Honors Chemistry Hour\_\_\_\_\_ Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  
Dr. Wexler  
Lab: Heat Capacity of a Metal  
Date\_\_\_\_\_

Chemists identify substances on the basis of their chemical and physical properties. One such physical property is specific heat capacity (Cp), which is the amount of heat energy needed to raise the temperature of one gram of a material by one degree celsius. In this lab, a foam cup calorimeter will be used to determine the change in temperature of water when hot metal is added to the water. This represents the transfer of heat (q) from the metal to the water. Based on the law of conservation of energy, heat released by a hot object (metal) must be equal to the heat absorbed by a cool object (water in calorimeter); that is, qlost by metal = qgained by water

Since the specific heat of water is known, the specific heat of a metal can easily be determined experimentally using the formula mcH2OΔT to determine qgained, the heat gained by water. Since qgained by water = qlost by metal = mcmetalΔT, it is a simple matter to calculate cmetal from the data.  
Note: m = mass in grams  
 c = specific heat  
 ΔT = change in temperature in degrees Celsius  
 CH2O = 4.18 Joules/g•°C  
 q (heat) = mcΔT  
 Law of Conservation of Energy: qlost = qgained

Purpose: The purpose of this experiment is to determine the identity of metals based on their specific heat capacities.

Materials:   
foam cup calorimeter  
500mL beaker  
Temperature probe/SPARK digital sensor   
Ring stand   
Bunsen burner  
Tongs  
Four unknown metals: labeled 1, 2, 3, 4

Procedure:

1. Weigh each piece of metal  
2. Fill the beaker between one half to two-thirds full of water and place all four metals in the water. Bring to a boil. Assume the temperature of the water and the metals is 100°C.  
3. Add exactly 100. mL water to the foam cup calorimeter and insert the temperature probe.  
4. Stir briefly with the probe. Record the temperature.  
5. Transfer one of the hot metals to the calorimeter using tongs. Be extremely careful to drop the metal into the calorimeter without touching the water with the tongs because otherwise heat from the tongs will enter the water and alter your data.  
6. Monitor the rise in temperature using the SPARK device. Swirl carefully (don’t spill) to distribute the heat until the temperature no longer rises.  
7. Record the maximum temperature obtained.  
8. Repeat with the other three metals. Be sure to remeasure the temperature of the water each time.

Data:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Unknown Metal | mmetal (g) | mH2O (100mL = 100g since dH2O = 1.0g/mL) | TH2O (before heating) (°C) | TH2O (after heating) (°C) | ΔTH2O (°C) = TH2O (after) - TH2O (before) | ΔTmetal (°C) = 100°C - TH2O (after) |
| 1 |  | 100g |  |  |  |  |
| 2 |  | 100g |  |  |  |  |
| 3 |  | 100g |  |  |  |  |
| 4 |  | 100g |  |  |  |  |

Calculations:

1. Calculate qlost by metal: the amount of heat (joules) gained by the water = the amount of heat lost by the metal (Law of Conservation of Energy).   
Note: cH2O = 4.18 Joules/g•°C

qgained by water = mH2O x cH2O x ΔTH2O = 100g x 4.18 J/g•oC x ΔTH2O = qlost by metal

Unknown Metal 1

Unknown Metal 2

Unknown Metal 3

Unknown Metal 4

2. Calculate the specific heat of each metal in J/g•oC  
qlost by metal = mmetal x cmetal x ΔTmetal

Rearrange the above equation to solve for cmetal :

Calculate cmetal for each unknown:

Unknown Metal 1

Unknown Metal 2

Unknown Metal 3

Unknown Metal 4

Conclusions:

Identify each of the unknowns based on the following table:

**Specific Heat Capacity Table**

|  |  |
| --- | --- |
| **Substance** | **Specific Heat Capacity**  **at 25oC in J/goC** |
| **magnesium** | **1.020** |
| **aluminum** | **0.900** |
| **calcium** | **0.650** |
| **iron** | **0.444** |
| **zinc** | **0.39** |
| **copper** | **0.385** |
| **lead** | **0.160** |

|  |  |  |
| --- | --- | --- |
| Unknown metal | cmetal (J/g•°C) | Identity of Metal |
| 1 |  |  |
| 2 |  |  |
| 3 |  |  |
| 4 |  |  |

**Required Questions:**

1. Determine the specific heat of a metal if 200 g of the metal is heated to 80oC and then put into a foam cup with 100 g of water at 25.0oC. The temperature of the water rises to 28oC. (Show all calculations! Be organized! Show all units!)

2. Using the actual specific heat of aluminum from the Specific Heat Capacity Table above, determine the mass of a piece of aluminum from the following data:

temp. of hot metal = 102.5oC  
mass of water in calorimeter = 36.8 g   
initial temp. of water in calorimeter = 25.0oC  
final temp. of water in calorimeter = 28.5oC