Physics 233 **Lab 9**
November **Calorimetry**

Goals

1. To measure the specific heat of a metal sample and determine what it is.
2. To practice calculating uncertainties.
3. To write a complete lab report.

Equipment:

Calorimeter cup set with stopper, metal sample, temperature sensor, LabPro interface, computer, hot plate, beakers, electronic scale, digital camera

Reading:

- Review Chapter 3 (How to Write a Lab Report) and Chapter 7 (Propagation of Uncertainty) of the lab reference manual
- Review chapter T1

Pre-Lab Problems: Enter these equations in WebAssign, but also record this work in your notebook as you'll be using it to analyze work you'll do in lab.

You will be performing the experiment shown in figure T1.3. You will measure the masses of the metal (m_m), the water (m_w), and the cup (m_c), the initial temperatures of the metal (T_{mi}) and the water (T_{wi}), and the final temperature (T_f). You can look up the specific heats of water (c_w) and the cup (c_c).

1. Derive a formula (no numbers!) for the specific heat of the metal mass in terms of measureable quantities defined above.
2. Derive a formula for the uncertainty in the specific heat of the metal. You may assume that the uncertainties in the masses of the objects and in the specific heats of water and the cup are negligible. In other words, you only have to consider uncertainties in the temperatures.

Lab Procedure:

- Select a cylindrical piece of metal and record its number. Measure the mass of the metal.
- Suspend the metal in a beaker of boiling water. The metal should be fully submerged and should not touch the bottom of the beaker.
- The inner calorimeter cup is made of aluminum. It is fairly well insulated from the surroundings, including the outer cup. Measure the mass of the inner calorimeter cup.
- Fill the inner calorimeter cup about two thirds full with room temperature water. Determine the mass of the water.
- Plug the temperature probe into "CH 1" of the LabPro interface. Open the file "TemperatureSensor.xmbl " which is on the computer's desktop.
- Put the calorimeter together and place the temperature probe through the lid into the water. Measure and record the temperature of the water.
- The experiment needs to be carried out quickly to get good results, so read this *whole* paragraph carefully before doing anything! Press the "Collect" button in the LoggerPro program. One person should lift up the lid of the calorimeter. Another person should carefully and quickly remove the metal from the boiling water, dry it, and gently place it in the calorimeter so that no water is splashed out. The person holding the lid should quickly put it back on. Keep the

thermometer near the middle of the water. It should *not* touch or be too close to the metal cylinder.

- The temperature of the water will rise, then eventually drop because the calorimeter cup is not perfectly insulated. Use the maximum temperature that the water reaches as the *final* temperature.

Post-Lab Assignment:

1. Use your measurements to determine the specific heat of the metal and its uncertainty. You may use the program *PropUnc* to check your calculation of the uncertainty, but you must show your calculation.

2. Write a *complete* lab report for this experiment. It should be typed.

Specific Heats (near room temperature)

Lead 128J/kg·°C	Brass 385 J/kg·°C	Copper 387 J/kg·°C
Iron 452 J/kg·°C	Steel 502 J/kg·°C	Aluminum 900J/kg·°C