Specific Heats and Latent Heat (Heat of Fusion of Water)

Name_____ ID_____ TA_____

Partners_____

Date_____ Section_____

Caution

Use extreme caution when you handle the hot water, otherwise it may result in serious personal injuries. If you are not sure how to handle the containers with hot water, ask TA to pour the water for you.

ⓘ Use the SI units, kg, °C (or K), and J. through this lab. 🌡

1. Specific heat of solid materials

Hints:

1. Spend a sufficient time to make a material warmed completely.
2. Use the right amount of cold water (just enough to cover the whole material). If you use too much cold water, the temperature rise of the cold water will be only a degree or two.
3. Read temperatures up to 1/10 of a degree with the thermometer.
4. Heat radiates easily, so transferring solid into water material should be done quickly.
5. After each trial, calculate the specific heat. Then for next trial, improve your experiment in order to obtain a better result.

The Formula of Specific Heat of Solid Materials

$$C_m = \frac{M_W C_W (T0 - T_W)}{M_m (T_m - T0)}.$$ where C_W = 4186 J / kg ·°C (Specific Heat of Water).

Mass of the calorimeter: M_{cal} _____

- **Material 1** _____

Mass of the material Mm	Total mass of calorimeter and cold water	Net mass of cold water Mw	Initial temperature of material Tm	Initial temperature of cold water Tw	Final temperature T0	Specific heat of the material Cm (J/kg.°C)	% difference $\frac{\lvert \text{ex. value-ref.} \rvert}{\text{ref. value}} \times 100$

- **Material 2** _____

Mass of the material Mm	Total mass of calorimeter and cold water	Net mass of cold water Mw	Initial temperature of material Tm	Initial temperature of cold water Tw	Final temperature T0	Specific heat of the material Cm (J/kg.°C)	% difference $\frac{\text{ex. value-ref.}}{\text{ref. value}} \times 100$

Specific heat reference values

Material	Lead	Iron	Copper	Aluminum
Cm (J / kg·°C)	128	448	387	900

2. Latent Heat (Fusion of Water)

Hints:
1. Always use the lid for the cup.
2. Read temperatures up to 1/10 of a degree.

Weight of the cup for "warm water": M_{cup} =_____(kg)

Warm water + cup, M_{w+cup} =_____(kg)

Net mass of warm water, $M_w = M_{w+cup} - M_{cup}$ =_____(kg)

Initial warm water temperature, T_1 =_____(°C)

Final water temperature, T_2 =_____(°C)

Mass of water + cup + melted ice, M_{total} =_____(kg)

Melted ice, $M_i = M_{total} - M_{w+cup}$ =_____(kg)

Heat of fusion = $\frac{M_w C_w (T_1 - T_2) - M_i C_w (T_2 - 0)}{M_i}$ = _____(J/kg)

(The ref. value: 3.33×10^5 J/kg)

Lab Procedure for Specific Heats and Latent Heat

Specific Heat of Solid Materials

1. **Weigh the solid materials provided.**
   This is the procedure to get Mm on the data sheet.
2. **Take an appropriate amount of hot water, and put a material into there to make it warm.**
   This is a procedure to get Tm on the data sheet. The water should be half of the small cup. You should wait several minutes for this even if it is stabilized.
3. **Take cold water with the large mug cup, weigh the total mass, and measure the temperature.**
   The water should be 1/3 of the large cup. If you subtract M_{large} from this, you will obtain Mw. And this temperature will be Tw.
4. **Measure the temperature of hot water containing a material.**
   After you wait for several minutes to make a material completely warmed, you will take a data for Tm.
5. **Pick up the material from the hot water, and put it into the cold; then stir it properly.**
   Heat radiates easily. Therefore, you should conduct this process as quickly as possible.
6. **Measure the cold water temperature containing the warmed material.**
   After stabilized, pick out the temperature for T0.
7. **Calculate the specific heat of material.**
   You can use the formula, $C_m = \frac{M_W C_W (T0 - T_W)}{M_m (T_m - T0)}$, for this.
   However, C_W = 4186 J / kg ·°C (Specific Heat of Water)
8. **Calculate also the percent difference for each trial.**
9. **Repeat the process for the other material(s).**

Heat of Fusion of Water

1. **Weigh the small cup without water.**
   This is to obtain the net mass of water, and the mass of melted ice.
2. **Take warm water with the small cup.**
   That should be a half of the cup.
3. **Weigh the total mass.**
   This is for M_{w+cup}. Always use the lid to minimize the radiation of heat.
4. **Measure the initial temperatures.**
   This data will be T_1. It will take a couple of minutes to be stabilized.
5. **Take a right amount of ice, and remove the excess water on ice before putting into the warm water; then measure the final temperature.**
   The equilibrium state of water and ice makes 0 °C. Slip ice into the cup gently, and shake the cup slowly to minimize the radiation. Then take the stabilized temperature, T_2.
6. **Calculate heat of fusion of water.**
   Follow the data sheet to calculate them.

- **Lab Report**

Discuss the experimental results from the percent difference. Make sure if you obtained the good value for specific heat of a material compared with the reference values. If not, please discuss why. If you have any insights about this based on your studies and jobs, please write them down in the discussion.