**Determining Calorimeter Constants**

1. Make a table of your data from part A.

**Table 1.** Time and Temps for 3 Trials of Styrofoam Cup Calorimeters

|  |  |  |  |
| --- | --- | --- | --- |
| **Time (Seconds)** | **Trial 1 Temp(C)** | **Trial 2 Temp(C)** | **Trial 3 Temp(C)** |
| 0 | 19.62 | 20.41 | 20.71 |
| 30 | 52.97 | 50.04 | 49.71 |
| 60 | 52.29 | 49.55 | 48.95 |
| 90 | 51.59 | 49.05 | 48.47 |
| 120 | 50.98 | 48.55 | 47.49 |
| 150 | 50.45 | 48.03 | 47.45 |
| 180 | 49.88 | 47.49 | 47.01 |
| 210 | 49.32 | 47.02 | 46.54 |
| 240 | 48.78 | 46.56 | 46.10 |
| 270 | 48.28 | 46.11 | 45.66 |
| 300 | 47.73 | 45.66 | 45.25 |

1. Create a plot of Temperature vs. Time from your part A data. This plot should include all 3 trials, and the trials should be clearly marked. Include the value for final temperature for each trial in the caption of this plot.

**Graph 1.** Cal. Temp vs Time for 3(With Initial Temp). Final Temp1=47.47C, Final Temp2=45.66C, Final Temp3=45.25

1. Show your entire calculation for the calorimeter constant for trial 1 from part A. Begin with a general formula and continue from there. Your smart worksheet guides you through this. You will only be asked to show this work once, so make sure it’s correct.

Trial 1:

Qcal +Cwater\*mcoldwater\*deltaTcoldwater +Cwater\*mhotwater\*deltaThotwater = 0

CcalT = -Cwater\*mcoldwater\*deltaTcoldwater -Cwater\*mhotwater\*deltaThotwater

Qcal \* (47.73-19.62) = -4.184(38.64)(47.73-19.62) – 4.184(49.28)(47.73-100)

Qcal = 222.4 J/C

1. What is the average calorimeter constant, and what is the standard deviation for your data from part A? You do not need to show your work for these questions, but if the values are incorrect there will be no partial credit.

Average = 276.8 J/C

Std. Dev = 47.21 J/C

1. Scratch Work for Question 4:

2. Trial 2:

3. QcalT +cwater\*mcoldwater\*deltaTcoldwater +cwater\*mhotwater\*deltaThotwater = 0

4. QcalT = -cwater\*mcoldwater\*deltaTcoldwater -cwater\*mhotwater\*deltaThotwater

5. Qcal \* (45.66-20.41) = -4.184(39.07)(45.66-20.41) – 4.184(51.48)(45.66-100)

6. Qcal = 300.97 J/C

7. Trial 3:

8. QcalT +cwater\*mcoldwater\*deltaTcoldwater +cwater\*mhotwater\*deltaThotwater = 0

9. QcalT = -cwater\*mcoldwater\*deltaTcoldwater -cwater\*mhotwater\*deltaThotwater

10. Qcal \* (45.25-20.71) = -4.184(38.49)(45.25-20.71) – 4.184(50.28)(47.25-100)

11. Qcal = 307 J/C

1. Make a table of your data from part B.

**Table 2.** Time and Temps for 3 Trials of Beaker Calorimeters

|  |  |  |  |
| --- | --- | --- | --- |
| **Time (Seconds)** | **Trial 1 Temp(C)** | **Trial 2 Temp(C)** | **Trial 3 Temp(C)** |
| 0 | 19.8 | 20.8 | 20.2 |
| 30 | 47.7 | 50.3 | 47.3 |
| 60 | 47.0 | 49.6 | 46.7 |
| 90 | 46.4 | 48.9 | 46.6 |
| 120 | 45.8 | 48.3 | 45.5 |
| 150 | 48.2 | 47.6 | 44.6 |
| 180 | 44.6 | 47.0 | 44.3 |
| 210 | 44.0 | 46.5 | 43.8 |
| 240 | 43.5 | 46.0 | 43.3 |
| 270 | 43.0 | 45.4 | 42.8 |
| 300 | 42.5 | 44.8 | 42.9 |

1. Create a plot of Temperature vs. Time from your part B data. This plot should include all 3 trials, and the trials should be clearly marked. Include the value for final temperature for each trial in the caption of this plot.

**Graph 2.** Cal. Temp vs Time for 3(With Initial Temp). Final Temp1=42.5C, Final Temp2=44.8C, Final Temp3=42.9C

1. What is the average calorimeter constant, and what is the standard deviation for your data from part B?

Trial 1:

Qbeaker +Cwater\*mcoldwater\*deltaTcoldwater +Cwater\*mhotwater\*deltaThotwater = 0

Cbeaker(42.5-19.8) = -4.184(38.61)(42.5-19.8) + -4.184(48.72)(42.5-100)

C = 352.1 J/C

Trial 2:

Qbeaker +cwater\*mcoldwater\*deltaTcoldwater +cwater\*mhotwater\*deltaThotwater = 0

Cbeaker(44.8-20.8) = -4.184(40.01)(44.8-20.8) + -4.184(49.44)(44.8-100)

C = 308.37 J/C

Trial 3:

Qbeaker +cwater\*mcoldwater\*deltaTcoldwater +cwater\*mhotwater\*deltaThotwater = 0

Cbeaker(42.9-20.2) = -4.184(39.57)(42.9-20.2) + -4.184(48.39)(42.9-100)

C = 343.72 J/C

Avg = 334.73

Std. Dev = 23.21

1. Make a table of your data from part C.

**Table 3.** Time and Temps for 3 Trials of Coffee Mug Calorimeters

|  |  |  |  |
| --- | --- | --- | --- |
| **Time (Seconds)** | **Trial 1 Temp(C)** | **Trial 2 Temp(C)** | **Trial 3 Temp(C)** |
| 0 | 20.84 | 25.46 | 25.65 |
| 30 | 45.70 | 43.55 | 47.55 |
| 60 | 43.65 | 42.46 | 45.60 |
| 90 | 42.62 | 41.66 | 44.61 |
| 120 | 41.85 | 41.00 | 43.78 |
| 150 | 41.18 | 40.42 | 43.13 |
| 180 | 40.52 | 39.90 | 42.58 |
| 210 | 39.91 | 39.39 | 42.01 |
| 240 | 39.36 | 38.90 | 41.45 |
| 270 | 38.85 | 38.44 | 40.89 |
| 300 | 38.34 | 38.00 | 40.38 |

1. Create a plot of Temperature vs. Time from your part C data. This plot should include all 3 trials, and the trials should be clearly marked. Include the value for final temperature for each trial in the caption of this plot.

**Graph 3.** Cal. Temp vs Time for 3 Coffee Mug Calorimeters(With Initial Temp). Final Temp1=38.34 C, Final Temp2=38.00 C, Final Temp3=40.388 C

1. What is the average calorimeter constant, and what is the standard deviation for your data from part C?

Trial 1:

Qcoffeemug + Cwater\*MColdwater\*DeltaTcoldwater + Cwater\*Mhotwater\*DeltaThotwater = 0

Qcoffeemug = -Cwater\*MColdwater\*DeltaTcoldwater -Cwater\*Mhotwater\*DeltaThotwater

Ccoffemug(38.34-20.84) = -4.184(39.2)(38.34-20.84) – 4.184(48.93)(38.34-100)

Trial 2:

Ccoffemug(38.00-25.46) = -4.184(39.79)(38-25.46) – 4.184(49.41)(38-100)

Trial3:

Ccoffemug(40.38-25.65) = -4.184(39.21)(40.38-25.65) – 4.184(51.67)(40.38-100)

C1 = 557.31

C2 = 855.64

C3 = 710.97

Avg = 707.97 J/C

Std Dev = 121.8 J/C

1. A good calorimeter prevents heat loss to its surroundings (the air around it, the table under it, etc.). Using the data you collected (both your graphs and calculated values), explain which material is the best calorimeter.

Heat Capacity uses the measure J/C, meaning for every unit increase in temperature, how much energy an object absorbs. Taking our averages of 222.4 for the Styrofoam cups, 334.72 for the beaker, and 707.31 for the coffee mug, the heat capacities indicate how many joules of energy are lost or gained per degree Celsius. So, our coffee mug has the highest, so it wouldn’t be a very ideal calorimeter if it quickly lost heat/energy for every degree of temperature lost. But the Styrofoam cups don’t heat up quickly, and don’t lose heat quickly, so I would say make the best calorimeter.

**Determining Enthalpy of a Reaction**

1. Make a table of your data from part D.

**Table 4.** Time and Temps for 2 Trials of HCl and NaOH reactions

|  |  |  |
| --- | --- | --- |
| **Time (Seconds)** | **Trial 1 Temp(C)** | **Trial 2 Temp(C)** |
| 0 | 20.20 | 20.06 |
| 30 | 27.04 | 26.85 |
| 60 | 26.96 | 26.77 |
| 90 | 26.88 | 26.68 |
| 120 | 26.80 | 26.59 |
| 150 | 26.71 | 26.51 |
| 180 | 26.62 | 26.42 |
| 210 | 26.53 | 26.34 |
| 240 | 26.45 | 26.25 |
| 270 | 26.37 | 26.18 |
| 300 | 26.28 | 26.09 |
| 330 | 26.21 | 26.02 |
| 360 | 26.13 | 25.94 |
| 390 | 26.04 | 25.85 |
| 420 | 25.96 | 25.77 |
| 450 | 25.88 | 25.63 |
| 480 | 25.79 | 25.55 |
| 510 | 25.66 | 25.48 |
| 540 | 25.58 | 25.39 |
| 570 | 25.49 | 25.32 |
| 600 | 25.41 | 25.25 |

1. Create a plot of Temperature vs. Time from your part D data. This plot should include both trials, and the trials should be clearly marked. Include the value for final temperature and the mass of each solution for each trial in the caption of this plot.

Graph 4.. Cal. Temp vs Time for 2 HCl and NaOH Reactions(With Initial Temp). Final Temp1=25.41 C, Final Temp2=25.25 C, Final Mass1=113.94g, Final Mass2=113.66g

1. Show your entire calculation to determine the heat (**q**) released or absorbed by the reaction between NaOH and HCl for trial 1. Begin with a general formula and continue from there.

Qtotal = -(qsolution+qcalorimeter)

Qtotal = masssolution\*C(water)\*deltaT+ Cstyrofoam\*deltaT

Qtotal = 113.94\*4.184\*(25.41-20.20) +222.4(25.41-20.20)

Qtotal = -3642.44

1. What is the average heat (**q**) of reaction from both trials? You do not need to show your work for this.

Trial 2 =

Qtotal = -(113.66\*4.184\*(25.25-20.06) + 222.4(25.25-20.06))

Qtotal = -3622.38

Qavg = -3632.41

1. Using your average heat (**q**) of reaction, determine the enthalpy of this reaction (**H**) in kJ/mol. Show all your work for this question.

50ML of 1.1M HCl = .055mol

50ML of 1.9M NaOH = .05mol

NaOH is limiting reactant

deltaH = q/n

deltaH = -3.63231 kJ /.05 mol

= -72.64 kJ/mol

**Lab Notebook**

Include ALL lab notebook pages and tag everything appropriately in Gradescope.

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