Experiment 8

Heat of Fusion

During melting, heat is absorbed by the melting solid. In this experiment, you will determine how much heat is needed to melt 1 g of ice. Heat has units of joules (J). The heat used to melt the ice will come from the cooling of warm water and will be measured with a calorimeter. A calorimeter is an insulated container fitted with a device for measuring temperature. You will use a simple calorimeter made of a Styrofoam cup, a 250 mL beaker, and an EasyTemp temperature probe.

OBJECTIVES

In this experiment, you will

- Use a calorimeter.
- Use an EasyTemp probe to measure temperature.
- Determine heat of fusion for ice (in J/g).

MATERIALS

TI-84 Plus or TI-84 Plus Silver Edition graphing calculator	balance
Vernier EasyTemp	warm water
Vernier EasyData application	100 mL graduated cylinder
styrofoam cup	one ice cube
250 mL beaker	one paper towel

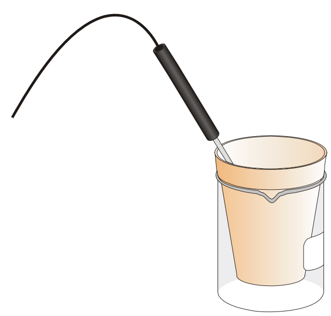

Figure 1

PROCEDURE

1. Turn on your TI-84 Plus (or TI-84 Plus Silver Edition) graphing calculator and make sure that it is on the home screen. Plug the EasyTemp probe into the USB port of the graphing calculator. The EasyData application will automatically start and the Main screen will be displayed.

2. Set up the data collection.

   a. Select **File** from the Main screen, and then select **New**.
   b. Select **Setup** from the Main screen.
   c. Select **Time Graph…**.

d. Select Edit.
e. Press CLEAR on the calculator and type **4** as the time between samples in seconds. Select Next.
f. Press CLEAR on the calculator and type **75** as the number of samples. Select Next. The length of the data collection will be 300 seconds (5 minutes).
g. Confirm that time graph settings are correct. Select OK.

3. Get a 250 mL beaker and a Styrofoam cup. Place the Styrofoam cup into the beaker, as shown in Figure 1. Use a balance to measure the mass of the 250 mL beaker and the Styrofoam cup. Record the mass in your data table.

4. Use a 100 mL graduated cylinder to measure out 100 mL of the 30°C water into the Styrofoam cup. Measure the mass of the 250 mL beaker, Styrofoam cup, and 100 mL of warm water. Record the value in the data table.

5. Break an ice cube into a few pieces in a paper towel.

6. Place the EasyTemp probe into the warm water. Select Start to begin data collection. The temperature reading, in °C, is displayed at the top of the screen. Wait until the temperature reaches a maximum (it will take a few seconds for the cold probe to reach the temperature of the warm water). As soon as this maximum temperature is reached, add the ice pieces to the water in the Styrofoam cup. Record the maximum temperature in your data table.

7. Gently stir the contents of the cup as the ice melts. After all the ice has melted, continue stirring until the temperature has reached a minimum (and begins to rise). Record the minimum temperature in your data table.

8. Data collection will stop after 5 minutes, or select Stop halt data collection *before* 5 minutes have elapsed. Measure and record the mass of the 250 L beaker, Styrofoam cup, and water (original water + ice melt).

9. A graph of temperature *vs*. time is displayed on the calculator screen. To confirm the maximum and minimum values you recorded earlier, use ▶ to examine the data points along the curve. As you move the cursor, the time (X) and temperature (Y) values of each data point are displayed above the graph.

10. Select Main to return to the Main screen. Select Quit and then select OK to exit the EasyData application.

DATA

mass of beaker and cup	______ g
mass of beaker, cup, and warm water	______ g
mass of beaker, cup, and water (original + ice melt)	______ g
initial water temperature (maximum)	______ °C
final water temperature (minimum)	______ °C

PROCESSING THE DATA

1. Determine the mass (in g) of warm water used (mass of beaker, cup, and warm water – mass of beaker and cup).

2. Calculate the change in water temperature, Δt ($t_{max} - t_{min}$).

3. Calculate the heat (in J) lost by the cooling water using the equation

$$H = \Delta t \bullet m \bullet C_p$$

where H = heat (in joules), Δt = change in temperature (in °C), m = mass of water cooled (in g), and C_p = specific heat capacity (4.18 J/g°C for water).

4. Determine the mass (in g) of ice melted (mass of beaker, cup, and water (original + ice melt) – mass of beaker, cup, and warm water).

5. Use your answers to Steps 5 and 6 to calculate the heat needed to melt 1 g of ice (J/g).

6. An accepted value for the heat of fusion of ice is 334 J/g. Calculate your percent error using the formula

$$\% \text{ Error} = \frac{\text{calculated value - accepted value}}{\text{accepted value}} \times 100$$

7. What assumption did we make about heat lost by the water in the calorimeter as compared to heat gained by the melting ice?

EXTENSION

1. Design an experiment to find out if an ice cube taken from a freezer and immediately placed into a calorimeter needs the same amount of energy per gram for melting as does an ice cube that has been outside the freezer for ten minutes.