Latent Heat of Fusion

Introduction

The purpose of this lab is to determine the Latent Heat of Fusion of ice. In this experiment the heat of fusion of ice will be determined by using the method of mixtures (Quantity of heat lost = Quantity of heat gained).

Equipment

Computer w/ Logger Pro SW	Triple Beam Balance	Water
Calorimeter	Digital Scale	
Digital Themometer	Ice	

Theory

When a solid has reached its melting point, additional heating melts the solid without a temperature change. The temperature will remain constant at the melting point until ALL of the solid has melted. The amount of heat needed to melt the solid depends only on the mass of the solid. We have:

$$Q = ML_f \qquad \textbf{Eq. 1}$$

where Q is the amount of heat absorbed by the solid, M is the mass of the solid and L_f is the latent heat of fusion measured in cal/g (to fuse means to melt). Ice will be added to a calorimeter containing warm water. The heat energy lost by the water and calorimeter does two things:

1. It melts the ice;
2. It warms the water formed by the melting ice from zero to the final temperature.

Heat lost = Heat gained

Heat lost by warn water = heat needed to melt ice + heat needed to warm water which was once ice

$$\mathbf{M_w C_w (T_w - T_f) = M_{ice} L_f + M_{ice} C_w (T_f - 0)} \qquad \textbf{Eq. 2.}$$

* Note: The mass of the melted water is the same as the mass of the ice.

where
- M_w = mass of warm water initially in calorimeter
- M_{ice} = mass of ice and water from melting
- C_w = specific heat of water
- L_f = heat of fusion of ice
- T_w = initial temperature water
- T_f = equilibrium temperature of mixture

Experimental Procedure:

1. Using the digital scale or the triple beam balance determine the mass of the empty calorimeter cup M_c. Record the value in the Data Section below.

2. Fill the calorimeter cup to about half full with warm water. The water temperature should be between 5^o-10^o above room temp. (Room temp ~20^oC.)

3. Determine the mass of the calorimeter cup and water M_{cw}. Record the values in the Data Section.

4. Calculate the mass of the added water, M_w. Record the values in the Data Section.

5. Measure and record the initial temperature of the water, T_w.

6. Dry several small pieces of ice with a paper towel to remove any adhering water. We want to add ice and not the liquid water on the ice.

7. Add the pieces of ice to the calorimeter and keep adding ice periodically until the temperature of the mixture is between 5^o and 10^o C below room temperature. Keep the mixture well stirred.

8. When all the ice has melted, measure and record the equilibrium temperature (T_f).

9. Measure and record the combined mass of the calorimeter cup and water, which now includes water from the melted ice M_{cwi}.

10. Calculate and record the mass of the ice, $M_{ice} = M_{cwi} - M_{cw}$

Data

1. Mass of empty calorimeter cup (M_c) _____ g
2. Mass of calorimeter cup and warm water (M_{cw}) _____ g
3. Mass of warm water ($M_w = M_{cw} - M_c$) _____ g
4. Mass of calorimeter cup and water (after ice melts) (M_{cwi}) _____ g
5. Mass of ice added ($M_{ice} = M_{cwi} - M_{cw}$) _____ g
6. Initial temperature of warm water (T_w) _____ ^{o}C
7. Final temperature of water and melted ice (T_f) _____ ^{o}C
8. Specific Heat of Water (C_w) 1.00 cal/(g ^{o}C)

9. Use Equation 2 and the data in the Data Section to solve for the latent heat of fusion $\mathbf{L_f}$.

Heat lost = Heat gained

Heat lost by warm water = Heat needed to melt ice + Heat needed to warm the water which was once ice

$$\mathbf{M_w C_w (T_w - T_f) = M_{ice} C_w (T_f - 0) + M_{ice} L_f} \quad \text{Eq. 2}$$

10. Latent Heat of Fusion of ice, L_f _____ cal/g

11. Accepted value for the Latent Heat of Fusion of ice 80.0 cal/g

12. Percent error _____ %

Common Errors

1. STIRRING: It is important to stir the water and ice mixture to ensure that the temperature through out the water is uniform. Not stirring the ice and water mixture causes the final temperature to be too warm and gives an experimental value of the Latent Heat of Fusion that is too low.

2. THERMOMETER: The SS thermometer should not come into contact with the styrofoam calorimeter. This contact causes the final temperature to be too warm and gives an experimental value of the Latent Heat of Fusion that is too low.

3. DRYING THE ICE: If the ice is not dried there will be water at 0^oC on the ice. The added water will contribute to the final mass of liquid but it will not gain the amount of heat that an equivalent amount of ice would gain. The initial temperature of the water in the calorimeter will not have to drop as far. Hence the final temperature will be too high. The result will be an experimental value of the Latent Heat of Fusion that is too low.

Lab Report

Discuss the various errors and how they impacted your experimental results. You may use the back of this lab handout.