Tom Ralph, Table 5

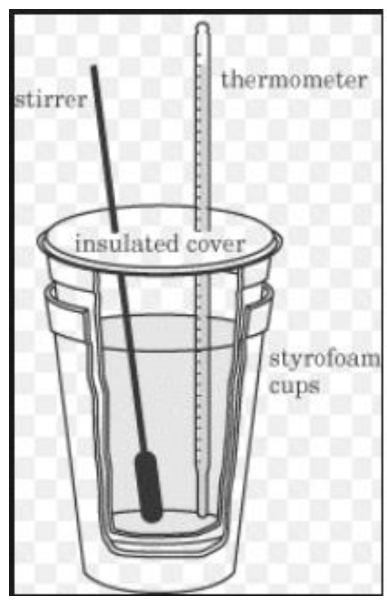
Calorimetry Lab

Purpose
Determine the specific heat capacity and identity of an unknown metal. Find the relationship between heat lost by the metal and heat gained by a fluid during calorimetry.

Materials and Equipment
Hot Plate, Beaker, PASCO Temperature Sensor, Tongs, Styrofoam Cup, Metal Samples, Stirring Stick, Test Tube, Graduated Cylinder

Background
Specific heat is the property of a substance that describes how the sample's temperature changes as it absorbs or loses energy. See the table below for the specific heats of liquid water and several metal solids. The relationship between energy, change in temperature, and mass is given by the equation: $Q = mc\Delta T$
Where Q is energy in Joules, m is mass, c is the specific heat, and ΔT is change in temperature. (Note that since we are using the change in temperature it does not matter whether we use °K or °C. °F however, still does not work.)

Substance	Specific Heat, J/(g°C)
water (liquid)	4.184
aluminum (solid)	0.901
chromium (solid)	0.448
copper (solid)	0.386
iron (solid)	0.450
lead (solid)	0.129
nickel (solid)	0.443
tin (solid)	0.217
zinc (solid)	0.386



Procedure

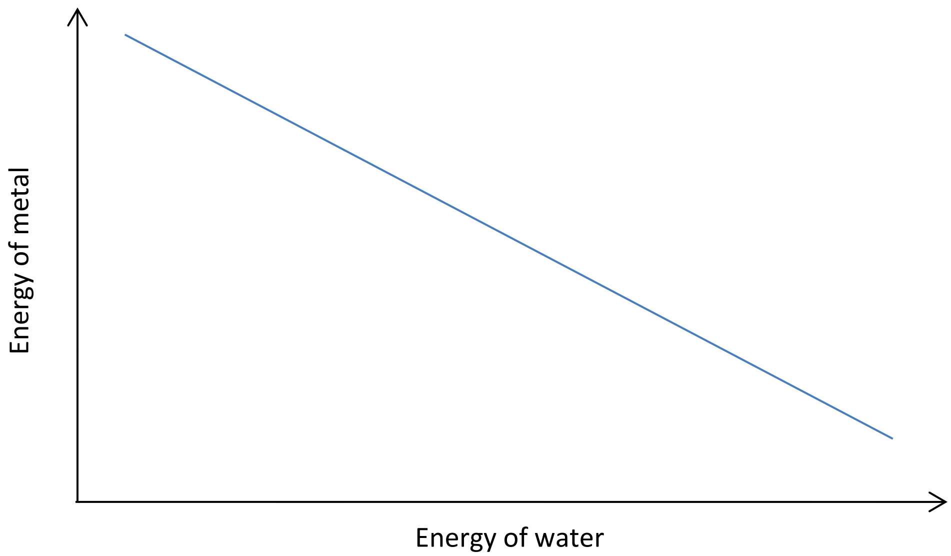
1. Pour 250mL of water into the beaker
2. Place the beaker on the hot plate and boil the water.
3. Measure and record the mass of the metal sample.
4. Place the metal sample in a test tube.
5. Clamp the test tube and submerge the test tube with metal into the boiling water. Heat the metal for 5 mins
6. Meanwhile, measure 100 mL of water and pour into the Styrofoam cup.
7. Measure and record the temperature of the water in the Styrofoam cup. Also record the temperature of the heated metal sample as 100 degrees Celsius
8. Remove the test tube and pour the metal sample into the Styrofoam cup
9. Cap the Styrofoam cup with the insulated cover and put the thermometer and stirring rod into the water.
10. Gently stir the metal sample and notice the temperature slowly rise. Record the **maximum** temperature achieved.
11. Graph the relationship between the energy of the metal and the energy of the water below. Use two points for each graph, initial and final. Have the energy of water on the x-axis and energy of metal on the y-axis. Remember $Q = mc\Delta T$ (for water, assume 1mL/1g)

Data Table

Initial temp of metal	100º C
Initial temp of tap water	23 º C
Max temp of mixture	24.5 º C
Mass of metal	18.5 g
Mass of tap water	195 g
Specific heat of tap water (Cgained)	4.184 J/g*C

Tom Ralph, Table 5

Energy of Metal vs. Energy of Water



What is the relationship between the energy of the metal and the energy of the water?

The zeroth law of thermodynamics states that two samples of matter, initially at different temperatures, when placed into thermal contact, will exchange heat until both samples achieve the same final temperature. The First Law of Thermodynamics states that during heat exchange, heat is neither created nor destroyed.

From these two, we can conclude that the energy lost by the metal is equal to the energy lost by the fluid. Therefore, we can set the two equations for energy equal to each other in order to identify the specific heat capacity of the unknown metal.

$$Q_{lost} = Q_{gained} \qquad (mC\Delta T)_{lost} = (mC\Delta T)_{gained}$$

Analysis

What is the experimental specific heat capacity and identity of your unknown metal?

$$18.5 * C * (24.5 - 100) = 4.184 * 100 * (24.5 - 23)$$
$$C = 0.449, \qquad Copper$$

Find the percentage error for the experimental specific heat capacity.

16.3% error

What sources of error can be identified in the experiment?

- Poor insulation in calorimeter
- Impurities in water or metal
- Inaccurate measurements