

Latent Heats

Name _____ ID _____ TA _____

Partners _____

Date _____ Section _____

Caution

Keep flammable stuff away from the heater. And use extreme caution when you handle the hot water and beaker. If you are not sure how to handle the beaker with hot water, ask me to pick it up for you.

Please use the units, g, °C, and Cal. through this lab.

1. Heat of Fusion of Water

Weight of the cup for “warm water”: $M_{cup} =$ _____ (g)

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

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

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

Final water temperature, $T_2 =$ _____ (°C)

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

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

Heat of fusion = $\frac{M_w(T_1 - T_2) - M_i(T_2 - 0)}{M_i} =$ _____ (cal/g)

Hints:

1. Please use the lid of cup always.
2. When reading temperatures, estimate to 1/10 of a degree. Not just the whole numbers.

2. Heat of Vaporization of Water

Mass of: beaker + lid = _____ (g) ←(1) Water + beaker + lid = _____ (g) ←(2)

Water, $M_w = (2) - (1) =$ _____ (g)

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

Temperature change with time:

Time t (s)	Temperature T (°C)
0(sec.)	$T_1 \rightarrow$
60(sec.) [1 min.]	
120(sec.) [2 min.]	
180(sec.) [3 min.]	
240(sec.) [4 min.]	
300(sec.) [5 min.]	
360(sec.) [6 min.]	
420(sec.) [7 min.]	

Put the temperature data on the Excel sheet from the time 120 (s) to 420 (s).

Slope: $\Delta T / \Delta t =$ _____ (°C/s)

Rate of heat transfer to water is

$$\Delta Q / \Delta t = M_w \times (1 \text{ cal/g} \cdot \text{°C}) \times (\Delta T / \Delta t) = \text{_____ (cal/s)}$$

The time interval after boiling, from time, t_1 to t_2 should be 10 minutes (600 seconds).

The time when the temperature reaches 100 °C, $t_1 =$ _____ (s)

The time to stop boiling, $t_2 = t_1 + [10 \text{ minutes (600 seconds)}] =$ _____ (s)

Final mass of: water + beaker + lid = _____ (g) Water, $M'_w =$ _____ (g)

Evaporated water, $(M_w - M'_w) =$ _____ (g)

$$\text{Heat of vaporization} = \frac{(\Delta Q / \Delta t) \times (t_2 - t_1)}{M_w - M'_w} = \text{_____ (cal/g)}$$

Lab Procedure for Latent Heats

Part 1. 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} . You should 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 make it dry to put into the warm water; then measure the final temperature.**
The equilibrium state of water and ice makes $0\text{ }^{\circ}\text{C}$. 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.**
You can just follow the data sheet to calculate them.

Part 2. Heat of Vaporization of Water

- 1. Make the lid of a beaker with aluminum foil, and weigh those.**
The lid minimizes heat radiation and unwanted vaporization.
- 2. Take warm water from the faucet with a beaker; and weigh the total mass.**
The amount should be between $250\text{m}\ell$ and $300\text{m}\ell$.
- 3. Measure the initial temperature of the water for T_1 .**
It should likely be from $30\text{ }^{\circ}\text{C}$ to $40\text{ }^{\circ}\text{C}$.
- 4. Leave the thermometer in the beaker, and cover it with lid; then start heating up and measuring time.**
Turn on the heater to be the maximum. Simultaneously, start the stopwatch.
- 5. Measure the each temperature with respect to the specified time.**
You can keep the stopwatch going. At every minute, just read the temperature until one digit. (For example, $72.3\text{ }^{\circ}\text{C}$.)
- 6. When the temperature reaches $100\text{ }^{\circ}\text{C}$, write down the time as t_1 , and take the thermometer and lid away from the beaker; then wait for 10 minutes.**
After boiling, the water should be reduced by vaporization. The time to be waited should be 10 minutes.
- 7. After 10 minutes, turn off the heater, and pick up the beaker and put it on a balance; then cover it with lid immediately.**
You should be very careful about this. To pick up the beaker, you can use tongs and a small towel. If you do not have confidence in doing this process, please ask me.
- 8. Weigh the final mass of "beaker + lid + water" in order to obtain the final net mass of water.**
- 9. Put your data taken in procedure 5. on the Excel sheet, and obtain the slope.**
To calculate heat of vaporization of water, you have to get the rate of temperature change, which is the slope of the graph, T vs. t .
- 10. Calculate heat of vaporization of water.**
You can just follow the data sheet to get the final result. The time interval, $t_2 - t_1$ is 600 seconds (10 minutes) as specified.

- **Lab Report**

How well do your results in part 1 and 2 agree with the reference values?

Ref. Values: Heat of fusion of water $\rightarrow 80\text{ cal/g}$; Heat of vaporization of water $\rightarrow 540\text{ cal/g}$