# Lesson Plan for Ice-Cream Making Activity (Freezing Point Depression)

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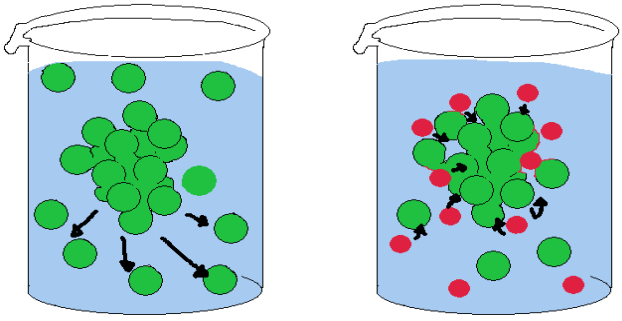
## Introduction & Background Information for Mentors

Most things on earth are liquids, solids, or gases, which are the three states of matter. States of matter can change from one to others through melting (solid to liquid), freezing (liquid to solid), boiling (liquid to gas), sublimation (solid to gas), and deposition (gas to solid). Substances have a temperature point where each of these phase changes occur. For this experiment, freezing point is a crucial concept.

Freezing point is the point where a liquid becomes a solid. The freezing point of water is 0 degrees Celsius. The process of freezing deals with how compact the particles are. Imagine a solid composed of many molecules tightly packed together. In contrast, liquids are more fluid because their molecules are not as tightly packed together. When you freeze a substance, the liquid molecules become more compact and become solid. Pure liquids are not the only liquids that can be frozen. Solutions can be frozen as well.

Solutions consist of solutes and solvents. A solute is the substance dissolved, while a solvent is the substance that the solute dissolves in. For example, salt dissolves in water. Salt is the solute, and water is the solvent.

Imagine freezing pure water. Water molecules will become more tightly compact and become solid when they are frozen at zero degrees. Now imagine freezing a solution mixture, such as salt in water. The salt molecules will get in the way of crystal formation, and therefore the solution will have a harder time freezing. Because the salt molecules are in the way, the ice will melt faster. This is because the water molecules can easily be separated from one another since the salt molecules prevent them from being as close to each other as they are when pure water is frozen. This means that when salt is added to ice, it makes the ice melt faster, resulting in a slushy mixture at zero degrees, rather than solid ice at zero degrees. If at zero degrees the salt in water is a slushy mixture, then the point where this solution will freeze will be a lower temperature. This is known as the lowering of the freezing point, also called freezing point depression.



System A

The particles in this solid can easy shift into the liquid phase at the normal freezing point temperature as shown by the arrows.

System B

However, the particles in this solid cannot shift into the liquid phase at normal freezing point temperature because solute particles block movement from solid phase to liquid phase.

http://www.scienceiscool.org/solutions/fpdepression.html

For this lab, it is important to lower the freezing point to make ice cream. Ice cream forms at temperatures lower than 0 degrees Celsius Making ice cream without a freezer is difficult to do with ice formed by pure water because the solid ice is at about zero degrees Celsius. By lowering the freezing point by putting salt on ice, a water-salt-ice solution is formed which is lower than zero degrees and will allow the ice cream to freeze.

## Topics

- Physical Reaction: Change in the physical appearance of the reactants, such as their states of matter (liquid → solid)
- Freezing Point Depression: when adding a solute to a solvent changes the freezing point of the mixture (in this case, salt would change the freezing point of the ice)

## Student Objectives

- Explain different types of physical reactions
- Observe the physical changes related to the experiment
- Understand the effect of salt on ice (freezing point depression)
- Understand the difference between a solute and a solvent
- Make ice cream!

## Overview of the Lesson Process (about 1 hour)

- Briefly explain the concept and characteristics of physical reactions. Discuss the molecular interactions of different states of matter and show picture examples. Introduce the concept of freezing point. Help students to deduce how salt interacts with the water molecules. (10 minutes)
- Divide up into small groups and make ice cream. Have each mentor walk through the lab with the students. Ask questions about the observed reaction. (35 minutes)
- Group discussion: ask students again about the interaction between the salt and the water molecules. Review the physical states of matter, specifically the liquid-to-solid phase transition. (10 minutes)
- Clean up (about 5 minutes)

## Materials

| | Qty per site | Estimated Cost | |
|---|---|---|---|
| Salt | -- | 26 oz container | $1 |
| Gallon size Ziplock Bags | 1 | Ziploc freezer gallon (40) | $4 |
| Quart size Ziplock Bags | 1 | Ziploc freezer quart (40) | $4 |
| Half and Half | 4 | Quart of Half and Half | $16 |
| Ice | 2 | 20lb bags | $6 |
| Plastic cups | 1 | Plastic cups (20 pack) | $2 |
| Paper Towels | 1 | Paper towels (1 roll) | $2 |
| Spoons | 1 | Plastic spoons (24-pack) | $2 |
| | | **Total** | **$37** |

## Procedure

1. Place ice how much? in large Ziploc bag and place milk how much? in smaller Ziploc bag. Should sugar also be added? We've also used a bit of vanilla extract in past lessons.
2. Add 2 teaspoons of salt to large Ziploc bag. Seal and shake gently for 30 to 45 seconds. Make observations. Anything in particular they should observe? Will there be a worksheet or discussion guide?
3. Empty most of the air from the smaller bag. Carefully seal this bag and place it inside the large bag with the ice mixture. Seal the large bag tightly to prevent leaks.
4. Gently shake the sealed baggies back and forth in your hands to make sure that the ice mixture coats the entire surface of the milk bag. Shake back and forth for 3 to 10 minutes until a solid product forms.
5. Carefully remove the small bag and use paper towels to clean salty water off of the opening of the smaller bag. Open baggie and enjoy your ice cream!
6. Clean up.

## Resources

NTTI Lesson Plan: http://www.thirteen.org/edonline/ntti/resources/lessons/s_freeze/freeze3.pdf