LATENT HEAT OF FUSION

INTRODUCTION

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 upon both the amount and type of matter that is being melted. Therefore:

$$Q = ML_f \quad \text{Eq. 1}$$

where ***Q*** is the amount of heat absorbed by the solid, ***M*** is the mass of the solid that was melted and L_f is the latent heat of fusion for the type of material that was melted, which is measured in J/kg, NOTE: to fuse means to melt.

In this experiment the latent heat of fusion of water will be determined by using the method of mixtures $\Sigma Q=0$, or $Q_{Gained} + Q_{Lost} = 0$. 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 equilibrium temperature of the mixture.

Heat gained + Heat lost = 0

Heat needed to melt ice + Heat needed to warm the melt water + Heat lost by warn water = 0

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

* 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 the melted ice
- C_w = specific heat of water
- L_f = latent heat of fusion of water
- T_w = initial temperature water
- T_f = equilibrium temperature of mixture

APPARATUS: Calorimeter, thermometer, balance, ice, water

OBJECTIVE: To determine the latent heat of fusion of water

PROCEDURE:

1. Find and record the mass of the empty calorimeter cup M_c.

2. Fill the calorimeter cup about half full of luke warm water. (The water temperature should be between 5^o-10^o above room temp.)

3. Determine the mass of the calorimeter cup and water. Record in the Data Table.

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

5. Determine and record the initial temperature of the water (T_w).

6. Warm the ice to 0° C by placing the ice in a separate water bath. Dry small pieces of ice with a paper towel in order to remove adhering water prior to placing them into the calorimeter cup.

7. Add a mass of ice approximately equal to 1/3 to 1/4 of the mass of the water in the calorimeter. Keep the mixture well stirred.

8. When all of the ice is melted entirely keeping the mixture well stirred, find and record the equilibrium temperature (T_f).

9. Find and record the combined mass of the calorimeter cup and water, which now includes water from the melted ice.

10. Find and record the actual mass of the ice, M_{ice}

DATA

1. Mass of empty calorimeter cup ($\mathbf{M_c}$) _____ kg
2. Mass of calorimeter cup and warm water _____ kg
3. Mass of warm water ($\mathbf{M_w}$) _____ kg
4. Mass of calorimeter cup and water (after ice melts) _____ kg
5. Mass of ice added ($\mathbf{M_{ice}}$) _____ kg
6. Initial temperature of warm water ($\mathbf{T_w}$) _____ °C
7. Final temperature of water and melted ice ($\mathbf{T_f}$) _____ °C
8. Specific Heat of Water ($\mathbf{C_w}$) 4,186 J/(kg C °)
9. Use equation 2 to solve for the latent heat of fusion $\mathbf{L_f}$.

Heat gained + Heat lost = 0

Heat needed to melt ice + Heat needed to warm the melt water + Heat lost by warn water = 0

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

10. Heat of fusion of ice, L_f _____ J/kg

11. Accepted value for the heat of fusion of ice $3.33*10^5$ J/kg

12. Percent error _____ %