Lab Activity 19: Specific Heat of Four Metals

Pre-Lab Discussion:

The specific heat is a physical property which expresses the amount of energy (in Joules) needed to raise the temp of one gram of a substance by one degree Celsius. When applied to metals, specific heat (C_p) is used to compare energy absorption and energy transfer.

This lab will include the following concepts and you must become familiar with the following before you enter the lab:

Heat gradient - the tendency of heat energy to flow from an area of high heat concentration to an area of low heat concentration.

Calorimeter - an insulated container used to measure heat energy changes.

Get familiar with the following symbols

$q = mC\Delta T$	q = heat	H_f = heat of fusion
$q = mH_f$	m = mass	H_v = heat of vaporization
$q = mH_v$	C = specific heat capacity	
	ΔT = change in temperature	

And this constant for water:

Specific Heat Capacity of H_2O (ℓ)   4.18 J/g•°C

You will need this formula to complete the lab: $q = m \bullet \Delta T \bullet C$

**Hint: you can rearrange the formula to look like this*:

$$C = \frac{q}{m \bullet \Delta T}$$

Here is the formula for percent error:

$$\% \text{ error} = \frac{\text{measured value} - \text{accepted value}}{\text{accepted value}} \times 100$$

Purpose:

By the end of this lab you should be familiar with the idea of different forms of energy, heat transfer, and specific heat of a substance. You should also understand the meaning of specific heat, what it tells us about a substance, and how to solve specific heat problems.

Materials:

-Wire Gauze	-Tongs	-Thermometer
-250 mL Beaker (2X)	-Ring Stand	-Stirring Rod
-4 metal samples	-Iron Ring	-Bunsen Burner

Procedures:

1) Set-up a water bath using 125 mL of water in a 250 mL beaker. Heat the water and allow it to boil. This is the boiling water bath, which will heat the metal to 100 C^o. ***This water***

sample will not be included in your calculations, it only transfers heat to the metal from the flame.

2) Obtain a metal sample, and record its color. Mass the metal sample and record the mass in your lab notebook. Carefully place the metal into the boiling water and allow the metal to sit in the BOILING water bath for at least5 minutes to ensure the metal reaches 100 C^o. It is vital that the metal and water equilibrate to 100 C^o.

3) While the water boils in your first beaker, fill the second beaker with 50 to 100 ml of water, record the mass of the water in the cup. **Remember that 1.0 ml is 1.0 gram of water (density is 1g/ml); your volume and mass of water are the same near STP**. This is your calorimeter, be certain to record the mass accurately.

4) From step 4 onward, the "water" mentioned is from beaker #2, not the boiling water from step 2. Measure the temperature of the water in the second beaker, this is your initial temperature and it will be used in your calculations. Then quickly and carefully remove the metal from the boiling water bath with laboratory tongs, and gently place it in the second beaker without allowing the water to splash. Gently stir the water as you watch the temperature, **RECORD THE MAXIMUM TEMPERATURE REACHED BY THE WATER**, and use this value as your final temperature value when making your calculations.

5) Using the equations listed above, determine the C_p of each metal. *Hint: the ΔT value you will use in your calculations will be derived from the initial and final temperatures you observed during step 4. The heat value (q) you derive from the calculations is equal to the heat the water gained from the metal and the heat lost by the metal to the water. The initial temp of your metal is 100 C^o because it entered the calorimeter from the water bath, which was 100 C^o. The final temp of the metal was the maximum temp of the calorimeter which was also the temp of the metal in it.*

6) Using the percent error equation and the theoretical values of specific heat (obtain these values from your teacher), determine your percent error for each metal tested. Be sure to create a table and organize all your data.

-Courtesy of Michael Caifa, February 2005
(this lab was revised from its original form in Jan.2006)