Lab [15 pts] **Name** ____________________________
Specific Heat **Period** ______ **Date**________

Introduction:

Chemists identify substances on the basis of their chemical and physical properties. One physical property of a substance is its specific heat. Specific heat is the amount of energy needed to raise the temperature of one gram of the substance by one Celsius degree. Often applied to metallic elements, specific heat can be used as a basis for comparing energy absorption and transfer.

A calorimeter (a well-insulated container) is used to measure energy changes. The calorimeter is insulated to reduce the loss of gain of energy to or from the surroundings. Since energy always flows from on object at a higher temperature to an object at a lower temperature,

heat lost by warmer object = the heat gained by cooler substance.

In this experiment, you will determine the specific heat of a metal. This will be done by heating up a metal sample, placing the hot metal in cold water and measuring how warm the water gets. You will make the proper measurements and use the equation, **$q = (m)(c)(\Delta T)$** to solve for the specific heat of the metal.

Procedure: *(heat up a metal sample-- place hot metal in cold water-- measure how warm the water gets)*

1) Fill a 400 mL beaker about ¾-full of water. Place the beaker on a hot plate so it comes to a boil.
2) Find the mass of your metal sample and vial.
3) Place the metal into a large test tube, stopper it and place the test tube into the beaker of boiling water. Be sure the entire metal sample is below the surface of the water. While metal is heating up, move on to steps #4-6.
4) Mass your empty vial and determine the mass of your metal
5) Obtain a polystyrene foam cup (your calorimeter) and record its mass.
6) Fill the calorimeter about half full with cold tap water and record total mass.
7) After the metal has been in the boiling water for at least 10 mins, record the temperature of the hot metal. *Note: The hot metal is in the boiling water. Thus, temp of hot metal = temp of boiling water.*
8) Measure the temperature of the cold tap water in the calorimeter. Record temp.
9) Make sure thermometer is still in the cold water. Now, carefully remove the metal from the boiling water and immediately put the hot metal into the cold water in the calorimeter.
10) Use the thermometer to carefully stir the water in the calorimeter. (Be careful not to poke through!)
11) Monitor the temperature of the water. Record the highest temperature reached.
12) Remove metal from water, clean up and return all materials.

Data: [1pt]

Metal	**Water**
type of metal used ____________________	mass of calorimeter____________________
mass of metal + vial: ____________________	mass of calorimeter + water____________________
mass of vial: ____________________	mass of water ____________________
mass of metal ____________________	temperature of cold water____________________
temperature of hot metal____________________	final temperature of water ____________________
final temperature of metal____________________	

Calculations: [4 pts] ***Show all work on a separate sheet of paper. Every number must have units!***

a) Calculate the heat gained by the water in the calorimeter. (Keep 4 sig figs.)

Remember: heat gained by water = (mass of water) (specific heat of water) (ΔT of water)

Also: The specific heat of water is 4.184 J/g·°C

b) How much heat was lost by the metal? Briefly explain (no calc!) your answer in words. (Keep 4 SF.)

c) Calculate the specific heat of the metal. (Keep 2 sig figs.)

Remember: heat lost by the metal = (mass of the metal) (specific heat of the metal) (ΔT of the metal)

d) Calculate the percent error of your specific heat value for your particular metal. (Keep 2 sig figs.)

Accepted specific heat values of metals:

Nickel = 0.44 J/g·°C	*Aluminum = 0.90 J/g·°C*	*Lead = 0.16 J/g·°C*	*Iron = 0.451 J/g·°C*
Copper = 0.38 J/g·°C	*Tin = 0.21 J/g·°C*	*Zinc = 0.39 J/g·°C*	

Post Lab Questions: *[10 pts]* ***Answer on separate sheet. For all calculations, you must show all work, all numbers must have units, and all final answers must have correct significant figures.***

List of accepted specific heat values needed for post lab questions:
water = *4.184 J / g·°C* **aluminum** = *0.90 J / g·°C* **iron** = *0.451 J / g·°C*

1) Which substance takes more heat to warm up to the same temperature (assuming same mass)-- water or aluminum? Explain your answer in a couple of sentences. (Refer to specific heats above.)

2) Give two quantitative physical properties, other than specific heat, that one could measure to help confirm the identity of the metal you used in this lab?
Note: Qualitative properties, such as color and texture, would not be acceptable answers.

3) How much heat energy, in kJ, are required to heat 500.0 g of aluminum foil from 25.0°C to 250.0°C?

4) Calculate the specific heat of a metallic element if 314 joules of energy are needed to raise the temperature of a 50.0 g sample from 25.0°C to 50.0°C.

5) Suppose you pick up a 16-pound ball of iron (such as a "shot-put" ball). The iron ball has the same temperature as the atmosphere on a cool day, 16°C. How many kilojoules of heat energy must the iron ball absorb to reach the temperature of your body, 37°C? (1 pound = 454 g)

6) *A 192 g piece of an unknown metal was heated to 100.0°C in a boiling water bath, and then it was dropped into a beaker containing 750 g of water at 4.0°C. The temperature of the water rises to 6.0°C. What is the specific heat of this unknown metal? *(Use units of J/g·°C)*

7) One way to cool down your cup of coffee is to plunge an ice-cold piece of aluminum into it. Suppose you store a 20.0 g piece of aluminum in the refrigerator at 4.4°C and then drop into your coffee. The temperature of your coffee drops from 90.0°C to 55.0°C. How many kilojoules of heat energy did the aluminum block absorb? ***HINT****: The temperature of the aluminum rose from 4.4°C to 55.0°C. You only need to use the formula once!!*

8) *A 400.0 g piece of iron is heated in a flame and is then plunged into a beaker containing 1000.0 g of water. The original temperature of the water was 20.0°C, but it is 32.8°C after the iron bar is dropped in. What was the original temperature of the hot iron bar?

** These two questions require you to use the $q = mc\Delta T$ equation twice—once for the water and once for the metal.*