

CHEM 123L Lab 2 Report

Calorimetry

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Sorry about this being incomplete.

1 Introduction

2 Procedure

The experimental procedure used for this experiment was outlined in the CHEM 123L lab manual, Experiment #2. All steps were followed without deviation.

3 Observations and calculations

Data tables are located in Section 6, near the end of the document.

The mass of the empty calorimeter was 65.22 g.

3.1 Part A: Heat of dissolution of NaOH

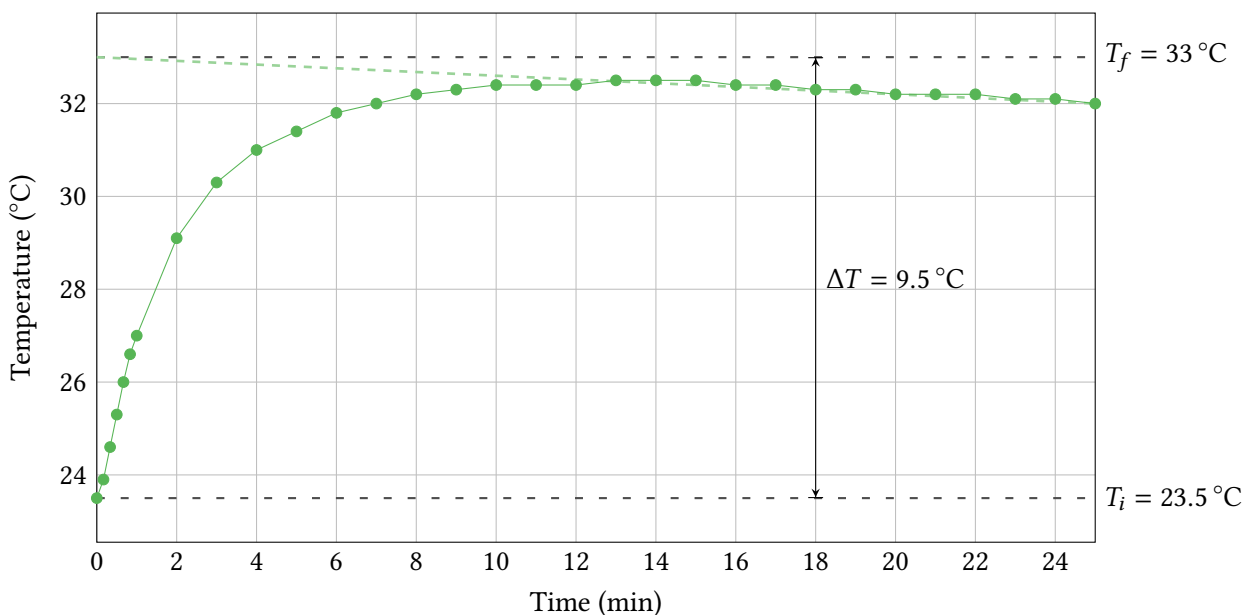
Mass of NaOH: 10.07 g

Initial temp. of water: 23.5 °C

$$m_{\text{soln}} = 10.07 \text{ g} + 250 \text{ g} = 260.07 \text{ g}$$

The sodium hydroxide was added into 250 mL of water, with an initial temperature of 23.5 °C. The temperature of the water was then measured over the next 25 minutes. A graph for this data is shown in Figure 1.

Figure 1: Temperature in the calorimeter for 25 minutes after addition of NaOH. (Data in Table 1)



The initial temperature in the calorimeter was measured to be $T_i = 23.5^\circ\text{C}$, and the final temperature was extrapolated to be $T_f = 33^\circ\text{C}$. Using this information, the molar enthalpy of solution, $\Delta_s H^\circ$, can be calculated.

First, the equation $q = mc\Delta T$ is used to calculate q_{soln} :

$$\begin{aligned} q_{\text{soln}} &= mc\Delta T \\ &= (260.07 \text{ g})(4.184 \text{ J K}^{-1} \text{ g}^{-1})(9.5 \text{ K}) \\ &= 10\,337.3 \text{ J} \end{aligned}$$

Then, $q_{\text{rxn}} = -q_{\text{soln}}$, so:

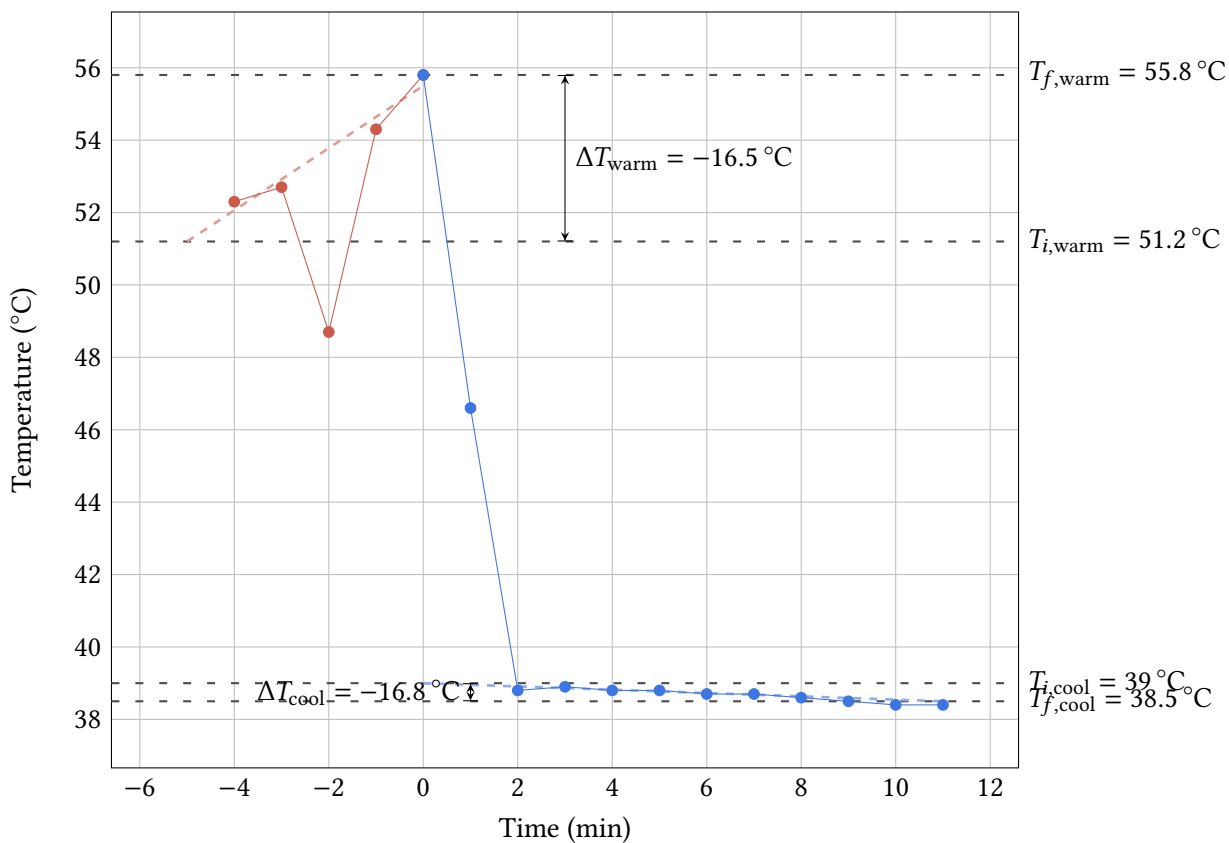
$$q_{\text{rxn}} = -10\,337.3 \text{ J}$$

3.2 Part B: Determining heat capacity of the calorimeter

Temp. of cool water: 20.9 °C
 Mass calorimeter + 125 mL DI: 166.58 g
 Mass calorimeter + 250 mL DI: 289.65 g

After adding the warm water to the calorimeter, the temperature was measured every minute for five minutes. Figure 2 shows these measurements.

Figure 2: Red shows the temperature in the calorimeter for 5 minutes after addition of warm water. Data point 3 was likely a misreading. Blue shows the temperature in the calorimeter for 10 minutes after addition of cool water. (Data in Table 2)



3.3 Part C: Neutralization of a strong base with a strong acid

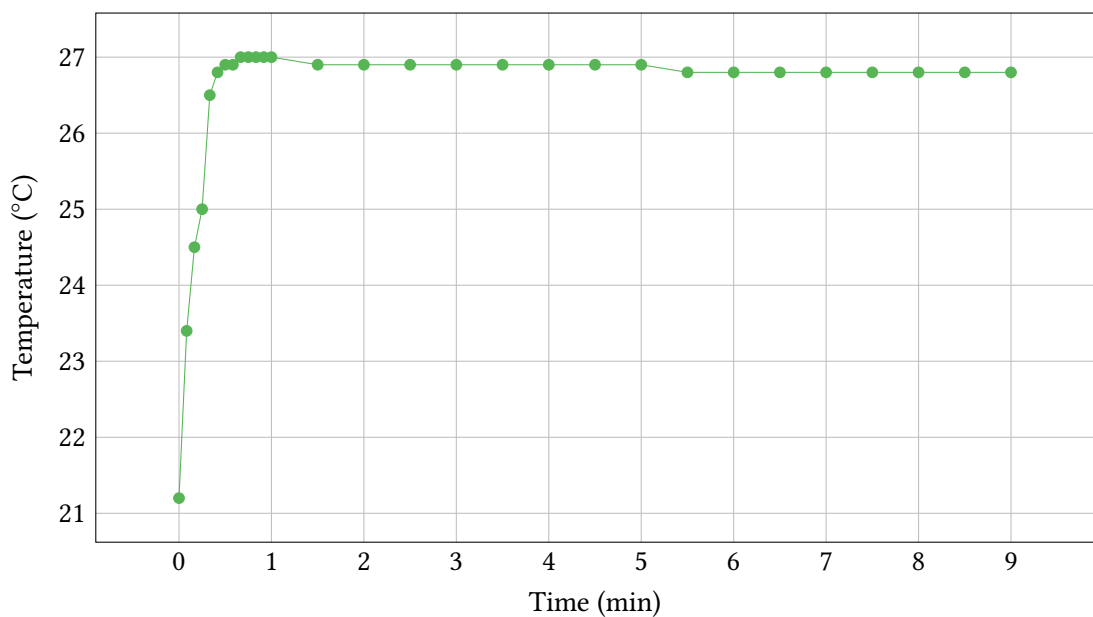
Conc. HCl: 0.9295 M

Temp. HCl before: 20.4 °C

Temp. NaOH before: 22.0 °C

Upon mixing the acid and the base, the temperature was measured every five seconds for one minutes, then every 30 seconds for an additional nine minutes. This is represented in Figure 3.

Figure 3: Temperature in the calorimeter after mixing the hydrochloric acid and sodium hydroxide solutions. (Data in Table 3)



4 Discussion

5 Conclusions

6 Data

Table 1: Part A. Temperature of dissolution of sodium hydroxide.

Time	Temperature (°C)
0 s	23.5
10 s	23.9
20 s	24.6
30 s	25.3
40 s	26.0
50 s	26.6
1 min	27.0
2 min	29.1
3 min	30.3
4 min	31.0
5 min	31.4
6 min	31.8
7 min	32.0
8 min	32.2
9 min	32.3
10 min	32.4
11 min	32.4
12 min	32.4
13 min	32.5
14 min	32.5
15 min	32.5
16 min	32.4
17 min	32.4
18 min	32.3
19 min	32.3
20 min	32.2
21 min	32.2
22 min	32.2
23 min	32.1
24 min	32.1
25 min	32.0

Table 2: Part B. Heat capacity of calorimeter.

Time	Temperature (°C)
<i>+Cool water</i>	
1 min	52.3
2 min	52.7
3 min	48.7
4 min	54.3
5 min	55.8
<i>+Warm water</i>	
6 min	46.6
7 min	38.8
8 min	38.9
9 min	38.8
10 min	38.8
11 min	38.7
12 min	38.7
13 min	38.6
14 min	38.5
15 min	38.4
16 min	38.4

Table 3: Part C. Neutralization of strong base with strong acid.

Time	Temperature (°C)
0 s	21.2
5 s	23.4
10 s	24.5
15 s	25
20 s	26.5
25 s	26.8
30 s	26.9
35 s	26.9
40 s	27
45 s	27
50 s	27
55 s	27
1 min	27
1.5 min	26.9
2 min	26.9
2.5 min	26.9
3 min	26.9
3.5 min	26.9
4 min	26.9
4.5 min	26.9
5 min	26.9
5.5 min	26.8
6 min	26.8
6.5 min	26.8
7 min	26.8
7.5 min	26.8
8 min	26.8
8.5 min	26.8
9 min	26.8

References

- [1] Sue Stathopoulos. *CHEM 123L Laboratory Manual*. Waterloo, ON, 2020. Chap. 2.