Lab7
Latent heat of Fusion of Ice
Physics 132 Lab

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0.1 Purpose

This experiment makes use of measuring the heat capacity of a calorimeter in order to improve the accuracy of a measurement of the latent heat of fusion of ice. In such a mueasurement, the heat transfers between ice, water, the calorimeter and the environment are given by:

$$Q_{water}(T_i \to T_f) = m_{water} \int_{T_i}^{T_f} c_p(T)dT \tag{1}$$

$$Q_{cal}(T_i \to T_f) = \int_{T_i}^{T_f} C_{cal}(T)dT \tag{2}$$

$$Q_{env}(T_i \to T_f) = \frac{Q_{cal}(T_i \to T_f)}{T_f - T_i}\frac{dT}{dt}\Delta t \tag{3}$$

$$Q_{ice}(T_f) = m_{ice}L + m_{ice} \int_{0°C}^{T_f} c_p(T)dT \tag{4}$$

And by conservation of energy:

$$\Delta U(T_i \to T_f) = Q_{water}(T_i \to T_f) + Q_{cal}(T_i \to T_f) + Q_{ice}(T_i \to T_f) = 0 \tag{5}$$

0.2 Materials and resources

- Calorimeter
- Digital scale
- Hot & cold water
- ice
- two 250 ML beakers
- Temperature sensor
- Data Studios
- **Love**

0.3 Procedure

Part I: Heat Capacity and the Calorimeter
The heat energy used to changef the temperature of the inner wall of the thermos is charactized by

$$mc_p(T_2 - T_f = C_{cal}(T_f - T_1)$$

1. Add 250 mL of cold water into the calorimeter. Allow several minutes for it to reach equilibirum.

2. Measure the common temperature of teh water and the calorimeter. (This will be T_1).

3. pour out the water and measure the weight of the empty beaker.

4. Get 200 mL of hot water in the beaker.

5. Measure the temperature of the hot water in the beaker. Take 30 temperature readings in 30 seconds, and record the 30th reading as T_2

6. Repeat this measurement two more times.

7. From the average of the three trials, calculate the uncertainty in L, only once, given by:

$$\Delta C_{cal} = C_{cal}\sqrt{(\frac{\Delta m_{water}}{m_{water}})^2 + (\frac{\Delta T_{cal}}{T_{cal}})^2}$$

Part II: Latent Heat of Fusion of Ice

1. Weigh the calorimeter plus the hot water together.

2. Record the initial temperature of the water and calorimeter, T_1. While gently stirring the water, record the temperature at 1 second intervals for 6 minutes, take measurements for about 1 minute and then proceed onto step number three. (Continue to take data and generate a graph of temperature vs. time.)

3. Carefully dry the ice cube in the Calorimeter. (**HOW IS THAT POSSIBLE?!!**)

4. The observed T vs. t graph should contain three distinct regimes: the initial constant temperature, a drastic drop in temperature, and the final temperature. Record a copy of T vs. t in the lab report

5. The temperature after the initial exchange of heat is the final temperature of the water, melted ice, and the calorimeter, T_f

6. Weigh the calorimeter with the water and melted ice. Calculate the mass of the ice from this measure-ment and the previous measurement of the calorimeter and original water alone.

7. Repeat this measurement two more times, and take the average of the three trials for lab report calculations.

8. From the average of the three trials, calculate the uncertainty in L, only once, given by:

$$\Delta L = L\sqrt{[\delta(T_f - 271.15K)]^2 + [\delta(\Delta T)]^2 + [\frac{\Delta C_{cal}}{C_{cal}}]^2}$$

0.4 Data Analysis

0.5 Questions

0.6 Answers to questions

0.7 Conclusion

0.8 Data

Part I, chromium

$T_H(C)$	$T_C(C)$	$T_F(C)$	$M_{Total}(g)$	$m_{H_2O}(g)$	$m_{cup}(g)$	$m_{chromium}(g)$
77.0	63.7	59.7	145.73	136.22	2.00	7.51
65.7	49.9	47.6	125.88	115.37	–	–
52.5	33.8	31.6	125.76	116.25	–	–
34.6	18.6	18.2	126.42	116.91	–	–
21.4	4.2	3.1	122.34	112.83	–	–

Part I, Copper

$T_H(C)$	$T_C(C)$	$T_F(C)$	$M_{Total}(g)$	$m_{H_2O}(g)$	$m_{cup}(g)$	$m_{Cu}(g)$
77.0	60.0	61.2	142.00	100.00	2.00	40.00
65.7	50.0	52.1	148.00	106.00	–	–
48.6	34.7	34.7	153.30	113.30	–	–
35.0	21.0	21.0	134.43	92.43	–	–
21.0	5.0	7.3	95.7	53.7	–	–

Part II, Chromium

$T_H(C)$	$T_C(C)$	$T_F(C)$	$M_{Total}(g)$	$m_{eth}(g)$	$m_{cup}(g)$	$m_{chromium}(g)$	$\frac{\partial m}{\partial t}$	$\Delta t(s)$
5.0	-10.0	-7.3	40.2	10.0	2.0	7.51	0.02	7
-10.11	-25	-24.41	38.5	–	–	–	0.01	8
-24.12	-40.0	-41.05	40.5	–	–	–	0.03	3
-40.00	-55.0	-54.45	44.6	–	–	–	0.02	5
-55.7	-75.0	-74.45	38.2	–	–	–	0.08	13

Part II, Copper

$T_H(C)$	$T_C(C)$	$T_F(C)$	$M_{Total}(g)$	$m_{eth}(g)$	$m_{cup}(g)$	$m_{Cu}(g)$	$\frac{\partial m}{\partial t}$	$\Delta t(s)$
5.0	-9.8	-7.3	40.2	10.0	2.0	40.0	0.13	10
-10.2	-25.4	-24.41	38.5	–	–	–	0.15	9
-22.5	-39.9	-41.05	40.5	–	–	–	0.09	9
-42.3	-56.2	-54.45	44.6	–	–	–	0.15	11
-55.2	-75.5	-74.48	38.2	–	–	–	0.07	13