Chemistry

Scarsdale Alternative School

Heat Capacity

Objective:
Using the heat transfer equation, calculate the specific heat of an object in order to determine the material's composition.

Task:
Perform the attached lab.

Materials:
1. See attached lab procedure

Lab Report:

PRESENTATION COUNTS

Lab reports must be fully integrated and in the proper order. Either redraw the appropriate tables or cut and paste them into your lab. Stapling this lab handout to your work is NOT acceptable.

File Name: SHS_HC_LB_sec#_HeatCapacity_Lname

Share to: jwilliams@scarsdaleschools.org

1. Introduction
2. Results and Observations
3. Conclusion
4. References

Due Date: See Schedule

Note: Do not email the lab rubric – they will NOT be accepted. You must fill out the rubric and submit a paper copy to me in class or put a copy in my mailbox before the end of the due date.

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Heat Capacity

Introduction

Objects can either absorb or release heat to their surroundings. In this lab, the specific heat of an unknown metallic object will be determined using the heat transfer equation:

$$Q = m\ C\ \Delta T$$

Where Q represents the heat transferred, m is the mass of the object, C is the specific heat of the object and ΔT is the change in the temperature of the object.

In this lab, you will heat the unknown metal object in water so that the object has come to thermal equilibrium with the water. The object is then moved to a cup of water and the change in temperature is measured. By knowing the mass of the water, the specific heat of the water and the measured temperature change, the heat absorbed by the water is equal to the heat released by the unknown object. Using the mass of the unknown object and its change in temperature, the specific heat of the unknown material can be calculated. This calculated value can be compared to a reference table in order to determine the composition of the unknown material.

In order to confirm this, the density of the object can be easily determined. When this information is compared to a reference table, the composition of the unknown material has two independent tests from which to make the determination.

Reference:	Specific heat (Cp):	Water	4.18 J/g * °C
		Styrofoam	20.9 J/g * °C

Materials

1. Hot plate
2. Unknown metal samples
3. Beaker tongs
4. Calorimeter
5. LabQuest with Temperature Probe
6. Calculator
7. Reference tables
8. 250 mL beaker

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Procedure

1. Warm about 500 mL of tap water (to approximately 45 °C) in a beaker on the hot plate.

2. Select an unknown metal sample
    a. Record the sample's mass
    b. Measure the sample's volume
    c. Calculate the sample's density

3. Measure and record the temperature of the warm water

4. Place the unknown metal samples in the warm water and let it reach thermal equilibrium with the water

5. Weigh an empty Calorimeter and record its mass to the nearest 0.01g.

6. Place enough tap water (~100 mL) into the Styrofoam cup so that the metal sample will be completely submerged in the water. Measure the mass of the cup and water together.

7. Insert the temperature probe into the water and start recording the temperature.

8. Using beaker tongs to grasp the metal sample in the warm water, place the metal sample into the Calorimeter with the water.

9. Stir the water gently. Stop recording the LabQuest when the temperature of the water begins to decrease.

10. Remove the metal sample and dry it.

11. Repeat the experiment 3 times.

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Experimental Data Table	Warm Water Temp	Mass of the Metal Sample	Volume of the Metal Sample	Mass of the Styrofoam cup	Mass of the Styrofoam cup and water	Initial temperature of the water	Final temperature of the water
Measurement Units							
Trial 1							
Trial 2							
Trial 3							
Trial 4							

Calculations

<u>(For each calculation, show your work in your lab report.)</u>

1. Record the mass of the water in the Styrofoam cup (calorimeter).

2. Record the mass of the metal sample

3. Determine the change in temperature?

4. Determine the heat energy transferred from the metal sample to the water?

   $$Q = m * C_{H2O} * \Delta T$$

   where m is the mass of water in the cup and $C_{H2O} = 4.18$ J / g * ˚C

5. What large assumption did we make when calculating the heat energy transferred from the metal sample to the water? Is it a valid assumption? How could you test this assumption?

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6. Calculate the heat (Joules) **absorbed** by the water in the Styrofoam cup:

Trial	Mass $H_20_{(l)}$ (g)	Mass $Metal_{(s)}$ (g)	ΔT (˚C)	Heat: Q (J)
1				
2				
3				
4				

7. Calculate the specific heat of the unknown metal sample:

$Q_{H2O} = Q_{metal} = m_{metal} * C_p * \Delta T$

Trial	Heat: Q (J)	Mass $Metal_{(s)}$ (g)	ΔT (˚C)	Specific Heat C_{metal} (J / g * ˚C)
1				
2				
3				
4				
			Ave C_{metal}=	

8. Determine the percent error for the average experimental value compared to the accepted value (You must look up the possible specific heat values for the metals):

    a. Calculated Specific Heat value: ______________________________

    b. Calculated Density of metal: ______________________________

    c. Accepted Specific Heat value: ______________________________
    (Look up value in reference table)

    d. Percent error: ______________________________

    e. Accepted Density value ______________________________
    (Look up value in reference table)

    f. Percent error: ______________________________

Remember to include and show your calculations in your lab report!!!

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Specific Heat Calculation

Materials

1. Hot plates (x7)
2. Styrofoam calorimeters (x8)
3. LabQuest (x8)
4. Temperature probes (x8)
5. Metal blocks: Al, Cu, Pb, Fe (x8)
6. Stiring rods (x10)
7. 400 ml beakers (x10)
8. 600 ml beakers (x10)
9. Beaker tongs (x8)