Stringing an Ice Cube

Have you ever tried to handle ice cubes when your hands were wet? If so, you've probably had the uncomfortable experience of having your hands stick to the ice! How about driving on roads that have been treated with salt after a winter storm? Discover the relationship between these two experiences and this activity.

Materials

- ice cube
- string or thread (about 6–10 inches long)
- water
- table salt (preferably in a shaker)

Exploration

Step 1 Using only the string or thread, try to lift an ice cube without touching the ice cube with your hands or tying the string around it. Describe your attempts. Which, if any, were successful?

Step 2 Wet the string or thread with water and lay it over the top of the ice cube for several minutes. What happens when you gently raise one end of the string? If you were unsuccessful at lifting the ice cube, wait for a longer time before lifting the string. Explain your observations in terms of the temperature of the ice and the freezing point of water.

Step 3 Repeat Step 2, but this time sprinkle a small amount of table salt onto the ice cube in the area where the string is lying. Record your observations.

Step 4 Did the ice cube stick to the string more quickly in Step 2 or 3? More securely?

Challenge

How can the lifting of an ice cube with a piece of string (without touching the ice cube with your hands or tying the string around it) be accomplished and explained?

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Concept

freezing point depression, colligative properties

Expected Student Responses to Exploration

Step 1 A student most probably will be unsuccessful unless the ice cube begins to melt and the string becomes frozen to it.

Step 2 (a) The string usually freezes to the ice cube; a student may or may not be successful in lifting the ice cube.

(b) If successful, the temperature of the ice cube is considerably less than 0°C, the freezing point of water. The ice cube can absorb the heat from the liquid water in the string and still remain at or below the freezing point. The water in the string freezes, sticking the string to the ice cube. If unsuccessful, the temperature of the ice cube is close enough to 0°C that it rises above the freezing point when the ice cube absorbs the heat from the liquid water in the string. The ice melts and the string remains wet.

Step 3 Liquid water forms where the salt is spread. The string then becomes imbedded within the ice and the ice cube can be lifted.

Step 4 The sticking typically occurs faster and more securely in Step 3.

Expected Student Answer to Challenge

An ice cube can be lifted with a piece of string that has become frozen to the ice. This can happen either by wetting or salting the string. In the salt case, as heat flows from the salt and string to the ice cube, a very small amount of water melts, in which some salt dissolves. The freezing point of the resulting solution is lowered enough so that it does not freeze as its temperature drops below 0°C. Heat continues to flow from the solution to the ice cube and more ice melts. Because there is little mixing within the solution, some of the solution becomes more concentrated and that portion sinks to the bottom because of its greater density. The more dilute upper region of the salt-water solution eventually gets below its freezing point and freezes, causing the string to become imbedded below the surface of the ice so that it is possible to lift the ice cube with the string.

Reference

"Ice on a String"; *Fun with Chemistry: A Guidebook of K–12 Activities*, 2nd ed.; Sarquis, M., Sarquis, J., Eds.; Institute for Chemical Education: Madison, WI, 1995; Vol. 1, pp 47–48.

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