

# Heat of Fusion for Ice

Melting and freezing behavior are among the characteristic properties that give a pure substance its unique identity. As energy is added, pure solid water (ice) at 0°C changes to liquid water at 0°C.

In this experiment, you will determine the energy (in joules) required to melt one gram of ice. You will then determine the molar heat of fusion for ice (in kJ/mol). Excess ice will be added to warm water, at a known temperature, in a Styrofoam cup. The warm water will be cooled down to a temperature near 0°C by the ice. The energy required to melt the ice is removed from the warm water as it cools.

To calculate the heat that flows from the water, you can use the relationship

$$q = C_p \cdot m \cdot \Delta t$$

where  $q$  stands for heat flow,  $C_p$  is specific heat,  $m$  is mass in grams, and  $\Delta t$  is the change in temperature. For water,  $C_p$  is 4.18 J/g°C.

## OBJECTIVES

In this experiment, you will

- Determine the energy (in Joules) required to melt one gram of ice.
- Determine the molar heat of fusion for ice (in kJ/mol).

## MATERIALS

computer  
Vernier computer interface  
LoggerPro  
Temperature Probe  
250 mL beaker  
100 mL graduated cylinder  
tongs

Styrofoam cup  
ring stand  
utility clamp  
ice cubes  
stirring rod  
warm water

## PROCEDURE

1. Connect the probe to the computer interface. Prepare the computer for data collection by opening the file "04 Heat of Fusion" from the *Chemistry with Computers* folder.
2. Place a Styrofoam cup into a 250 mL beaker as shown in Figure 1.
3. Use a utility clamp to suspend the Temperature Probe on a ring stand as shown in Figure 1.
4. Use a 100 mL graduated cylinder to obtain 100.0 mL of water at about 60°C from your instructor.
5. Obtain 7 or 8 large ice cubes.
6. Lower the Temperature Probe into the warm water (to about 1 cm from the bottom).

## Experiment 4

- Click  to begin data collection. 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). This maximum will determine the initial temperature,  $t_1$ , of the water. As soon as this maximum temperature is reached, fill the Styrofoam cup with ice cubes. Shake excess water from the ice cubes before adding them (or dry with a paper towel). Record the maximum temperature,  $t_1$ , in your data table.

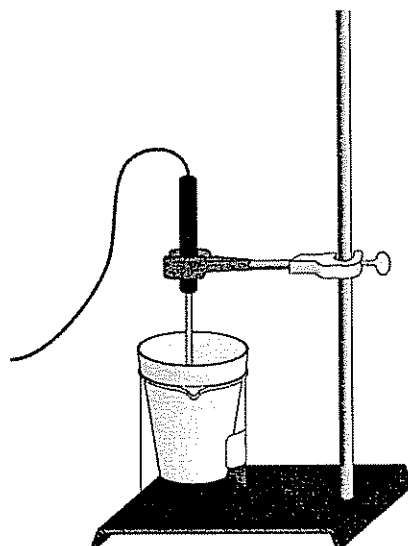


Figure 1

- Use a stirring rod to stir the mixture as the temperature approaches  $0^{\circ}\text{C}$ . **Important:** As the ice melts, add more large ice cubes to keep the mixture full of ice!
- When the temperature reaches about  $4^{\circ}\text{C}$ , quickly remove the unmelted ice (using tongs). Continue stirring until the temperature reaches a minimum (and begins to rise). This minimum temperature is the final temperature,  $t_2$ , of the water. Record  $t_2$  in your data table. Click  when you have finished collecting data.
- Use the 100 mL graduated cylinder to measure the volume of water remaining in the Styrofoam cup to the nearest 0.1 mL. Record this as  $V_2$ .
- You can confirm your data by clicking the Statistics button, . The minimum temperature ( $t_2$ ) and maximum temperature ( $t_1$ ) are listed in the floating box on the graph.

## PROCESSING THE DATA

- Use the equation  $\Delta t = t_2 - t_1$  to determine  $\Delta t$ , the change in water temperature.
- Subtract to determine the volume of ice that was melted ( $V_2 - V_1$ ).
- Find the mass of ice melted using the volume of melt (use 1.00 g/mL as the density of water).
- Use the equation given in the introduction of this experiment to calculate the energy (in joules) released by the 100 g of liquid water as it cooled through  $\Delta t$ .
- Now use the results obtained above to determine the heat of fusion—the energy required to melt one gram of ice (in J/g  $\text{H}_2\text{O}$ ).

6. Use your answer to Step 5 and the molar mass of water to calculate the molar heat of fusion for ice (in kJ/mol H<sub>2</sub>O).
7. Find the percent error for the molar heat of fusion value in Step 6. The accepted value for molar heat of fusion is 6.01 kJ/mol.

**DATA AND CALCULATIONS**

Initial water temperature, $t_1$	°C
Final water temperature, $t_2$	°C
Change in water temperature, $\Delta t$	°C
Final water volume, $V_2$	mL
Initial water volume, $V_1$	mL
Volume of melt	mL
Mass of ice melted	g
Heat released by cooling water ( $q = C_p \cdot m \cdot \Delta t$ )	J
J/g ice melted (heat of fusion)	J/g
kJ/mol ice melted (molar heat of fusion)	kJ/mol
Percent error	%

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