Calorimetry Memo

Date: 11/25/22

Group: 1

Lab: CHEM 117-502

Experiment Performed: 11/14/22

Lab group members: Hudson Hurtig, Andrew Woulds, Jesus Luna, Arman Ansari

Instructors: Dr. Altemose, Houston Smith

Introduction:

The purpose of this document is to present our argument for why we hypothesize that coffee cups with thick ceramic walls and minimal surface area exposure to the air will best help retain the temperature of hot liquids. We believe that coffee cups with thick ceramic walls and minimal surface area exposure to the air will best help retain the temperature of hot liquids because we believe that the walls of the coffee cup act as an insulator, and minimal surface area exposure minimizes the uninsulated transfer of heat to the surroundings. There were many mugs that fit this description in the lab. See figure 1.

Results and Calculations:

	Minitial(g)	Mcold(g)	Mf(g)
Trial 1	94.26	365.57	413.03
Trial 2	94.26	365.18	411.95
Trial 3	94.26	363.08	408.28

Table 1: Hudson's Table of Calorimeter masses

	Minitial(g)	Mcold(g)	Mfinal(g)
Trial 1	253.12	251.30	253.71
Trial 2	291.21	288.70	291.73
Trial 3	332.70	320.20	333.60

Table 2: Jesus's Table of Calorimeter masses

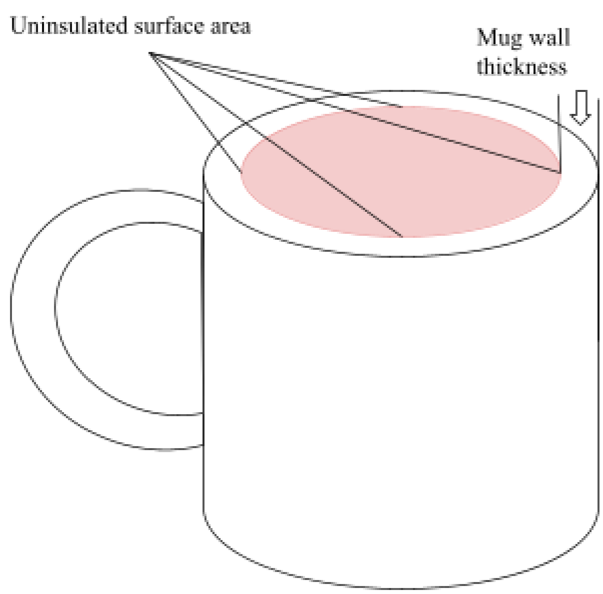

Figure 1: best mug characteristics visualization aid

	Qcold (J)	Qhot (J)	Qcal (J)	Ti (C°)	Tf (C°)	TΔ (C°)	Ccal (J/C°)
Trial 1	4216.89	-9411.41	5194.52	19.30	45.76	26.46	196.3

Table 3: Sample calculation of the calorimeter constant for Trial one of the coffee mug
Ccal: Derived from the division of the heat of neutralization (Qcal) over the Temperature change (TΔ)

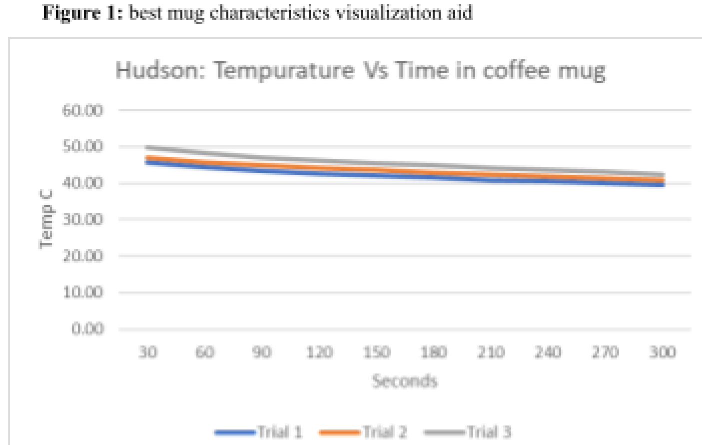

Figure 2: Hudson's 3 Trials with coffee mug

	Minitial(g)	Mcold(g)	Mfinal(g)
Trial 1	263.53	303.43	344
Trial 2	263.74	302.63	346.71
Trial 3	263.77	302.84	347.88

Table 4: Andrew's table of Calorimeter Masses

	Mass Initial (g)	Mass Cold (g)	Mass Final (g)
Trial 1	348.67	387.85	429.15
Trail 2	348.67	387.74	426.91
Trial 3	348.67	387.87	430.27

Table 5: Arman's table of calorimeter masses

	Ccal AVG (J/°C)	Ccal STDEV (J/°C)
Hudson	137.1	56.77
Arman	257.9	24.2445
Jesus	163.1	46.52
Andrew	191.1	12.7865

Table 6: Group Average Ccal and Standard Deviation

	Height of mug(cm)	Diameter of mug(cm)
Hudson	9.50	8.00
Arman	9.00	8.00
Jesus	10.48	8.00
Andrew	9.00	8.00

Table 7: group coffee cup dimensions

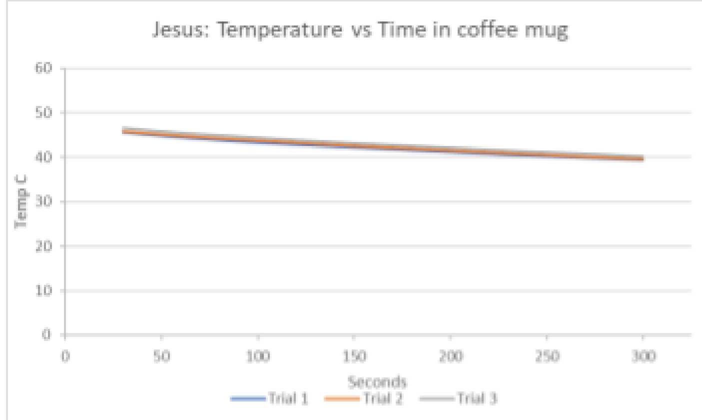

Figure 3: Jesus's Trials with coffee mug

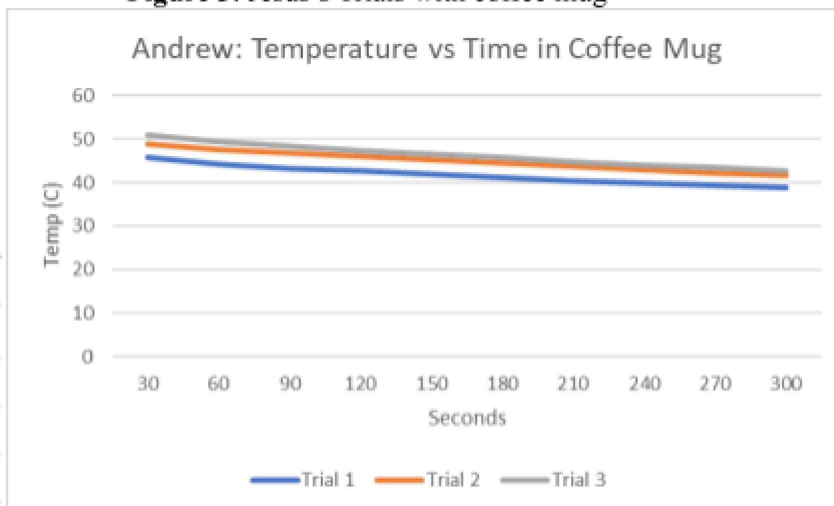

Figure 4: Andrew's Time vs Temp graph for Trials of Coffee Mug

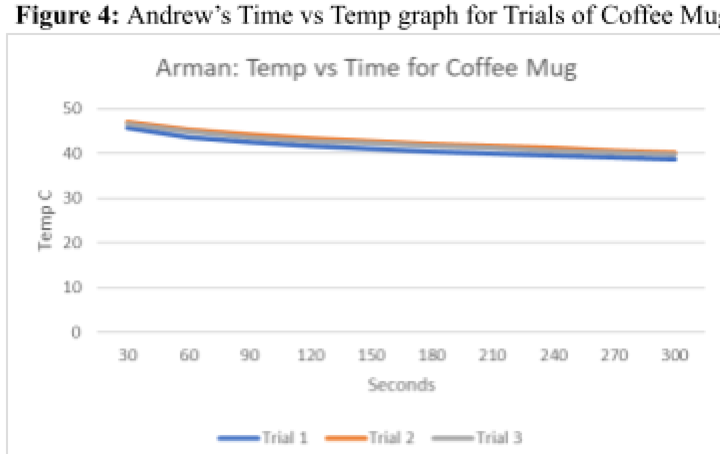

Figure 5: Arman's Time vs Temp graph for coffee mug

	Q cold (J)	Q hot (J)	Q cal (J)	Temp Initial (C)	Temp Final (C)	Change in temp	C cal
Trial 1	3936.48	-9501.65	5565.17	21.10	45.11	24.01	231.753
Trial 2	3366.37	-8769.06	5402.69	26.00	46.59	20.59	262.352
Trial 3	3537.21	-9567.86	6030.65	24.60	46.17	21.57	279.628

Table 8: Calculation for the calorimeter constant for each trial
C cal: Find the calorimeter constant by dividing the heat of neutralization (Q cal) by the change in temperature
C cal avg: Add all the calorimeter heat constants by 3, the number of trials

Results and Calculations

In our results regarding the trials done with different coffee mugs we could conclude that we had very similar outcomes in performance. However, we saw clearly that the mugs that were most "square", that is height is closer to diameter, had consistently higher calorimeter constants. Meaning, more energy was required to raise the temperature of the ceramic walls, thus they retained the temp of hot liquids better over the interval. Since all members of the group had ceramic mugs without a difference in the exposure of surface area to the surroundings, our previous hypothesis could not be proved. Our data rather posed different suggestions about what characteristics of a calimiter allow it to retain heat the best.

Calorimeter constant calculations

The steps we took in order to attain the Calorimeter constant of our Coffee Cup during one trial performed during the experiment involved the use of thermodynamic equations all round. In order to attain the calorimeter constant we first needed to derive the combined energies of heats of both the cold and hot waters that would be introduced into the ceramic cup. By using the equation $MC\Delta T$, we derive out the energies of both the cold, hot waters in the coffee cup. One example of this, subtracting the mass of the cold water from the calorimeter, 291.21 g - 253.12 g, and the temperature change during that period, 45.76 °c - 19.30 °c, and multiplying both the cold water mass by the temperature change and the specific heat of water, 4.184 J/°c g, to get the total Joules of energy in the cup during the time that the cold water is in it. Once that has been attained, the same could be done for the energy present in hot water. Using the equation, qCal = -(qCold + qHot), we subtract 4216.89 J from -9411.41 J and change the sign giving us the qCal of the whole reaction. We then use this variable to divide by the temperature change during the experiment, 45.76 °c - 19.30 °c, which will give us the result of 196.316 J/°c. Otherwise known as the Calorimeter constant of the trial as a whole.

Analysis and conclusion:

We believed that the ceramic coffee cups with uniform cylindrical bodies, thick walls, and minimal surface area exposure(see figure 1) retain the temperature of hot liquids the best. As seen in our data coffee mugs of this description resulted in an average loss of <.01 degrees centigrade every 30 seconds. In the context of this experiment Ccal refers to the heat capacity of the ceramic walls of the coffee cup, as seen in the data, the Ccal of the coffee mugs that fit our description were higher than that of those of other geometries and wall thickness. *Since the data provided could not prove our hypothesis we reference table 6 and 7 above to show the relationship between Diameter to Height ratio and how it relates to heat capacity.* Being, **the closer the Diameter to height ratio is to 1, the better the calimiter is able to retain heat.**