Physics 223
Experiment 3: Latent Heat of Fusion

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During the early development of Thermodynamics, it was assumed that there was a substance called *caloric* which passed out of a hot object into a cold one when the two were in contact. At the dawn of the 19th Century, Benjamin Thompson (who later became Count Rumford) conjectured that the agent involved was energy, the same as in motion. In this experiment, you will study the energy transfer from one object to the other, and in the process, experimentally determine the latent heat of fusion of ice.

Pure water undergoes a phase transition at $0\,^{\circ}C$. When ice melts, heat energy is absorbed to break the molecular bonds to change its phase from solid to liquid without any change in temperature. A container of ice water in thermal equilibrium will remain at $0\,^{\circ}C$ until all the ice has melted. Only after this will any heat absorbed cause an increase in temperature. We define the latent heat of fusion of ice L_f as the amount of heat required to melt a unit mass ice, i.e.

$$Q = mL_f$$

In this experiment, you are to determine the latent heat of fusion of ice using a "warm water calorimeter". There will be an ice bath from which you may take ice at $0\,^{\circ}C$ and a microwave oven available with which to heat the water to be used in the calorimeter. The "warm water calorimeter" consists of an isolated inner aluminum cup with a stirrer and an insertion point for a thermometer. The inner cup assembly is isolated from the outer cup by an insulating ring. This minimizes, but does not completely eliminate, the heat lost through the walls of the calorimeter.

Obtaining an accurate measurement of the latent heat will require a careful experimental procedure. It will be important to take into account the masses and thermal properties of calorimeter itself as well as the natural thermal losses through the calorimeter walls, and to devise a consistent procedure to determine initial (when the ice is first inserted) and final (when the ice is completely melted) temperatures. It will also be necessary to make sure that any change in temperature is large enough to be accurately measured. This means that you should take some extra time to calibrate the apparatus by understanding how the temperature varies with time before beginning to take measurements. Make sure that you discuss your procedure for this with the Teaching Assistant.

Once you have inspected the calorimeter and obtained calibration information, develop a procedure to measure the latent heat of the ice. Show the procedure you propose to use and the data you plan to acquire to your Teaching Assistant. In your procedure include information about how many trials you plan to make and what, if any variables you plan to change with each trial. You should also include details of how you will analyze your data to extract the latent heat of fusion of ice. Consider all sources of heat loss in formulating the governing equations.

The "article" you write for this experiment must include a detailed analysis of the heat balance in the system, including measured losses, with equations.