**Calorimetry and Thermochemical Measurements**

**Chemistry 101***: General Chemistry*

Post-Lab & Lab Report #5



*Sitthiphol Yuwanaboon*

*Professor Nina Ram*

*Lab Professor*

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**Calorimetry and Thermochemical Measurements**

**Purpose:**

Part I: To measure the heat flow in Styrofoam cup with boiling water, it helps us to define what the value of heat capacity of calorimetry which contains with water and Styrofoam. To find heat exchange (loss and gain) and its temperature to help us to understand about Thermochemical reactions.

Part II: To measure the heat capacity of metal such as aluminum and copper which require more heat to raise the temperature in one degree (K or Celsius) by doing an experiment in water as colorimeter.

Part III: To find enthalpy of reaction by consider how much gas flow through the chamber to make its neutralize state of it volume which transfer to displaced the chamber

**Procedures:**

Part I: get two Styrofoam cups and measure mass of both cups together without the lid. Get deionized 50 mL water in Styrofoam with thermometer on the top of the lid. Also get deionized 50 mL water put to the 150 beaker and boiling it up to 60 degree Celsius. And put the hot water into calorimeter and measure the temperature of its self every 30 second for 4 min.

Part II: A: get copper 40 gram – 50 gram put into the test tube about 7 or 8 inches and boiling with 400 ml water of 500 ml beaker. Wait it till it reaches 95 degrees. Get 100 mL water to Styrofoam cup and measure the temperature of initial temperature of water in calorimeter . When it reaches 95 degree then you put it into calorimeter and measure the temperature in calorimeter for every 30 second in 5 minute block.

B: repeat step A instead of copper , put the 30-40 gram of an aluminum.

Part III: get 50 mL of the 1 M NaOH and measure the mass of the solution. Place on the top of suitable beaker with a cover on the lid with the thermometer then rinse graduate cylinder with acid HCl with 3 time of tap water, then put deionized water in to rinse up. Evenually put the 1 M HCl in to the beaker

Record the temperature of the base in the cup. Also an acid, then put an acid into base gently swirl and record the temperature for a total of five minute at 30 second interval.

**Data**

|  |  |
| --- | --- |
| **time after mixed** | **temperatures** |
| 0 | 35.2 |
| 0.5 | 35 |
| 1 | 35 |
| 1.5 | 34.9 |
| 2 | 34.9 |
| 2.5 | 34.8 |
| 3 | 34.7 |
| 3.5 | 34.7 |
| 4 | 34.6 |

**Part I: Table of water in a cup and after mixed**

|  |  |
| --- | --- |
| **times** | **temperatures** |
| -4 | 21.7 |
| -3 | 21.7 |
| -2 | 21.7 |
| -1 | 21.7 |
| 0 | 21.7 |

The initial temperature of calorimeter is 21.7 Celsius and the final temperature is about 35.2 Celsius

Change in temperature = 35.2-21.7 Celsius = 13.5 Co

\*The calorimeter and water in the cup gain heat and the temperature in the cup

\* The hot water lost heat to cold water and calorimeter.

Qcold = -Qhot

Qcold+Qcup=-Qhot

ccup\*(35.2-21.7) =46.9478 g\*(4.184 J/g\*K)\*(61.5-35.2)- 48.9478 g \*(4.184 J/g\*K)\*(35.2-21.7)

ccup = 178. J/Co

I think the temperature is inaccurate because the heat exchange become a bigger number that we have to reconsider that temperature of final mixed should be higher or the temperature of hot water should be less than what we have right now. It will create a big chunk of number different than before.

|  |  |
| --- | --- |
| Table of masses | trial 1 |
| Mass of TWO DRY Styrofoam cups (g) | 5.9806 g |
| Mass of Styrofoam cups with water (g) | 54.9284 g |
| Mass of water in Styrofoam cups (g) | 48.9478 g |
| Mass of Beaker and Water (g) | 117.200 g |
| Mass of wet Beaker AFTER the transfer (g) | 70.2522 g |
| Mass of water in beaker (g) | 46.9478 g |
| Temperature of HOT water in beaker right before mixing (o C) | 61.5 Co |

**Part II: Copper**

|  |  |
| --- | --- |
| **times** | **Temperatures** |
| 0 | 24.8 |
| 0.5 | 24.8 |
| 1 | 24.8 |
| 1.5 | 24.8 |
| 2 | 24.8 |
| 2.5 | 24.8 |
| 3 | 24.8 |
| 3.5 | 24.9 |
| 4 | 24.9 |
| 4.5 | 24.9 |
| 5 | 24.9 |
| 5.5 | 24.9 |
| 6 | 24.9 |
| 6.5 | 24.9 |
| 7 | 24.9 |
| 7.5 | 24.9 |
| 8 | 24.9 |
| 8.5 | 24.9 |
| 9 | 24.9 |
| 9.5 | 24.9 |
| 10 | 24.9 |

Copper specific heat capacity: I want to treat Calorimeter capacity to be zero because it will create a big chunk error in the calculation for this experiment

|  |  |
| --- | --- |
| **times** | **Temperatures** |
| -4 | 21.6 |
| -3 | 21.6 |
| -2 | 21.6 |
| -1 | 21.6 |
| 0 | 21.6 |

|  |  |
| --- | --- |
| Mass of experiment part II Copper | Trial1 |
| Mass of two Styrofoam | 5.9806 g |
| Mass Styrofoam cup with water | 107.6560 |
| Mass water in a cup | 101.6754 |
| Mass of copper | 44.4140g |
| Temperature of hot copper right before mixed it | 95.1 C |

Qcold =-Qhot

mcwaterdt=-mccopperdt

101.6754g\*(4.184 J/g\*C)\*(24.8-21.6)= 44.4140g\*C\*(95.1-24.8)

Ccopper=.436 J/gC is similar to kelvin

The reference specific heat capacity of a copper is .386J/gK

The percent different is equal to (.436-.386)/386 \*100= 12.95 % error

The percent error is significant large but it term of decimal value is still small and reasonable to consider as the result of the experiment.

|  |  |
| --- | --- |
| **times** | **Temperatures** |
| 0 | 26.3 |
| 0.5 | 26.7 |
| 1 | 26.8 |
| 1.5 | 26.8 |
| 2 | 26.9 |
| 2.5 | 26.9 |
| 3 | 26.9 |
| 3.5 | 26.9 |
| 4 | 26.9 |
| 4.5 | 26.9 |
| 5 | 26.9 |
| 5.5 | 26.9 |
| 6 | 26.9 |
| 6.5 | 26.8 |
| 7 | 26.8 |
| 7.5 | 26.8 |
| 8 | 26.8 |
| 8.5 | 26.8 |
| 9 | 26.8 |
| 9.5 | 26.8 |
| 10 | 26.8 |

|  |  |
| --- | --- |
| **times** | **Temperatures** |
| -4 | 22.4 |
| -3 | 22.4 |
| -2 | 22.4 |
| -1 | 22.4 |
| 0 | 22.4 |

**Part II :Aluminum**

|  |  |
| --- | --- |
| Mass of experiment part II Copper | Trial1 |
| Mass of two Styrofoam | 5.9806 g |
| Mass Styrofoam cup with water | 103.400 g |
| Mass water in a cup | 97.4194g |
| Mass of copper | 30.5679g |
| Temperature of hot copper right before mixed it | 95.1 C |

Qcold =-Qhot

mcwaterdt=-mcaluminumdt

97.4194g \*(4.184 J/g\*C)\*(26.9-22.4)= 30.5679g \*C\*(95.1-26.9)

Calumium=.880 J/gC is similar to kelvin

The reference specific heat capacity of a copper is .900J/gK

The percent different is equal to (.900-.880)/.900 \*100= 2.5 % error

The percent error is significant less but it term of decimal value is still small and reasonable to consider as the result of the experiment.

We get the pretty good result for specific heat capacity of aluminum.

**Part III: Determination of the enthalpy change for a Neutralization Reaction**

|  |  |
| --- | --- |
| **time** | **temperature** |
| -4 | 22 |
| -3 | 22 |
| -2 | 22 |
| -1 | 22 |
| 0 | 22 |

|  |  |
| --- | --- |
| **time** | **temperatures** |
| 0.5 | 29.6 |
| 1 | 29.5 |
| 1.5 | 29.5 |
| 2 | 29.4 |
| 2.5 | 29.4 |
| 3 | 29.4 |
| 3.5 | 29.3 |
| 4 | 29.3 |
| 4.5 | 29.2 |
| 5 | 29.2 |

|  |  |
| --- | --- |
| **time** | **temperature** |
| -4 | 21.9 |
| -3 | 21.9 |
| -2 | 21.9 |
| -1 | 21.9 |
| 0 | 21.9 |

**Data Table: 3A**

|  |  |
| --- | --- |
| **Experiment Data** | **Trial 1** |
| Mass of two Styrofoam | 6.4467g |
| Mass of two Styrofoam with NaOH | 59.6227g |
| Mass of NaOH | 53.176g |
| Temperature of NaOH before mixing it | 21.9 Co |
| Temperature of HCl before mixing it | 22.0 Co |
| Mass of two Styrofoam after mixed it | 107.747g |
| Molarity of NaOH | 1.026 M |
| Molarity of HCl | 1.012 M |
| Mass of HCl | 48.1243 g |

**Calculation**

Mass (g) to ml of HCl \*=.997770

Mass (g) to ml of NaOH \*=.997792

We can ignore by using density as 1.0 g/ mL

NaOH(aq)+ HCl(aq) → NaCl (aq) + H2O (

Molarity of NaOH = 1.026M

Molarity of HCl = 1.012M

Mole of HCl = M \* Liter=1.012M\*48.1243mL/1000=0.04870 mole

Mole of NaOH= M \* Liter = 1.026M\*53.176g =.05456 mole

Mole of HCl are limiting reactant, so mole of H+=0.04870 mole

Since the mole of HCl and H+ is 1:1 so the mole of H+ are the same as the more of HCl

Heat in the solution is equal to =

Q= mcdt = 101.3003g\* 4.184J/g\*(29.6C-21.9 C) = 3263.6 J

Ignore Q calorimeter. Because it is accurate

But we can try Q =3263.6-178\*(29.6-21.9)= will be significantly less

Since HCl is the limiting reaction of the solution that we mixed and we found out that the solution after mixed is a basic solution.

So the molar Enthalpy of neutralization is 3263.6 J\*0.04870 mole /1000 = 67.01kJ / mole

By consider the density it would be 67.16 kJ/mole

**Summary:**

By we look for molar enthalpy of neutralization ,we can see that it has larger significant number which makes impact to the experimental value

Percent Error = (67.16-57.6)/57.6\*100 =16.6 %