INTRODUCTION: The specific heat of a substance may be regarded as the heat (in calories) which each gram of the substance must give up to cool by 1°C. The calorie is defined so that the specific heat of water is 1 cal/(g°C). Thus each gram of water requires 1 calorie to increase its temperature by 1°C, and 300 g requires 300 calories for a 1°C change. If water in a cup requires 300 calories for each degree of temperature increase, it will require 1500 calories for a 5°C increase, 3000 calories for a 10°C increase, etc. If the water is being heated by a hot piece of metal placed in the water, then the heat gained by the water must equal the heat given up by the metal. If this is 1200 calories, and the metal cooled 60°C, then it gave up 20 calories for each °C of temperature change. If the mass of the metal is 100 g and it gives up 20 calories per °C, then the specific heat of the metal is (20 cal/C°) / 100 g = 0.20 cal/(g°C).

The equation relating the transferred heat $Q$ and the temperature change $\Delta T$ is:

$$Q = mc\Delta T$$

where $c$ is the specific heat of the substance and $m$ is its mass.

A. PURPOSE: To determine the specific heat of a metal.

PROCEDURE:
1. Find the mass of the piece of metal, then place it in boiling water and keep it in the water for about five minutes.
2. Find the mass of the styrofoam cup. Put some cold water in the cup and find the mass of the cup with water. Place a thermometer in the cold water in the cup and record the temperature.
3. Measure the temperature of the metal and the boiling water. Remove the metal from the boiling water and place it in the colder water in the styrofoam cup. Stir gently and record the highest temperature of the water after the metal and water come to thermal equilibrium.

   **Heat gained by water in cup = Heat given up by metal**

   Calculate the heat gained by the water in the cup from: (specific heat of water) (mass of water) $(T_{\text{final}} - T_{\text{initial}})$ of water.

   Then set it equal to the heat given up by the metal: (specific heat of metal) (mass of metal) $(T_{\text{initial}} - T_{\text{final}})$ of metal.

4. Calculate the specific heat of the metal. You will have to determine the mass of the water, the temperature change of the water, the mass of the metal and the temperature change of the metal. Clearly show all your calculations here.
CALORIMETRY

B. PURPOSE: To determine the heat needed to melt one gram of ice.

PROCEDURE:
1. Place some warm (not hot) water in the styrofoam cup (about ½ to 2/3 full) and measure its temperature and mass.

2. Drop several ice cubes in the water and monitor the temperature while stirring. If the temperature does not drop rapidly, you need more ice.

3. When the temperature gets to 5°C, quickly remove the excess ice and determine how many grams of ice melted. (Measure the mass of cup, water, and the melted ice.)

4. Calculate the heat of fusion for water (the heat needed to melt one gram of ice) by using:

   **Heat to melt ice + Heat to raise it to 5°C = Heat given up by water that cooled**

   The initial temperature of the ice is 0°C.

   \[ m_{\text{melted ice}} \times L_f + m_{\text{melted ice}} \times c_{\text{water}} \times (T_{\text{final}} - 0°C) = m_{\text{water}} \times c_{\text{water}} \times (T_{\text{initial}} - T_{\text{final}}) \]

   where \( m_{\text{water}} \) is the mass of water in the cup before the ice was added, \( c_{\text{water}} \) is the specific heat of liquid water, and \( L_f \) is the heat of fusion for water.

   Calculation:

   \[
   \text{Heat of fusion} =
   \]

   5. What is the percentage error for your value of the heat of fusion for water?

   6. Is your % error reasonable? Identify and evaluate sources of error.