Heat of Fusion

Object:

Determine the latent heat of fusion for water by the method of mixtures.

Apparatus:

Calorimeter with stirrer, weighing scales, 50°C thermometer, beaker, melting ice, paper towels, bucket.

Theory:

We shall perform a cycle of operations in which, first, ice is added to warmed water so that the ice melts as the water is cooled. From appropriate weightings and temperature readings, it is then feasible to determine the latent heat of fusion for water. It is assumed that heat is conserved in the mixture consisting, in this case of water, calorimeter cup with stirrer, and added ice. This implies no net transfer of heat to the surroundings. The initial and final temperatures would be about equally far (say 10°C) above and below room temperature. Temperatures should be recorded on a thermometer graduated in 5ths or 10ths of a degree.

Before making measurements, examine the "heat gained = heat lost" relation given by:

$$ML_f + Ms_w(t_2-0) = (m_w s_w + m_1 s_1 + m_2 s_2)(t_1-t_2)$$

Where M is the mass of ice, in grams; L_f is the latent heat of fusion of ice in calories per gram, t_2 is the equilibrium temperature in °C, t_1 is the initial temperature of the water and colorimeter, m_w is the mass of warm water and s_w is its specific heat (1cal/°C-gm), $m_1s_1 + m_2s_2$ is the water equivalent of the calorimeter and stirrer, m_1 is the mass and s_1 is the specific heat of the calorimeter, m_2 is the mass and s_2 is the specific heat of the stirrer.

Details of Procedure:

1) Stir the water and carefully read its temperature. Then immediately add several cubes of melting ice that have been dried with paper towels. Continue stirring and (if necessary) add ice until the temperature of the water and completely melted ice is 10 to 15°C below room temperature. Obtain the mass of added ice from a reweighing of the mixture. This data permits the calculation of the heat of fusion.

The procedure should be repeated until two values of latent heat are obtained that agree within a few percent. In the Report, list all measured values for the latent heat under "Numerical Results".

Refer to Question 1, below. In the report, under "discussion", state what you consider to be the main factor, or factors, that limited the precision of the determination of latent heat. Comment also on factors, which may have contributed significant "hidden", or constant, errors.

Questions:

1) Give reasonable estimates of the precision (in percent) with which (i) the temperature fall of the water and (ii) the mass of ice were measured. What then do you estimate for the percent precision with which L_f is determined?

2) What is the percent discrepancy between the accepted value for the latent heat of fusion for water and the average (mean) value you found?

3) State your experimental value for the latent heat of fusion as: average value ± the standard deviation ($L_{ave} \pm \sigma$) where σ the standard deviation of your results is given by:

$$\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(Li - Lave)^2}$$

4) (a) Explain the error that would be introduced by using ice cubes taken directly from a freezer. Would the value found for L_f be too large, or too small?

(b) Why were you asked to dry the ice with a towel before adding it to the water?

Heat of Fusion Data:

Data Table	Trial #1	Trial #2	Trial #3
Mass of calorimeter = m_1			
Mass of water and calorimeter			
Mass of water = m_w			
Mass of resulting solution			
Mass of ice = M			
Mass of stirrer = m_2			
Initial temperature = t_1			
Final temperature = t_2			
Latent heat of fusion = L_f			

Specific heat of aluminum = 0.2154 cal/^{o}C-gm

Note: Be certain all added ice to calorimeter melts