San Diego Mesa College Name:_____

Physics 197 Laboratory Experiment Date: _____

Title: Calorimetry

Objective:

To investigate the relationship between temperature, heat and energy.

Theory:

When thermal energy is transferred between bodies there is a corresponding change in the temperature of the objects. The amount by which the temperature changes is dependent upon a few factors.

First, the type of material of which the object is composed will determine its reaction. Additionally, the amount of material which is involved will change the results. Finally, for a given object, the temperature changes are proportional to the energy transfer. Net increases in energy lead to higher temperatures.

Therefore, we define the *specific heat* of he material as the amount of energy required per unit mass to raise the temperature of the object by 1 degree Celcius or 1 degree Kelvin. For water, the specific heat is c_w = 1 calorie/gram•C°. The relationship between heat change (ΔQ), the object (m,c) and the temperature change (T_f-T_o) is given by:

$$\Delta Q = mc\Delta T$$

Equipment:

Small Steel Ball	Steam Generator
Distilled Water	Styrofoam Cups
Electronic Balance	Thermometers
Metal Tongs	'Unknown' Substances

Setup and Procedure: Part I: Determination of the specific heat of steel

Although the temperatures involved are not extreme, be careful when handling the steam generator and the heated objects to avoid possible injury. However, the thermometers contain Mercury, a potentially hazardous material. **If you break one, do not attempt to clean it up, move away from the affected area and notify the instructor immediately**.

1) Measure the mass of the steel ball.
2) Place it in the styrofoam cup and make note of what water level would be needed to cover the ball by about 1 cm.
3) Turn on the steam generator, place the ball inside and wait for the water to come to a boil. Once boiling, leave the ball in the boiling water for ~5 minutes.
4) While you wait, take the empty cup and place it on the balance. Press the 'on/tare' button to re-zero the balance.
5) Place distilled water in the cup until you reach the level found in step 3) and record the mass of the water in the cup.
6) Place a thermometer in the cup and record the temperature of the 'cool' water in the data table. Then, place the thermometer in the boiling water and record this temperature. If you only have 1 thermometer, place it in the cool water momentarily to 'reset' the temperature before taking data.
7) Place the metal tongs in the water for a short time to warm the ends which will grip the ball.

8) Working quickly in this series of step; Remove the ball from the hot water with the metal tongs and transfer it to the styrofoam cup of cool water then cover the cup with the lid to prevent undue heat loss to the environment.
9) Insert the thermometer into the cup and record the highest temperature that you see. Swirl the cup very gently to ensure mixing of hot and cold water to obtain a good temperature reading.
10) Repeat these steps with the two unknown substances and record the results in the appropriate data table.

Data: Part I: Determination of the specific heat of steel

Mass of steel ball		kg
Mass of cool water		kg
Temperature of hot water		C
Temperature of cool water		C
Final temperature of system		C

Data: Part II: Determination of the unknown substances

Marking on bottom		
Mass of unknown 1		kg
Mass of cool water		kg
Temperature of hot water		C
Temperature of cool water		C
Final temperature of system		C

Marking on bottom		
Mass of unknown 2		kg
Mass of cool water		kg
Temperature of hot water		C
Temperature of cool water		C
Final temperature of system		C

Analysis:

1) Use the conservation of energy relationship to derive an expression for the specific heat of the steel ball in terms of the specific heat of water. Assume no heat is transferred to the Styrofoam, to the thermometer or leaves the system..

2) Use your data to obtain the approximate specific heat of the steel ball. **Show all work, with units.**

3) Obtain the specific heats of the two unknown substances from your data and use a table of specific heats to find out what they are.

Unknown 1:_____ Unknown 2: _____

Conclusion: Briefly discuss the physics involved in the experiment, summarize the data, address potential sources of error and methods to reduce or eliminate them, and state whether or not the experimental results validate the theory.