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***.

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

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 30 cm long to the metal and lower it into the 400-mL beaker, half filled with water.
3. Heat the beaker with water and metal on a hot plate to boiling. While the water with the metal is heating up, determine the mass of the empty calorimeter (Styrofoam cup).
4. Fill the calorimeter 2/3 full with water that is several degrees lower than room temperature.
5. Take 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.
6. Stir the water in the calorimeter and record its temperature as intial temperature of the water.

PROCEDURE (CONT'D):

7. Lift the metal sample with the string and lift out of the boiling water. Allow any water clinging to the metal to drip before quickly transferring the block to the calorimeter.
8. Replace the cover on the calorimeter, and carefully swirl the calorimeter to stir the water.
9. Measure the final temperature of the water in the calorimeter 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

Name:_____

REPORT FORM

Experiment 7

DATA TABLE

	Sample 1	Sample 2
Mass of metal	_____ g	_____ g
Mass of calorimeter	_____ g	_____ g
Mass of calorimeter and water	_____ g	_____ g
Temperature of metal (initial)	_____ ?C	_____ ?C
Temperature of water (initial)	_____ ?C	_____ ?C
Temperature of metal and water (final)	_____ ?C	_____ ?C

CALCULATIONS TABLE

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

Name:_____

QUESTIONS:

1. Why must the water clinging to the metal strip be removed before placing it in the calorimeter?

2. Why is the change in temperature of the water smaller than the change in the temperature of the metal?

3. A hot water bottle containing 500-g of water is cooled from 70?C to 20?C. How much heat is given off by the bottle while it cools?

4. Same amount of heat is added to the same amount of two different materials. Do you expect the temperatures of the two materials to be the same or not? Explain your answer.

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.)