Name: _____ Section: _____

Experiment 6 – Specific Heat Capacity

The heat absorbed by any sample of matter when its temperature rises by 1 ^{o}C is called its heat capacity. Clearly, the heat capacity of a sample depends on its mass; the greater the mass of a sample, the greater the amount of heat it must absorb to increase its temperature by one temperature degree. The heat capacity of one gram of a substance is called its specific heat capacity, which is measured in J/g ^{o}C or J/g K.

The molar heat capacity is the quantity of heat that must be absorbed by one mole of a substance to raise its temperature by 1 ^{o}C or 1 K. Its units are J/mol ^{o}C or J/mol K. The SI unit of energy is the Joule (J), where 4.184 Joules of heat are equal to 1 calorie. A calorie is defined as the energy required to raise 1 gram of water by 1 ^{o}C.

The relationship between the temperature change and the heat associated with the change is given by the equation: $Q = ms\Delta T$, where Q = heat, m = mass, s = specific heat, and ΔT represents the change in temperature ($T_{final} - T_{initial}$). In any experiment involving calorimetry, the amount of heat lost by the solid is equal to the amount of heat gained by the water. However, since heat loss is given a negative sign, we state that:

$$Q(gain) = -Q(loss)$$

This can also be represented by: $Q(gain) + Q(loss) = 0$.

Procedure

1. Weigh and record the mass of a DRY metal sample. Please note that the mass of the attached string WILL NOT affect your results.

2. Setup a water bath in 250-mL beaker with enough water to completely immerse the metal at ALL times and does not touch the bottom of the beaker. Add 2-3 boiling chips and bring to a boil. Place the loop of the string over an appropriate clamp to suspend the metal into the boiling water bath and allow the metal enough time to equilibrate to the temperature of the boiling water (about 5 minutes). After a constant temperature is observed, measure the temperature of the boiling water with a thermometer, noting how to correctly read its scale. This is the initial temperature of the metal sample and should be recorded to within 0.01^{o}C. Afterwards, remove the thermometer from the water bath, and allow it to cool gradually.

3. Weigh an empty calorimeter (two styrofoam coffee-cups nested together with a plastic cover as the top).

4. Add between 50-100 mL of water to the calorimeter (to completely immerse the metal sample). Weigh and record the mass of the calorimeter and water using the SAME analytical balance.

5. Place the styrofoam calorimeter into a glass beaker for added stability. Insert the thermometer through a hole in the calorimeter lid. Use a thermometer clamp to hold it in place while water equilibrates to a constant temperature (should remain constant for approximately 2 minutes). Occasionally swirl the water to obtain its average temperature. Record this equilibrium temperature to within 0.01 ^{o}C. Be careful not to place the calorimeter near the Bunsen burner.

6. Quickly and carefully place the hot metal into the water in the calorimeter. Carefully return the lid and thermometer to the calorimeter. Gently swirl the calorimeter while observing the temperature. Remove the thermometer from the clamp for this part and hold by hand so that the cup can be constantly swirled. Note the temperature immediately and continuously observe until a constant, HIGHEST stable temperature is reached. Record this final, highest temperature to within 0.01 ^{o}C.

7. Repeat the experiment. Use the same calorimeter and piece of metal. Pour out the original water from the calorimeter and add a fresh 50 – 100 mL portion of water. Weigh and record this new mass.

8. When completely finished, dry the calorimeter, thermometer, and metal sample. Return them to the lab cart. Be sure to place the metal in its correct container.

Name: _____ Section: _____

Data and Calculations for Experiment 6

Be sure to record all numerical values to the correct significant figures and include units!

Identification of metal _____

Mass of DRY metal _____

Mass empty calorimeter _____

Mass calorimeter with water _____

Mass water _____

Initial temperature of water in calorimeter _____

Initial temperature of hot metal
(before adding it to calorimeter) _____

Final temperature of water + metal
in calorimeter _____

ΔT_{water} _____

ΔT_{metal} _____

1. Calculate the experimental specific heat of the metal. Show Calculation and units:

2. Find the accepted value for the specific heat of your metal in the table below (from the *CRC Handbook of Chemistry and Physics*). Calculate the % error of your experimental specific heat.

Metal	Accepted s_{metal} (J/g °C)
Al	0.903
Cu	0.385
Zn	0.387