Freezing Point Depression

Properties of Solutions

Introduction

To demonstrate the effect of adding salt (a solute) to the freezing point of water (a solvent).

Concepts

- Ionic structure
- Colligative properties
- Properties of solutions
- Consumer chemistry

Materials

Container of table salt

Ice cube

String, 30-cm length

Safety Precautions

Follow all laboratory safety guidelines. All food-grade items that have been brought into the lab are considered laboratory chemicals and are for lab use only. Do not taste or ingest any food items in the chemical laboratory and do not remove any remaining food items after they have been used in the lab. Remember to wash hands thoroughly with soap and water before leaving the laboratory.

Procedure

1. Place the ice cube on a clean, dry surface.
2. Place the string over the top of the ice cube.
3. Sprinkle a small amount of salt on the string that is in contact with the ice cube.
4. Holding each end of the string (one end in each hand, carefully pick up the string. (If the ice cube is not lifted along with the string, have the students attempt the experiment again with a fresh ice cube and a new piece of string.)

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines on specific procedures governing the disposal of laboratory waste. All chemicals used in this demonstration may be disposed of in the regular trash according to Flinn Suggested Disposal Method #26a.

Tips

- This demonstration may be taught as a student inquiry lab. Simply hand out the materials and ask your student to pick up the ice with the string without tying it to the ice cube.
- Extend the discussion to consumer chemistry by comparing the cost of rock salt vs. table salt to use on roadways in freezing areas. Purifying chemicals, especially to food grade level, can sometimes cost more than actually making them in the first place.
- In some areas of the country sodium chloride is used on the roadways but when it gets colder calcium chloride or a mixture of the two may be used. When studying colligative properties such as freezing point depression, calcium chloride $CaCl_2$ with three ions will depress the freezing point more that sodium chloride NaCl with two ions will. The calcium chloride is more expensive and is usually used when the temperatures are colder. In some parts of Canada chemical de-icers like sodium and calcium chloride are not used. Why would this be? The temperature is too cold for these salts to melt the ice. Many times sand is used to give traction to vehicles on the icy roads since the chemical de-icers are ineffective.

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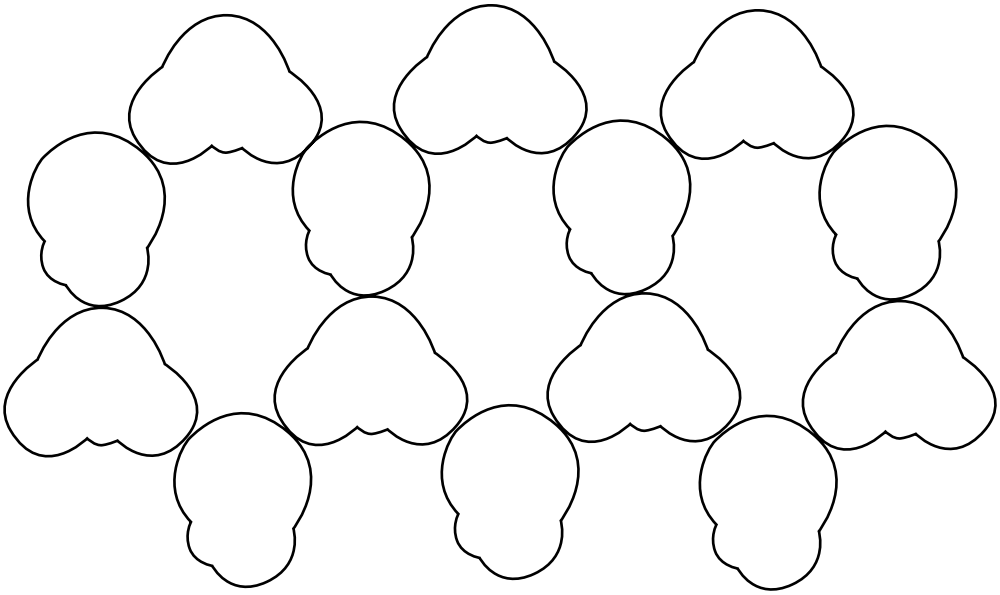
- Discuss using salt in a car radiator and why that is not practical due to its corrosive properties.
- If interested in furthering the discussion, dialog with the students about desired properties for the solution in the radiator of a car. Discuss use of ethylene glycol both as antifreeze and a coolant. Do your students know that ethylene glycol is poisonous and causes kidney failure but many animals still will ingest the chemical because of its sweet taste? Other alternates such as propylene glycol are commercially available and safer to animals, but have other issues.

Discussion

Pose the following question to the students: "Why do we use salt to freeze ice-cream in an ice-cream maker, yet we use salt to melt ice (or snow) after a winter storm?" Illustrate the freezing of water using the following patterns on the overhead projector.



Introduce patterns for the solute particles, Na^+ and Cl^-, showing how the freezing of water is disrupted by their presence, thus lowering the freezing point of water. When the freezing point of water is lowered, the ice (or snow) melts.

Adding salt to our ice cream maker lowers the freezing point of the ice. The resulting salt-ice bath has a colder temperature, thus allowing the ice-cream to freeze.

Discuss the cost of rock salt versus the cost of table salt, thus pointing out the importance (and increased cost) of chemicals that we ingest. Stress that either rock salt or table salt could be used for melting ice, but that the impure rock salt is more practical.

Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

Unifying Concepts and Processes: Grades K–12
Evidence, models, and explanation
Constancy, change, and measurement
Form and function

Content Standards: Grades 5–8
Content Standard A: Science as Inquiry
Content Standard B: Physical Science, properties and changes of properties in matter
Content Standard F: Science in Personal and Social Perspectives, personal health; natural hazards, risks and benefits, science and technology in society

Content Standards: Grades 9–12
Content Standard A: Science as Inquiry
Content Standard B: Physical Science, structure of atoms, structure and properties of matter
Content Standard F: Science in Personal and Social Perspectives, natural resources, natural and human-induced

hazards, science and technology in local, national, and global challenges

References

Phelps, A., *J. Chem Ed.* 1996, *73*, p 301.
Patterns of freezing water: Elna Clevenger.

Flinn Scientific—Teaching Chemistry™ eLearning Video Series

A video of the *Freezing Point Depression* activity, presented by Kathleen Dombrink, is available in *Properties of Solutions*, part of the Flinn Scientific—Teaching Chemistry eLearning Video Series.

Materials for *Freezing Point Depression* are available from Flinn Scientific, Inc.

Catalog No.	Description
S0065	Sodium Chloride, Rock Sale, Coarse, 1 kg
S0061	Sodium Chloride, Reagent, 500 g
S0064	Sodium Chloride, Laboratory Grade, 2 kg
AP4823	String, Ball, 75 g

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.