temperature at which a substance will freeze and become solid.
- Boiling point – the temperature at which a substance will boil and evaporate.
- Solution – a mixture of substances.
- Endothermic Reaction – a chemical reaction that requires energy in the form of heat to be absorbed from surroundings.
- Closed System – a system that does not require any matter apart of the system to escape.
- Matter – anything that has mass and takes up space by having volume.
- Energy transfer – when energy flows from one form to another.
- Heat – a form of energy that transfers from a warm object to a cooler object.
- Temperature – an average measure of how fast atoms or molecules are moving that tells us how something is hot or cold.

Physics & Explanation:

Elementary (ages 5-10):

Start by asking if participants have ever made a slushy before. **Ask how they make their slushies or how they assume slushies are made. Use figure 3 to explain how most slushies are made by blender ice and juice.** Introduce how they are going to make slushies in the demonstration: using ice and salt.

Figure 3. Slushy made in a blender with ice and fruit juice from Nostalgia Electrics

All substances have a freezing point, or the temperature at which a substance will freeze and become solid. The natural freezing point of pure water is 32 ºF or 0 ºC.

Use a thermometer to check the temperature of the ice before you add salt to the gallon sized bag. Verify and show participants it is about 32 ºF or 0 ºC. Ask participants what they think will happen to the temperature of the solution when the ice is mixed with the salt.

When ice is mixed with salt in the gallon sized bag, the salt causes the freezing point of water to decrease, so the ice begins to melt. Energy in the form of heat is used to turn the ice from a solid to a liquid. This makes the melting ice very cold in comparison to the normal temperature of pure ice. The temperature of the mixture in the gallon sized bag decreases from about 32 ºF to about 8 ºF in one minute according to figure 2. As the ice begins to melt and the bag is shaken, the ice will eventually reach its coldest point at 0 ºF or -18 ºC. This reaction and drop in temperature will freeze the fruit juice in the smaller bag that is surrounded by the ice and salt mixture in the gallon sized bag. After shaking the smaller bag in the gallon sized bag for about 5 to 10 minutes, the juice turns into a slushy.

Check the temperature of the ice and salt solution to see the difference in temperature.

- When adding salt to an ice cube, the ice cube's temperature becomes below its freezing point. This ice cube will do what any ice cube will do below its freezing point: it will melt. As the ice cube melts, it uses energy to turn from a solid to a liquid. This makes the closed system colder.

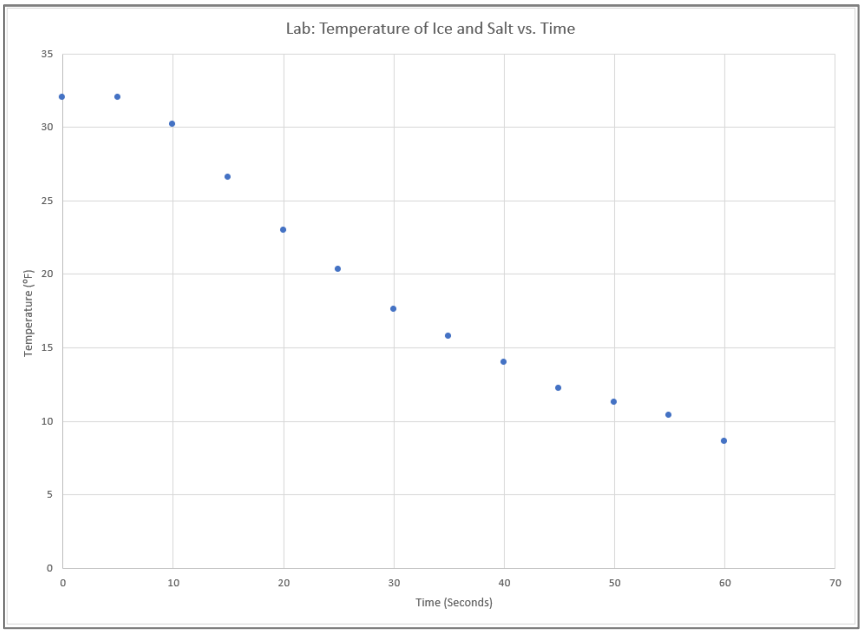

Figure 3. Graph of temperature of an ice and salt solution over the course of one minute. Data taken from "Lab: Temperature of ice and Salt vs. Time" posted by Dan Calder on YouTube.

Middle (ages 11-13) and general public:

Start by reminding participants how slushies are made. Typically, slushies are made by blending ice and juice in a blender as in figure 3. Introduce how they are going to make slushies in the demonstration: using ice and salt.

All substances have a freezing point, or the temperature at which a substance will freeze and become solid. The natural freezing point of water is 32 ºF.

Use a thermometer to check the temperature of the ice before you add salt to the gallon sized bag. Verify to participants the ice is 32 ºF or 0 ºC. Ask participants what they think will happen to the temperature of the solution when the ice is mixed with the salt.

When ice is mixed with salt to create a solution in the gallon sized bag or closed system, the salt causes the freezing point of water to decrease, so the ice begins to melt. Energy is used to make the ice go through a phase change from a solid to a liquid. This chemical reaction is called an endothermic reaction, where energy in the form of heat is absorbed by a substance undergoing a phase change. An endothermic reaction results in a substance to be colder, which explains how the solution in the closed system is very cold in comparison to the normal temperature of pure ice. The temperature of the solution decreases from about 32 ºF to about 8 ºF in one minute according to the experiment in figure 2. As the ice begins to melt and the closed system is shaken, the ice will eventually reach its coldest point at 0 ºF or -18 ºC. The endothermic reaction and drop in temperature will freeze the fruit juice in the smaller bag. After shaking the smaller bag in the gallon sized bag for about 5 to 10 minutes, the juice turns into a slushy.

Check the temperature of the ice and salt solution to see the difference in temperature.

- When adding salt to an ice cube, the ice cube's temperature becomes below its freezing point and it melts. As the ice cube melts, it uses energy to turn from a solid to a liquid. This makes the closed system colder.

The technique of using salt to decrease the freezing point of water is used widely today. One example is pouring salt on roads and sidewalks to prevent them from being ice-y and slippery in the wintertime. Pouring salt before a snowstorm or a chilly night prepares roads and sidewalks for safer travel. Salt is also believed to decrease the boiling point of water when cooking. This widely known cooking technique is a myth! Even though mixing salt and water decreases the freezing point of water, the solution will increase the boiling point of water. The next time you boil water in the kitchen, wait to add salt until the water is boiling to save time!

- Salt is mixed with water in different ways to create solutions for modern problems, like pouring salt on roads and sidewalks to prevent ice from forming. However, this some solutions are mythical, such as salt decreasing the boiling point of water to help water reach the boiling point faster while cooking.

Additional Resources:

- Crazy Russian Hacker, Ice and Salt Experiment: https://www.youtube.com/watch?v=eXSQnaEDazM
- Why Does Salt Cool Ice?: https://van.physics.illinois.edu/qa/listing.php?id=11767&t=why-does-salt-cool-ice

References:

1. Slushie Experiment Explanation: https://sites.google.com/site/sciencekiddoexperiments/fruity-ice-slush
2. Lab: Temperature of Ice and Salt vs. Time: https://www.youtube.com/watch?v=iEpRihe8tKw
3. Schroeder, Daniel V. An Introduction to Thermal Physics. Pearson India Education Services, 2018.
4. Zumdahl, Steven S., and Donald J. DeCoste. Introductory Chemistry. Cengage Learning, 2019.