Heat Capacity of Water

Reminder – Goggles must be worn at all times in the lab

PRE-LAB DISCUSSION:

When two bodies in an isolated system, initially at different temperatures, are placed in direct contact with each other, in time they will come to equilibrium at some common intermediate temperature. Because of energy conservation, the quantity of heat lost by the hot object is equal to that gained by the cold object provided that no heat is lost to the surroundings. This is the basis for the method of calorimetry through mixture: A metal sample is heated in boiling water to 100 °C. It is then quickly transferred to a Styrofoam calorimeter cup which contains a known volume of water of known temperature. When the metal specimen and the calorimeter (including the water) come to equilibrium, the final temperature is measured with a thermometer. It is assumed that the heat loss to the Styrofoam cup and thermometer is negligible and if the heat exchange with the environment is kept small, then the heat lost by the metal sample is equal to the total heat gained by the water.

SCENARIO/CLAIM:

A sample of a metal is heated to 100°C in boiling water. A sample of room temperature water in a Styrofoam cup has the same mass as the metal sample. When the metal is placed in the water, the temperature of the water increases and the temperature of the metal decreases until they are at the same temperature. Predict where the equilibrium temperature will be:

- Will it be at midpoint between the starting temperature of the water and the metal?
- Will it be closer to the starting temperature of the metal than the water?
- Will it be closer to the starting temperature of the water than the metal?
- What is the basis for your claim?

MATERIALS

Metal samples	Hot Plate	Thermometer or Temperature probe
Styrofoam cup	Milligram balance	
100 mL graduated cylinder	Crucible tongs	

PROCEDURE:

1. Set up a hot plate, and begin heating approximately 200 mL of water in a 400 mL glass beaker. Heat the water to boiling.
2. Get a metal object from the counter. Determine its mass, and record the results in the data section.
3. Lower the metal object into the water with your crucible tongs. Be careful not to drop the piece of metal into the beaker (you might crack the beaker).
4. Obtain a Styrofoam cup "calorimeter" and add to it a mass of water EQUAL to the mass of the metal piece. Remembering that the density of water is 1 gram per mL, record the mass of the water in your data table.
5. Place the thermometer in the Styrofoam cup, and record the initial temperature of the water.
6. When the metal object has been in the boiling water for 3 minutes, quickly move the metal to the Styrofoam cup using tongs. Do not allow the thermometer to come in direct contact with the piece of brass.
7. Record the temperature when the water and metal reach thermal equilibrium.
8. Perform a second trial, repeating steps 3 through 7 to confirm the results from the first trial.
9. When done with everything, return the metal and the Styrofoam cup to the counter. Do not attempt to empty the hot water beaker until it has cooled enough to allow safe handling of the beaker. This will usually be at least 30 minutes!

RESULTS

Observations and Data:

	Trial #1	**Trial #2**
1. Mass of the metal object	g	g
2. Volume of water in the calorimeter	mL	mL
3. Initial temperature of water in calorimeter	°C	°C
4. Initial temperature of metal	100 °C	100 °C
5. Final (highest) temperature of calorimeter	°C	°C