

SPECIFIC HEAT / CALORIMETRY Experiment 7

INTRODUCTION:

A simple device for determining heats of reactions is a *calorimeter*. In its most basic form, it can be constructed from a Styrofoam coffee cup, with a piece of foil as covering for the top. The amount of heat gained or lost by a substance when it undergoes a change in temperature is calculated as the product of the mass of substance, its change in temperature, and its *specific heat*.

$$\text{Heat} = \text{mass} \times \Delta T \times \text{specific heat} \quad (1)$$

Specific heat of a substance is defined as the amount of heat required to raise the temperature of 1 gram of the substance 1 °C. According to the law of conservation of energy, the total amount of heat lost by a hot object equals the total amount of heat gained by the cold object with which it comes in contact. Consequently, in this experiment the total heat lost by the solid on cooling is the heat gained by the water and calorimeter as they are warmed.

APPARATUS & MATERIAL:

- balance
- Styrofoam calorimeter
- thermometer, -10°C to 110°C
- hot plate
- 400-mL beaker
- 2 samples of metal
- string

PROCEDURE:

1. Measure the mass of the first metal sample. Record in data table.
2. Attach a piece of string about 10 cm long to the metal and lower it into the 400-mL beaker, half filled with water. Be sure the sample is completely submerged in water.
3. Heat the beaker with water and metal on a hot plate to boiling. After the water comes to boil for a few minutes, measure the temperature of the boiling water. Since the metal block is being heated in the boiling water, its temperature is also the same. Record on data sheet as the initial temperature of metal.
4. While the water with the metal is heating up, determine the mass of the empty calorimeter (Styrofoam cup).
5. Fill the cup 2/3 full with cool tap water that is several degrees lower than room temperature. Determine the mass of the cup and the water and record in data table.
6. Stir the water in the cup, and record its temperature as initial temperature of the water.

PROCEDURE (CONT'D):

7. Lift the metal sample with the string and remove from the boiling water. Allow any water clinging to the metal to drip before quickly transferring the block to the Styrofoam cup containing the cool water.
8. Replace the foil cover on the cup, and carefully swirl the it to stir the water.
9. Measure the final temperature of the water in the cup after it has risen to its highest point. Record this temperature as the final temperature of the metal and water.
10. Repeat steps 1-9 with the second metal sample.

CALCULATIONS:

For each sample,

1. Determine the mass of water in the calorimeter.
2. Determine the temperature change of water and calorimeter.
3. Determine the heat gained by the water and the calorimeter using equation (1). Specific heat of water is 1.0 cal/g°C.
4. Determine the heat lost by the metal. Recall that the conservation of energy principle states that the heat lost by the metal is equal to the heat gained by the water.
5. Determine the specific heat of the metal using equation (1).

SPECIFIC HEAT OF SOME METALS

Metal	Specific heat (cal/g°C)
Aluminum	0.22
Brass	0.090
Copper	0.092
Iron	0.105

REPORT FORM

Experiment 7

DATA TABLE

	Sample 1	Sample 2
Identity of metal		
Mass of metal	_____ g	_____ g
Mass of empty of cup	_____ g	_____ g
Mass of cup and water	_____ g	_____ g
Temperature of metal (initial)	_____ °C	_____ °C
Temperature of cool water (initial)	_____ °C	_____ °C
Temperature of metal and water (final)	_____ °C	_____ °C

CALCULATIONS TABLE

	Answers (include units)		Show calculations for one sample here
	Sample 1	Sample 2	
Mass of water			
Temperature change of water			
Heat gained by water			
Heat lost by metal			
Temperature change of metal			
Specific heat of metal			

5. Use the true values for specific heat on page 2, and calculate the percent error for each of your samples.

6. How do the specific heats of the two samples compare to each other and to the specific heat of water? (Hint: Are they close and similar or are they very different? Try and relate your answer to the observed heating properties of water and metals.)