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The Heat of Fusion of Ice

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Introduction

Students have learned that when heat energy is added to any substance the temperature of this substance increases and, conversely, when heat energy escapes from the substance the temperature decreases.

Based upon this concept, the idea of the heat of fusion of ice does not make sense. The idea that each gram of ice a 0° C can absorb 80 calories of heat energy and become a gram of water with the temperature still 0°C does not seem logical. The student may accept the "if you say so" approach, but some meaningful laboratory data will be more convincing.

The usual laboratory procedure for measuring the heat of fusion involves starting with a measured quantity of water in a double walled calorimeter. Pieces of ice are dried with a paper towel and, hopefully before more of the ice can melt, are added to the water in the calorimeter. These pieces of ice are allowed to melt in the calorimeter.

I have found that with this procedure the students become lost in the maze of measurements and calculations. When the investigation has been completed, they are not sure what they have discovered. Also, the results are usually so poor that the experiment becomes a discouraging experience. My physics students have obtained surprisingly good results with the "ice calorimeter" procedure for measuring the heat of fusion of ice. The results are usually within one or two calories per gram when compared with the accepted value. Also, the simplicity of the measurements and calculations make it possible for the students to understand what they are doing. The results are meaningful to the students.

Methods and Materials

The only apparatus needed are a glass or plastic funnel, a piece of metal, a scale balance, two containers to catch water, a means of suspending the piece of metal in boiling water, two ring stands, and a bunsen burner.

Weigh the piece of metal. It will also be necessary to determine the specific heat of the metal. (We use a 300 gram block of iron.) Suspend the block of metal in a beaker of water and heat the water to boiling. The metal needs to be in contact with the boiling water until the total block has a uniform temperature of approximately 100° C. Fill the funnel with crushed ice. After the ice has started to melt and water is dripping from the funnel spout at a uniform rate, determine the rate at which the water drips from the funnel. This can be done by placing an empty catch container under the spout and simultaneously starting a clock. After about five minutes, remove the catch container and measure the amount of water that it contains. This measurement of time and the amount of ice that melted in this period is used to determine the rate at which the heat energy absorbed from the surroundings cause the ice in the funnel to melt.

Now place a second empty catch container under the funnel. Remove the heated metal from the boiling water and place this metal on the ice in the funnel. Simultaneously start a clock. Make certain that the metal makes immediate direct contact with the ice. After about four or five minutes, measure the amount of water in the second catch container.

It is now possible to determine the amount of ice melted by the piece of metal as it cooled from 100° C to 0° C. It is only necessary to determine how much ice would have melted if the metal had not been placed in contact with the ice. This determination can be made from the original set of data collected. This amount is subtracted from the amount of water in the catch container. The total amount of heat given up by the piece of metal in cooling from 100° C to 0° C (100 X mass of metal X specific heat of metal) divided by the mass of ice melted by the metal is the heat of fusion of ice in calories per gram.

Who Cares

Often the impact of our courses is lost because we present the facts and ideas without relating these to the real world of student experiences. How does the heat of fusion make a difference in our daily experiences?

Try to have the students imagine what it would be like if all of the accumulated ice and snow melted the first warm day of spring. The frozen soil would also thaw in one or two days. This would make spring come early, but we probably wouldn't be around to enjoy it because we would be carried away by a disastrous flood.

Our lakes and other large bodies of water do not *freeze solid* during the winter. The usual factor cited to account for lakes freezing only on the surface is that water has its greatest density at 4° C. This allows the water with a temperature of 0° **C** to float on the surface and become a coat of ice as it freezes. The ice formed then acts as an insulator to prevent loss of heat by the lower layers of water. This is only part of the story. It is the large amount of heat that needs to escape as water freezes that makes this ice insulator effective. If ice did not have the high heat of fusion, most lakes would freeze to the bottom. This would make for safe skating but rather poor fishing and swimming.

Ice chests are an important piece of equipment when camping or traveling. It is not difficult to see how the heat of fusion of ice plays a prominent role in keeping food cool in an ice chest. Then there is the iced beverage with ice cubes to lower its temperature and keep it cool. Take away the heat of fusion of ice and we would probably have less opportunity to enjoy cold beverages.

Some students will be intrigued by the application of energy theory and molecular theory to the explanation for the heat of fusion.

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New Botany Text

Dr. John D. Dodd, Professor of Botany and Plant Pathology at Iowa State University, has just published a new botany text suitable for a one term course in general botany.

Course Book in General Botany, published by the Iowa State University Press, emphasizes descriptive rather than the physiological aspects of plants. Botany as taught in this text enhances students' awareness of the role of plants in natural environments. They are encouraged to consider plants as whole organisms in natural settings before going into molecular biology.

A brief review of botanical topics generally covered in basic biology is presented in the introduction of the eucaryotic plant cell. However, this is not a substitute for a general biology course. Following chapters consider transpiration as the price of life on land, and the plant bodies of vascular plants in terms of general structure, variation and evolutionary origins. The reproduction of lower green land plants and of higher green land plants is discussed. Also introduced are the green algae, fungi, bacteria and nongreen algae. The author gives an overview of green plants and a classification scheme for plants.

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Mood Rings

The "stone" of the mood ring, which supposedly changes colors as your emotions change, is composed of photographic paper similar to that used in the construction of digital thermometers that change color as temperatures fluctuate.

The "stone" is made by gluing the paper to the back of a clear object and then bonding it with an epoxy resin to protect it from moisture. The paper is made at NCR-Encapsular Products, Dayton, Ohio.

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Try It

Songbirds sometimes end it all by mistakenly dashing into picture windows or sliding doors. One way to reduce such deaths is to cut the silhouette of a hawk out of paper and tape it to glass. If the birds see the hawk-like outline, they should stay away from the glass. *Missouri Conservationist*