7.2A Coffee Cup Calorimetry II – Specific heat capacity of a Metal

Subjects: Thermodynamics, enthalpy, calorimetry, specific heat

Description: Using a coffee cup calorimeter, the specific heat of a metal is experimentally determined.

Materials:
Two Styrofoam coffee cups – nested, with 250 mL water
Lid or parafilm (w/ rubberband to secure parafilm)
Thermometer or thermocouple* – preferably with USB interface for transfer of data to computer
500 mL beaker
metal of known mass
tongs
250g mL graduated cylinder
hot plate or burner*

*Shared items. Located in the drawers opposite the storage shelves.

Procedure:
1. Measure 250 mL of water and pour it into the calorimeter.
2. Measure the temperature of water in the calorimeter.
3. Boil the water in the beaker
4. Add the piece of metal and allow the temperature to equilibrate
5. Remove the metal from the boiling water with the tongs and add to the calorimeter.
6. Measure the change in temperature of the water.
7. Calculate specific heat capacity

Discussion:
The purpose of this demo is to find the heat capacity of the metal. The equations for the calculations are given below. The system is defined as the water and the metal. The surroundings are defined as the cup and environment. Energy is transferred as heat from the metal to the water (q_m). The water absorbs heat and becomes warmer (q_w). Because we assume that no energy is lost to the surroundings and because of the law of the conservation of energy:

$q_m + q_w = 0.$

$q = C*m*\Delta T$ (C= heat capacity, m = mass, T = temperature)

$(C_{metal}*m*\Delta T) + (C_{water}*m*\Delta T) = 0$

By rearranging this equation, we can calculate the specific heat of the metal (C_{metal}).

Safety: Use caution handling boiling water and the hot metal to avoid burns.

Disposal: Metal can be cooled and used again.

References:
1. J. Kotz, P. Treichel, J. Townsend; *Chemistry & Chemical Reactivity* 7th ed. Instructors Edition; Brooks/Cole; 2009