Specific Heat

Introduction

The purpose of this lab is to determine the specific heats of several different metals.

Equipment

Computer & Logger Pro SW	Electric Hot Plate	Digital Scale
Temperature Sensor	Beaker	String
Calorimeter	Set of metals	

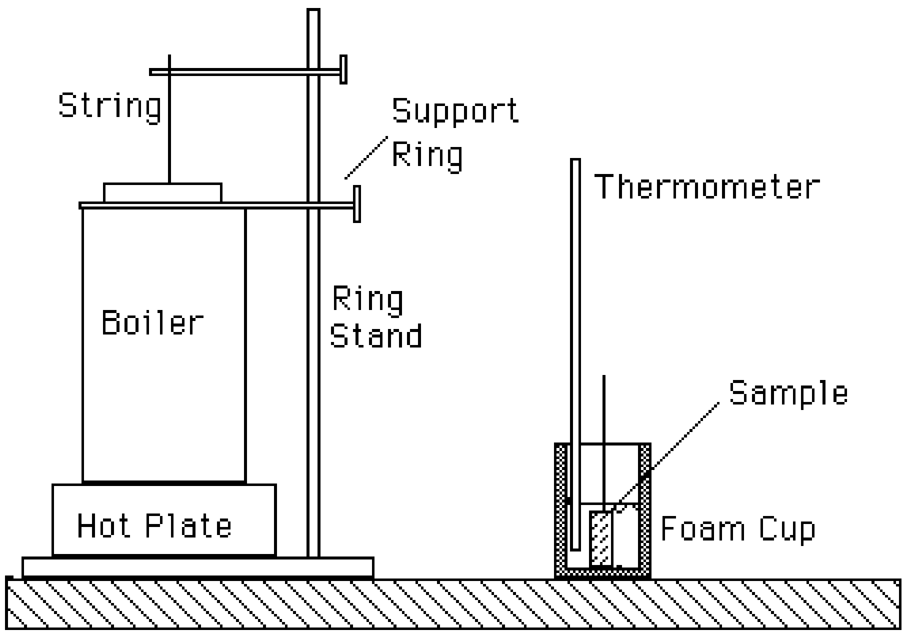

Figure 1

Theory

If you mix hot and cold water together, the temperature of the final mixture will be between the two temperatures of the component liquids. The exact value of the final temperature depends on how much hot water is added to how much cold water and the specific temperatures of each of the liquids. If you throw a hot branding iron into a pail of cool water, you know that the temperature of the iron will go down. You also know that the temperature of the water will rise--but will its rise in temperature be more, less, or the same as the temperature drop of the iron? That is, will the temperature of the water rise as much as the temperature of the iron goes down? Or will the changes of temperature instead depend on the relative masses and the thermal properties of the iron and the water?

In this experiment, you are going to **investigate the quantity of heat per gram per degree(Celsius)**, known as the **specific heat**.. Water has a specific heat of 1.00 cal/g°C--relatively large compared to most substances.

The heat (**Q**) lost by a specimen, say a piece of metal, submerged in water equals the heat (**Q**) gained by the water and by the container. In this experiment we will neglect the heat absorbed by the Styrofoam container as it is negligible.

$$Q_{lost} = Q_{gained}$$

Heat, Q = Specific Heat of Substance x Mass of Substance x Change in Temperature.

Heat lost by metal block = Heat gained by water

$$C_m M_m (T_{im} - T_f) = C_w M_w (T_f - T_{iw}) \quad \ldots\ldots \quad \textit{Equation 1}$$

Where C_m = specific heat of the metal	C_w = specific heat of water
M_m = mass of metal	M_w = mass of water
T_{im} = initial temperature of the metal	T_f = final temperature of metal and water
T_{iw} = initial temperature of the water	

<u>SAFETY WARNING:</u> This is the most dangerous lab that you will perform during this course. There will be a container of boiling water on your lab table. Place it where you won't bump into it or tip it over.

<u>Procedure</u>

1. Plug in the Hot Plate, turn it on and turn up the temperature control. Place a beaker, half full of water, on the Hot Plate and bring it to a boil.

2. Find the mass of the metal samples (M_m) and record the values in the Data Table.

3. Attach a piece of string to the metal and lower it into the beaker. Be sure the metal is completely immersed in the water. Heat the metal in the water for at least 5 minutes. Our assumption will be that the *metal's temperature is the same as that of the boiling water.* Measure and record the temperature of the boiling water, even though this should be 100°C, it might be 1 or 2 degrees lower.

   The initial temperature of the metal (T_{im}) is assumed to be equal to the temperature of the boiling water.

4. Measure and record the mass of the *empty calorimeter cup.* (M_c).

5. Fill the calorimeter cup about one-half full of cold water (about 5° below room temperature) and measure the mass of the cup and water (M_{cw}).
   Subtract the mass of the cup to obtain the mass of the water in the cup (M_w).

Note: The temperature of the water is brought below room temperature to further reduce the net amount of heat exchanged with the room. The calorimeter will spend about as much time below room temperature (where is absorbs heat) as it does above room temperature (where it sends heat into the room).

6. Measure and record the initial temperature of the water (T_w) in the cup.

7. Holding the metal block by the string, quickly (but carefully) transfer the metal block from the boiler into the calorimeter cup.

8. Wait for the temperature of the water in the calorimeter cup to stop rising. Stir the water periodically. Don't let the thermometer touch the Styrofoam calorimeter. Record the temperature of the water when it reaches its *highest point* (T_f). This is the most critical measurement in the lab.

9. Repeat the above procedure for a total of three (3) different metals.

Data Analysis

1. Calculate the specific heats of the three metals by using the data in your Data Table and Equation 1.

2. Compare the specific heats of the three metals to their accepted values. Calculate their respective percent errors.

Data Table

Type of Metal	Mass of Metal M_m (g)	Mass of cup + water M_{cw} (g)	Mass of cup M_c (g)	Mass of Water M_w (g)	T_{im} °C	T_{iw} °C	T_f °C	Exper. Specific Heat (cal/g°C)	% error

Specific Heats for Laboratory Samples at 20° C						
Fe	Cu	Sn	Zn	Al	Pb	Brass
0.119	0.092	0.054	.0925	0.214	0.0306	.0917

Lab Report

Your Laboratory Report should follow the document "Format for Formal Lab Reports."