

Determining the Latent Heat of Fusion of Ice

Just as steam has a higher internal energy than water, water has a higher internal energy content than ice. When ice melts into water it absorbs thermal energy from its surroundings, but the ice does not change temperature. The absorbed energy enables water molecules in the crystalline form of ice to break free of the bonds that hold them together.

The phase change from solid to liquid involves a transfer of thermal energy into the substance, but doesn't involve a temperature change of the substance. The thermal energy absorbed by the ice depends on the mass of ice present and the latent heat of fusion of ice.

In this lab we will attempt to determine the latent heat of fusion of ice by allowing a sample of ice to melt in water. To be able to accurately measure the latent heat of fusion of ice, we need to keep track of all heat energy transfers that take place. When the ice melts in liquid water it clearly goes through a phase change from a solid to a liquid state. However, the final temperature of the resulting water is most likely not going to be zero degrees. This means that not only did the ice melt into liquid water, that liquid water then also experienced a temperature change! By using the law of conservation of energy, and keeping track of all phase and temperature changes, we can accurately determine the latent heat of fusion of ice.

Chemicals

Distilled Water
Ice

Equipment

2 Styrofoam cups, 250 mL beaker, 2 thermometers (1 digital, 1 normal), 0.01 digital scales, hot plate, insulated glove, 100 mL graduated cylinder

Procedure

Part 1 – Heat Capacity of the Calorimeter

1. Prepare the Hot Water

Fill a 250 mL beaker with 50.0 mL of distilled water and begin to heat it on the hot plate. Make sure to monitor the water while you are completing the next step. It should be heated until it is about 40°C – 50°C. Use your non-digital thermometer to read this temperature.

2. Set up Calorimeter

Styrofoam is an excellent insulator and should transfer minimal amounts of heat to the surroundings, so it works well as a calorimeter. However, to be as accurate as possible,

you will need to determine the heat capacity of your calorimeter. Record the mass of an empty Styrofoam cup. Fill the Styrofoam cup with 50.0 mL of room temperature water. Record the mass of the cup with the room temperature water. Using the digital thermometer (if available), stir the room temperature water until it remains at an approximately constant temperature. Record the temperature of the room temperature water present in the cup.

3. Mix Water Samples

You are going to pour the hot water in the beaker in to the water in the Styrofoam cup. Just before you are ready to pour the hot water out, remove it from the hot plate. Let the hot water set for a moment watch the temperature carefully. Record its temperature when it has stopped rising and seems somewhat constant. Immediately pour the hot water in to the water in the Styrofoam cup. Stir the water in the cup with the digital thermometer, and record the final temperature it rises to (the highest temperature it rises to). Before disposing of the water, make sure to record the mass of the cup and all water present at the end of the trial.

Prepare data tables similar to the following in your lab report:

Mass of Calorimeter Cup	
Mass of Calorimeter Cup and Room Temperature Water	
Initial Temperature of Room Temperature Water	
Mass of Calorimeter Cup, Room Temperature Water, AND Hot Water	
Initial Temperature of Hot Water	
Final Temperature of Water in Calorimeter Cup	

Using your data and your understanding of heat energy, determine the heat capacity of the Styrofoam cup in $J/^{\circ}C$.

Part 2 – Latent Heat of Fusion of Ice

1. Prepare the Calorimeter

Obtain the same calorimeter cup you used in Part 1 of the lab. Record the mass of the cup. Fill the calorimeter cup about half way full of room temperature water and record the mass of the cup and water on your data table. Place a thermometer in the room temperature water and record its temperature.

2. Obtain Ice & Mix

Obtain several chunks (3 – 4) of ice from the bin. Do NOT use too much ice, as this can cause issues with your experimental result. Using a paper towel, wipe off any excess water on the ice chunks and immediately place them in the calorimeter. We will assume that the ice is at an initial temperature of 0°C. Using the thermometer stir the ice and water until ALL the ice has melted. Once all of ice has melted record the final temperature of the water on your data table. Before you empty the water down the sink make sure to measure the mass of the calorimeter cup plus the water AND melted ice, and record on your data table.

3. Determine the Latent Heat of Fusion of Ice

Prepare data tables similar to the following in your lab report:

Mass of Calorimeter Cup	
Mass of Calorimeter Cup and Water	
Mass of Calorimeter Cup, Water, and Melted Ice	
Initial Temp. of Water	
Final Temp. of Water	

Using the data you collected, your knowledge of heat energy, AND the discussion presented in the introduction to the lab, calculate the experimental latent heat of fusion of ice. Determine your percent error.

Questions

1. Why did you need to make sure not to add too much ice to the calorimeter in Part 2?
2. What was the purpose of drying the ice before adding it to the water?
3. During an experiment, 3.0g of sodium acetate, $\text{NaC}_2\text{H}_3\text{O}_2$, were added to 20.0 ml water at 20.0°C. The temperature dropped to 18.0°C.
 - a) Is the reaction endothermic or exothermic? Explain.
 - b) Find the heat of reaction for sodium acetate dissolving in water in kJ/mol. (assume the specific heat of the solution is the same as that of water)
 - c) Draw a sketch of an energy vs. time graph representing this reaction. Label the heat of reaction you calculated in b) on your diagram.