Name _____ Hour _____

Calorimetry Lab

Honors Chemistry

Introduction

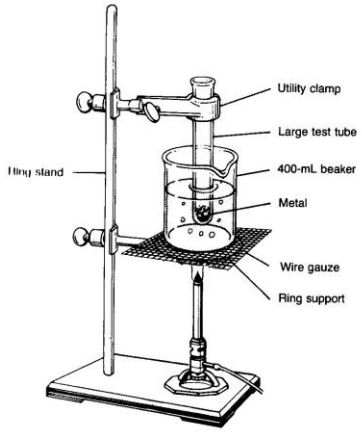
Chemists identify substances on the basis of their chemical and physical properties. One physical property of a substance is the amount of energy it will absorb per unit of mass. This property can be measured quite accurately and is called specific heat (Cp). Specific heat is the amount of energy measured in joules, needed to raise the temperature of one gram of the substance one Celsius degree. Often applied to metallic elements, specific heat can be used as a basis for comparing energy absorption and transfer.

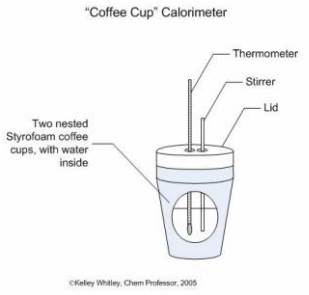
To measure specific heat in the laboratory a calorimeter of some kind must be used. A calorimeter is a well-insulated container used in measuring energy changes. The calorimeter is insulated to reduce the loss or gain of energy to or from the surroundings. Energy always flows from an object at a higher temperature to an object at a lower temperature. The heat gained by the cooler substance equals the heat lost by the warmer substance, if we assume no loss of heat to the surrounding environment. (heat lost = heat gained)

In this experiment, you will determine the specific heat of a metal sample. The metal sample will be heated to a high temperature then placed into a calorimeter containing a known quantity of water at a lower temperature. Having measured the mass of the water in the calorimeter, the temperature change of the water (ΔT) and knowing the specific heat of water (4.184 J/g °C) the heat gained by the water (lost by the metal) can be calculated as follows: (q= mass x C x ΔT)

MATERIALS

safety goggles	utility clamp
400-mL beaker	100-mL graduated cylinder
ring stand	styrofoam cup
Centigram balance	250-mL beaker
Apron	thermometer
Hot Plate	Large test tube
Lead shot	distilled water





SAFETY FIRST!

In this lab, observe all precautions, especially the ones listed below

- Caution: Wear your safety goggles and apron. (All steps.)
- Caution: Lead is a toxic metal. Wash your hands thoroughly after use.
- Caution: Do not touch hot equipment.
- Caution: If you should break a thermometer, immediately report the incident to your teacher.
- Return or dispose of all materials according to the instructions of your teacher.

- **Lab Procedure:** ***(Read Carefully)***

Step 1: Using a hot plate, heat 250-mL of water in a 400-mL beaker until it is boiling.

Step 2: While the water is heating, measure the mass of the lead and record your mass in the data table

Step 3: Place the lead sample in a large dry test tube and use a utility clamp to suspend it in the boiling water. Make sure the lead is below the level of the water and heat the lead for 12 minutes.

Step 4: Obtain 100-mL of water. Record its mass your data table

Step 5: Place your 100-mL sample of water in a Styrofoam cup and record the temperature after 10 minutes of sitting at room temperature. That is our initial temperature of the water in the cup.

Step 6: After 12 minutes of heating, take the temperature of the boiling water. That is our initial temperature of the heated lead. We are assuming the boiling water and lead have the same temperature.

Step 7: Using your gloves, add the hot lead to the room temperature water in the Styrofoam cup and immediately place the lid on top and begin stirring with the thermometer.

Step 8: Record the maximum temperature of the lead and water in the cup. This is the Final Temperature of the lead/water mixture

Step 9: Repeat these steps for each trial using a different sample of lead.

Pre Lab Questions

1) What is the purpose of this lab?
2) Can specific heat be used to help you identify unknown metal samples? Explain why or why not?
3) Why is water an excellent material to use in the calorimeter?
4) Why do you think we are using a Styrofoam cup in this experiment?
5) What substance will lose heat in this experiment?
6) What substance will gain heat in this experiment?
7) Predict whether the lead or water will have a greater change in temperature. Explain your answer.
8) Explain what “low specific heat” means in terms of heat retention and heat requirements.

Data Table: Measurements of Mass and Temperature		
	Trial 1	**Trial 2**
Mass of Lead		
Initial Temperature of Water in Cup		
Initial Temperature of Lead		
Final Temperature of Lead and Water Mixture		
Mass of Water		

Calorimetry Lab Data Sheet

Honors Chemistry

Data Table: Measurements of Mass and Temperature		
	Trial 1	**Trial 2**
Mass of Lead		
Initial Temperature of Water in Cup		
Initial Temperature of Lead		
Final Temperature of Lead and Water Mixture		
Mass of Water		

Using the above data, answer questions 1 – 7. You MUST show all work!!!

1. Determine the change in temperature *(in ºC)* of the water.

2. Determine the change in temperature *(in ºC)* of the lead.

3. Calculate the heat gained *(in joules)* by the water. *(Hint: use the formula that has a temperature change)*

4. Calculate the specific heat *(in J/g x ºC)* of the lead. *(Hint: the "q" of lead is the "q" of water)*

5. Using the accepted value for the specific heat of lead, what is the percent error?
   (The accepted value for the specific heat of lead is: $C_{lead} = 0.13$ J/g x ºC)

$$\frac{\text{Experimental – accepted}}{\text{accepted}} \times 100$$

6. Of all the data collected, which was most likely to have been wrong due to lab error? Explain.

7. You assumed the temperature of the lead was the same as the boiling water. If the temperature of the lead was slightly lower than the water, how would your specific heat of lead be affected?

8. Compare your values for the specific heat of lead with the data collected by your classmates.Can specific heat be used to identify substances? Explain why or why not using data collection.