Survey of Physics

Lab 12: Specific Heat Capacity of Lead

Name:_____

partner name(s):_____

Theory:

The purpose of this experiment is to acquaint you with the use of calorimeters. You will use a calorimeter to obtain data that will allow you to calculate the specific heat of lead.

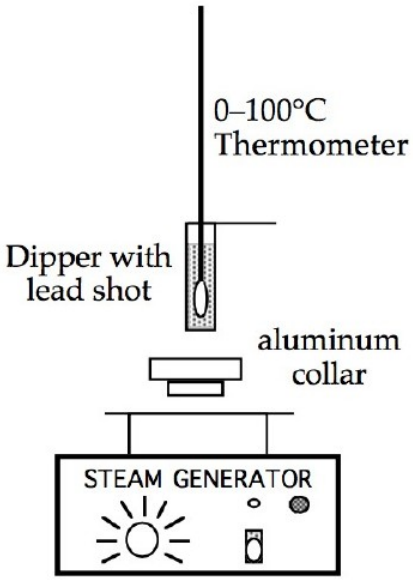
In this experiment, you will be adding lead metal shot that you have heated to a high temperature to cool water inside a calorimeter. Shortly afterward, the water and lead shot will be at the same temperature (thermal equilibrium). The lead shot will lose heat as the combination reaches thermal equilibrium, and the water and inner calorimeter cup will gain an equal amount of heat.

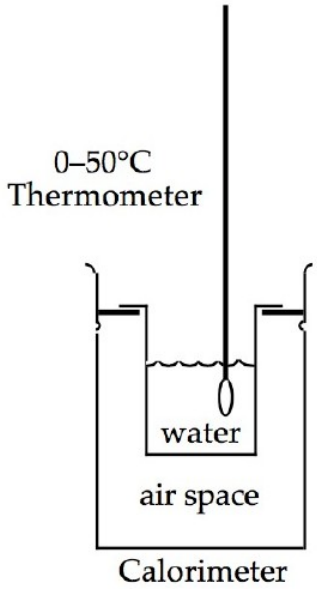
Total heat gained + Total heat lost = 0

or, alternatively:

Total heat gained = Total heat lost

You will be using the specific heat equation, $Q = mc\Delta T$, to calculate the amount of heat gained by the calorimeter water and the inner calorimeter cup. The sum of these is the total heat gain. It is equal (but opposite in sign) to the heat lost by the lead. You will use this to find an experimental value for the specific heat for lead.





Procedure:

1. Fill the steam generator half full with deionized water and begin heating.

2. Measure out 600 grams of lead shot and place this shot in a dipper. Record the exact mass of the lead shot, in grams, below.

3. Do not put lead directly into the hot water. Insert a thermometer into the shot and place the dipper in the steam generator. The lead should get up to at least 97 °C.

4. Measure the mass of the empty inner calorimeter cup, and record the value (in grams) in the Data section. Fill the calorimeter about one-third full with water using ice water provided in the lab room. The water temperature should be at least 8 °C cooler than room temperature. Remove any ice not yet melted. Measure and record (in grams) the mass of the cup with water in the Data section below.

5. Using a different thermometer (not the one in the lead shot), measure the initial temperature of the water in the calorimeter and record the value in the Data section.

6. Measure the temperature of the lead, which will be its initial temperature, and record in the Data section. Quickly remove the dipper from the steam generator and pour the lead shot into the calorimeter. Carefully stir the mixture until the temperature stabilizes. Record this final temperature in the Data section.

7. Go through the steps on the following page to calculate an experimental value for the specific heat of lead. Keep all values of heat positive.

8. Carefully drain the water from your calorimeter. Do not spill any lead shot in the sink! Deposit your lead shot into a drying container.

Measured Data:

Mass of lead: $m_{Pb} =$ Mass of empty cup: $m_{Al} =$

Mass of cup and water: $m_w + m_{Al} =$

Initial temp of water: $T_{i,w} =$ Initial temp of lead: $T_{i,Pb} =$

Final temp of water and lead (after combining): $T_f =$

Calculations:

1. Find the mass of just the water (m_w).

2. Find the amount of heat (Q_1) gained by the calorimeter, where $Q_1 = m_{Al} c_{Al} \Delta T_{Al}$
   Use $c_{Al} = 0.22$ cal/g °C.

3. Find the amount of heat (Q_2) gained by the water, where $Q_2 = m_w c_w \Delta T_w$
   Use $c_w = 1.00$ cal/g °C.

4. Since Total heat gains + Total heat losses = 0, use your values of Q_1 and Q_2 to determine the heat loss of the lead as it cooled (Q_3), where $Q_1 + Q_2 + Q_3 = 0$.

5. From the heat loss of the lead, calculate your experimental value for the specific heat of lead.

6. Calculate the percent error in your experimental value, compared to the accepted value. The accepted value is $c_{Pb} = 0.031$ cal/g °C.

   % error = $\frac{c_{meas} - c_{accept}}{c_{accept}} \times 100\%$