Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Date:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Time:\_\_\_\_\_\_\_\_\_\_\_\_

Partner's Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Specific Heat and Latent Heat**

**Purpose:** To determine the specific heat of metals and the latent heat of fusion of ice by the method of calorimetry.

**A. Specific Heat**

Apparatus: Calorimeter with lid (negligible specific heat), metal objects (Al, Fe, Cu, Pb), temperature sensor, PC w/interface, electronic balance, hot plate, beaker (400-mL), room-temperature water, and thread.

Theory:
In this experiment the metal object will be heated in boiling water (temperature = 1000C) and transferred to the calorimeter cup with water. The rise in temperature will be measured with a temperature sensor. In order to calculate the specific heat you need to derive an expression for the specific heat of the metal, Cm in terms of measurable quantities.



In the space below **derive** an expression for the specific heat of the metal, Cm in terms of the following measurable quantities:
Mm = mass of the metal object, temperature of the hot metal (1000C), Tf = final temperature of the metal object, Mw = mass of water, Cw = specific heat of water, Ti = initial temperature of the calorimeter cup and water, Mc= mass of the calorimeter cup, Cc= specific heat of the calorimeter cup, Tf = final temperature of the calorimeter cup and water.
 

Procedure:

1) Fill the beaker with tap water (about 4/5 full), place it on the hot plate, and bring the water to boil.

2) Find the mass of a metal object.

3) Find the mass of the calorimeter. Fill it with room-temperature water (about 2/3 full) and find the mass of the calorimeter with water.

4) Tie a piece of string to the metal object and immerse it in the boiling water. Make sure that the metal is completely immersed and not to touch the bottom or sides of the beaker. You need to hold the metal in the boiling water for about 2-3 minutes, to make sure its temperature reaches the boiling point of water.

****

5) While you are holding the metal in the boiling water, let your partner measure the initial temperature of the calorimeter cup and water by following procedures 6 & 7.

6) To measure temperature:
a. Make sure that the power for the interface is turned on.
b. Plug in the temperature sensor to analog input A, white arrow on top.
c. Open **PASCO Capstone** software from the desktop.
d. Click **Hardware Setup** under Tools on the left, click on the interface input where the sensor is connected and select **Temperature Sensor**. Click **Hardware Setup** again to close it.
e. Double-Click **Digits** under Displays on the right, click **Select Measurement**, and select **Temperature**.
f. Click **Record**.

7) Place the temperature sensor inside the calorimeter cup and record the initial temperature of the calorimeter cup and water, Ti, to the nearest tenth of a degree.

8) Open the lid and transfer the metal object from the boiling water, quickly to the calorimeter cup. Try to minimize the heat loss to the room. Close the lid, stir the water with the temperature sensor, and watch the temperature until the temperature stabilizes. Record this equilibrium temperature. (Tf)

9) Calculate the specific heat and compare it with the accepted value. If the % error is high consult the instructor.

10) Repeat procedures 2-9 for the other metal object, using fresh tap-water each time.

**DATA:**

Specific heat of the calorimeter cup material = Cc = 0.215 cal/(g.C0)

Specific heat of water = 1.0 cal/(g.C0)

Mass of the calorimeter cup = Mc =\_\_\_\_\_\_\_\_\_g.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Type of metal……………………….->** | **Aluminum** | **Iron** | **Copper** | **Lead** |
| mass of the metal object, Mm |  |  |  |  |
| mass of (calorimeter + water) |  |  |  |  |
| mass of water, Mw |  |  |  |  |
| initial temperature of water, Ti |  |  |  |  |
| final temperature of water, Tf |  |  |  |  |
| calculated specific heat, Cm [cal/(g.C0)] |  |  |  |  |
| accepted specific heat [cal/(g.C0)] | 0.215 | 0.108 | 0.093 | 0.031 |
| percent error |  |  |  |  |



**B. Latent Heat of fusion of Ice**

Apparatus: calorimeter with jacket, water, ice cube, temperature sensor, PC w/interface, and, electronic balance.

Theory: In this part ice at 00C (mass Mi) will be added to a calorimeter cup (mass Mc) with water (mass Mw).



In the space below, **derive** an expression for the latent heat of fusion of ice,Lf.
 (Use the following measurable quantities: Mi - mass of ice, Lf - latent heat of fusion of ice, Cw - specific heat of water, Tf - final temperature of water, Mc- mass of the calorimeter cup, Cc- specific heat of the calorimeter cup, Ti- initial temperature of the calorimeter cup, Tf - final temperature of the calorimeter cup, Mw- mass of the water, Cw- specific heat of the water, Ti- initial temperature of water, Tf - final temperature of water)

Procedure:

1) Find the mass of the calorimeter cup.

2) Fill the calorimeter 1/2 full of room temperature water and find the mass of the calorimeter with water.

3) Place the calorimeter cup with water in the calorimeter jacket and put on the lid. Record the temperature of the water, Ti, to the nearest tenth of a degree.

4) Add a cube of ice to the water. Watch the temperature while stirring and record the minimum temperature reached, Tf. Make sure the ice cube is completely melted.

5) Find the mass of the calorimeter, water, and melted ice.

6) Compute Lf and its percent error.

7) Write a combined conclusion for both activities.

DATA

|  |  |
| --- | --- |
| Specific heat of the calorimeter cup |   |
| Mass of the calorimeter cup |   |
| Mass of the calorimeter cup with water |   |
| Mass of water |   |
| Initial temperature of water |   |
| Final temperature of water  |   |
| Mass of the calorimeter cup, water, and melted ice |   |
| Mass of ice  |   |
| Calculated L*f*  |   |
| Accepted L*f*  | 79.5 cal/g |
| % Error    |   |