Lab 2: Specific heat

Graded

Student

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Total Points

80 / 97 pts

Question 1

Data tables

15 / 15 pts

- **– 0 pts** Correct

great! Super clear and well labeled.

Question 2

Four-Line Summaries

20 / 20 pts

- **– 0 pts** Correct

Question 3

Sample Calc's

10 / 10 pts

- **– 0 pts** Correct

Question 4

Questions

8 / 12 pts

– 0 pts Correct

– 4 pts Point adjustment

5 The key thing about conductivity is time, it is about how quickly the change in temperature spreads throughout the material. Specific heat is how resistant a material is having it's temperature change. (-1)

6 Conceptually, yes. Can you use the equation to demonstrate this though? (-1)

7 True, but the most important thing to remember here is that the room as a source of error has the opposite effect in the first and second part of the experiment. In the first part, heat leaks in, and in the second, heat leaks out. This happens because we are centered around room temp. (-2)

Question 5

Error worksheet

14 / 15 pts

– 0 pts Correct

– 1 pt Point adjustment

1. Yes, the thermometer erroneously reading from a cold pocket or a hot pocket could give an error in either direction.
2. good job giving a quantitative explanation that explains the direction in which your results were wrong.
3. Over multiple trials, the random error associated with the poor stirring would have averaged out. It would have lead to a larger AE, but not an inaccurate experimental average.
4. Heat loss would always result in the specific heat values being erroneously small. So this is not a random error, but a systematic error. -1

Question 6

Challenge

13 / 25 pts

– 0 pts Correct

– 12 pts Point adjustment

Questions assigned to the following page: 3 and 4

1. The specific heat capacity is the quantity of heat/energy required to raise the temperature of the object. Thermal conductivity refers to the object's ability to absorb and diffuse energy in a changed environment. Specifically where they differ is specific heat is the capacity of energy required to change the temperature of the object while the thermal conductivity is the object's ability to allow energy pass through.

2. If the values for specific heat are consistently too low, the most probable source of error is due to an uncontrolled environment, starting with how each material was being transferred, as soon as it is out of that water, energy is being dispersed not only to the environment, but also to the tongs, along with every time we move with the material while transferring it into the calorimeter. All of these events in sequence cause low values because the energy dispersed in the calorimeter will not be correct and when we get the values it will be consistently too low. We would need a way to directly move the material from one controlled container to heat to a given heat, then transferred in a controlled environment into a controlled calorimeter directly to begin to get the accurate result.

3. It is preferable to have the changes in temperature be centered around room temperature because it reduces the heat lost between transfers. As the room temperature water is already in the calorimeter (controlled), when the material is being transferred in a room temperature environment, the changes in temperature of the material is minimized until quickly being put into the calorimeter. This helps get more accurate results and reduce error/ inaccuracy when gathering data.

Sample calc:

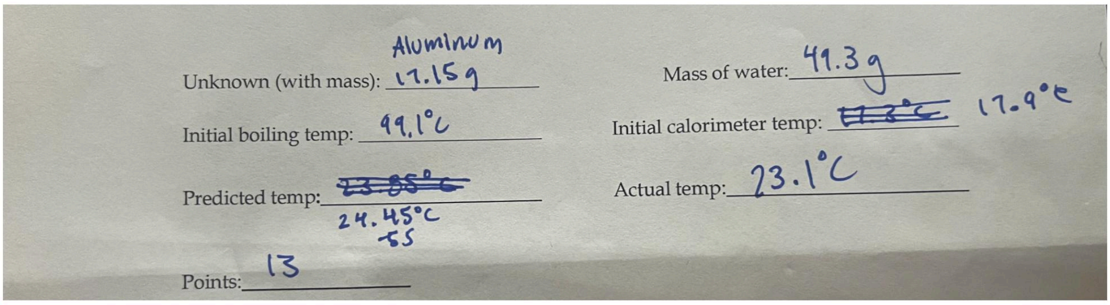
Aluminum:

$$c = \frac{(T_F - T_c) \cdot (m_{water}(1 + m_{cal})(c_{cal}))}{m_{unk}(T_{boiling} - T_F)}$$

$$\Rightarrow c = \frac{(99°C - 20.9°C)(55g(1 + .215\ cal/g°C)(26.1g + 3.8g))}{56.7g(99.0°C - 26.7°C)}$$

Question assigned to the following page: 6

Challenge:



Unknown (with mass): Aluminum 17.15 g

Mass of water: 49.3 g

Initial boiling temp: 99.1°C

Initial calorimeter temp: ~~17.3°C~~ 17.9°C

Predicted temp: ~~23.85°C~~ 24.45°C -55

Actual temp: 23.1°C

Points: 13

Questions assigned to the following page: 2 and 1

m_{cal} (g)	26.1	0.215
$m_{stirrer}$ (g)	3.8	0.215
T_{room} (°C)	23.1	
		49.3

m_{unk} 1 (g): 17.15 Aluminum

$T_{boiling}$ (°C)	T_{cold} (°C)	m_{water} + m_{cal} (g)	T_{final} (°C)	m_{water} (g)	Specific Heat (cal/g (°C))
101.7	20.9	78.4	24.8	52.3	0.173669299
101.6	19.7	77.6	24.3	51.5	0.201004831
101.8	20.2	80.6	24.5	54.5	0.197626566
101.8	19.8	71.6	24.9	45.5	0.200810071

(cal/g (°C))

mean	stdev	SE	AE
0.19328	0.01316	0.006582	0.0129004

Aluminum object (cal/g (°C))
Result: .193 +/- .013
Range: .180 to .206
Expected: .215
Agree: No

m_{unk} 2 (g): 56.7 Copper

$T_{boiling}$ (°C)	T_{cold} (°C)	m_{water} + m_{cal} (g)	T_{final} (°C)	m_{water} (g)	Specific Heat (cal/g (°C))
99.0	20.9	81.1	26.7	55	0.08691136
99.1	21.2	73.3	27.6	47.2	0.08466161
99.0	20.9	75.9	27.3	49.8	0.088518543
99.0	21.4	78.2	27.8	52.1	0.092786398

(cal/g (°C))

mean	stdev	SE	AE
0.08822	0.00343	0.001716	0.0033624

Copper object (cal/g (°C))
Result: .088 +/- .003
Range: .085 to .091
Expected: .0923
Agree: No

m_{unk} 3 (g): 53.7 Brass

$T_{boiling}$ (°C)	T_{cold} (°C)	m_{water} + m_{cal} (g)	T_{final} (°C)	m_{water} (g)	Specific Heat (cal/g (°C))
99.1	21.6	70.5	27.5	44.4	0.07799594
99.1	20.9	76.5	27.5	50.4	0.097549
99.0	21.2	79.6	26.8	53.5	0.086558546
99.0	21.3	77.9	26.9	51.8	0.084219775

(cal/g (°C))

mean	stdev	SE	AE
0.08658	0.00816	0.004078	0.0079932

Brass object (cal/g (°C))
Result: 0.0866 +/- .008
Range: .0858 to .0874
Expected: .094
Agree: No

Question assigned to the following page: 5

1. - Weighing mass of objects using Ohaus Scale (+/- .1g)

   (materials, calorimeter cup, mwater + mcal (g), etc.)

   -

2. The most prominent sources of random error in this lab came from heat loss due to the temperature change during the transfer process along with random error from not stirring the water while the object was in the calorimeter. Starting with the heat loss, while the object was being transferred into an calorimeter with water at room temperature, the object is at a much higher heat of 99.0°C - 99.1°C and suddenly move out making a large dispersion of energy as soon as it comes out of the water, then by the time it reaches the calorimeter the specific heat of the material would be already at least slightly inaccurate do to that short duration of transfer along with being picked up by the tongs. Moving onto the stirring of the water while the object was enclosed by the calorimeter, this action was done far less then we should have, while we did generally do it a little bit, it wasn't done often or very long during each trial for each material done. Not stirring the water enough leads to uneven heat distribution in the water which means the thermometer used could've read an inaccurate temperature likely further lowering the result values collected, especially the final specific heat value of each material.

3. Based on the experimental results, There is indication of systematic error due to the consistently low specific heat value results for each material. Seeing as none of the specific heat results agreed with the expected values, and the experimental setup not entirely controlled, there is strong indication towards systematic error throughout the lab leading to lower collected data values .

4. The most likely source of systematic error comes from heat loss when transferring the object from the boiling water to the calorimeter. As soon as the object is pulled out with tongs, it starts losing heat to the air before it even reaches the water in the calorimeter. This means the actual starting temperature of the object is lower than what was recorded, leading to less heat being transferred to the water. Since specific heat is calculated using $c=Q/(m\Delta T)$, and the heat transfer Q is lower than expected, the calculated specific heat values end up being too low. Furthermore, not stirring the water enough in the calorimeter caused uneven heat distribution, which likely led to inaccurate final temperature readings. If the thermometer was placed in a cooler spot, the final temperature would be lower than the true equilibrium temperature, further skewing the results. Since this issue was in every trial for every material, it systematically caused the specific heat values to be lower than expected.