Course no: CHEM 118

Experiment no:

Group no: 6

Student ID : 2405029

Partner's ID : 2405007

Name of the experiment: CALORIMETRIC DETERMINATION OF HEAT OF DISSOLUTION REACTIONS (HEATS OF DISSOCIATION)

Date of Performance: 26.01.2026

Date of Submission :

## Introduction:

Chemical reactions involve the making and breaking of bonds, processes inherently associated with energy changes. These energy changes can manifest as heat, which is either absorbed/released into the surroundings. When a solid ionic compound dissolves in water, a complex interplay of forces determines the overall heat change. The theory underlying these processes is rooted in the concepts of enthalphy, entropy and the enegetics of solute-solvent interactions.

- Enthalpy:

Enthalpy ($\Delta H$) tracks how heat moves between the chemical system and its surrondings. In exothermic ($\Delta H < 0$), the system releases heat because the energy realeased when ions bond with water is greater than the energy needed to pull the solid apart. where, endothermic is vice-versa

- Dissolution process:

Disruption of Ionic Lattice (Endothermic) — ionic bonds in the solid lattice must be broken, which requires a significant amount of energy. This energy is known as the Lattice energy (U), which is always positive

Hydration of Ions (Exothermic) — once free, ions are solvated by water. Because water is polar, its partial charges attract the ions. This sticking process is exothermic and releases energy ($\Delta H_{hydration}$)

- Net Enthalpy Change ($\Delta H_{soln}$):

$$\Delta H_{solution} = U + \Delta H_{hydration}$$

$$MgSO_4(s) + H_2O(l) \longrightarrow Mg^{2+}(aq) + SO_4^{2-}(aq) + heat$$

$$NaNO_3(s) + H_2O(l) \longrightarrow Na^{+}(aq) + NO_3^{-}(aq) - heat$$

The dissolution of ionic compounds also involves changes in entropy (S), which is a measure of disorder. Even if a dissolution process is endothermic, it may still occur spontaneously if the increase in entropy is significant. Dissolution generally increases the disorder of the system because the structured ionic lattice breaks down into freely moving ions in solution. The Gibbs free energy ($\Delta G$), given by, $\Delta G = \Delta H - T\Delta S$, ultimately determines the spontaneity of the dissolution.

Name of the Chemicals:

- $MgSO_4$
- $NaNO_3$
- Distilled water

List of Apparatus:

- Calorimeter
- Thermometer
- Measuring cylinder

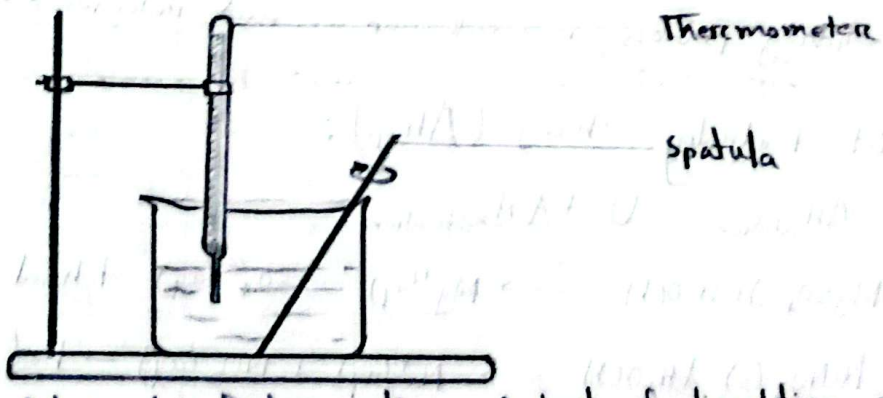



Fig: Calorimetric Determination of heat of dissolution reaction

## Data :

### Table-1: Observation of temperature over time for $MgSO_4$

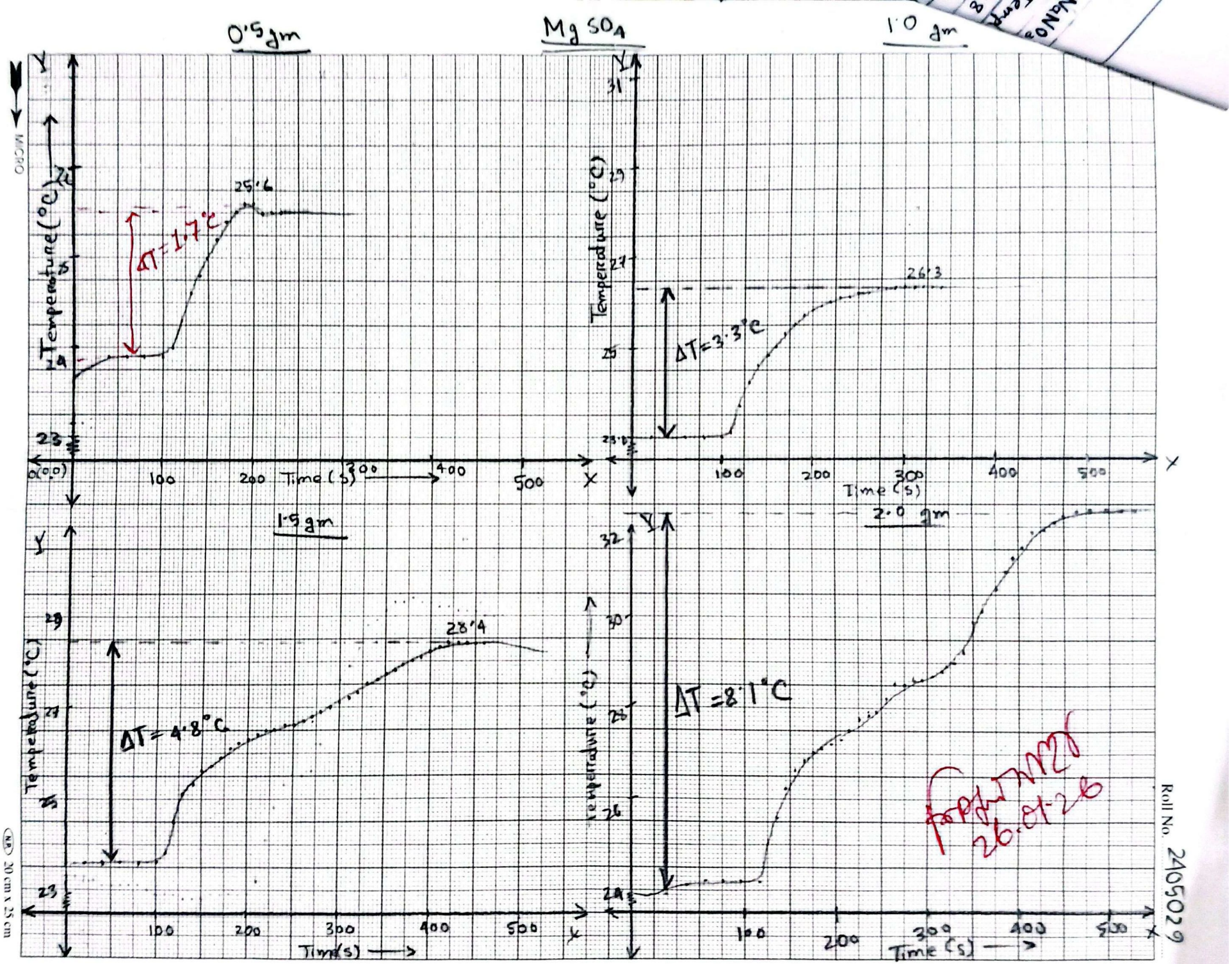
| Mass of $MgSO_4$ (0.5gm) | | Mass of $MgSO_4$ (0.5gm) | | Mass of $MgSO_4$ (1.0gm) | | Mass of $MgSO_4$ (1.0gm) | |
|---|---|---|---|---|---|---|---|
| ~~$MgSO_4$ (0.5gm)~~ Time (s) | Temp (°C) | Time (s) | Temp (°C) | Time (s) | Temp (°C) | Time (s) | Temp (°C) |
| 0 | 23.3 | 230 | 25.5 | 0 | 23.1 | 230 | 26.1 |
| 20 | 23.8 | | | 20 | 23.0 | 240 | 26.1 |
| 40 | 23.9 | | | 40 | 23.0 | 250 | 26.2 |
| 60 | 23.9 | | | 60 | 23.0 | 260 | 26.2 |
| 80 | 23.9 | | | 80 | 23.0 | 270 | 26.3 |
| 100 | 23.9 | | | 100 | 23.0 | 280 | 26.3 |
| 110 | 24.0 | | | 110 | 23.1 | 290 | 26.3 |
| 120 | 24.3 | | | 120 | 23.7 | 300 | 26.3 |
| 130 | 24.6 | | | 130 | 24.2 | 310 | 26.3 |
| 140 | 24.8 | | | 140 | 24.6 | 320 | 26.3 |
| 150 | 25.0 | | | 150 | 24.8 | 330 | 26.3 |
| 160 | 25.2 | | | 160 | 25 | 340 | 26.3 |
| 170 | 25.4 | | | 170 | 25.3 | | |
| 180 | 25.5 | | | 180 | 25.5 | | |
| 190 | 25.6 | | | 190 | 25.7 | | |
| 200 | 25.6 | | | 200 | 25.8 | | |
| 210 | 25.5 | | | 210 | 25.9 | | |
| 220 | 25.5 | | | 220 | 26 | | |

| Mass of $MgSO_4$ (1.5gm) | | Mass of $MgSO_4$ (1.5gm) | | Mass of $MgSO_4$ (2.0gm) | | Mass of $MgSO_4$ (2.0gm) | |
|---|---|---|---|---|---|---|---|
| ~~Mass~~ Time (s) | Temp (°C) | Time (s) | Temp (°C) | Time (s) | Temp (°C) | Time (s) | Temp (°C) |
| 0 | 23.6 | 260 | 26.8 | 0 | 22.7 | 300 | 28.5 |
| 20 | 23.6 | 270 | 26.9 | 20 | 23.9 | 310 | 28.6 |
| 40 | 23.6 | 280 | 27 | 40 | 24.1 | 320 | 28.6 |
| 60 | 23.6 | 290 | ~~27.1~~ | 60 | 24.1 | 330 | 28.7 |
| 80 | 23.6 | 300 | 27.2 | 80 | 24.2 | 340 | 28.8 |
| 100 | 23.6 | 310 | 27.3 | 100 | 24.2 | 350 | 28.9 |
| 110 | 23.8 | 320 | 27.3 | 120 | 24.2 | 360 | 29.0 |
| 120 | 24.5 | 330<br>340 | 27.5<br>27.6 | 140 | 24.2 | 370<br>380 | 29.3<br>~~29.8~~ |
| 130 | 25.1 | 350 | 27.7 | 150 | 25.0 | 390 | 30.1 |
| 140 | 25.3 | 360 | 27.8 | 160<br>170 | 25.6<br>~~26.6~~ | ~~400~~<br>410 | ~~30.6~~<br>31.0 |
| 150 | 25.6 | 370 | 27.9 | 180 | 26.6 | 420 | 31.3 |
| 160 | 25.7 | 380 | 28 | 190<br>200 | 26.8 | 430<br>440 | 31.5<br>31.8 |
| 170 | 25.9 | 390 | 28.1 | 210 | ~~27.3~~<br>27.1 | 450 | 31.9 |
| 180 | 26.1 | 400 | 28.2 | 220 | 27.2 | 460 | 32.1 |
| 190 | 26.2 | 410 | 28.3 | 230 | 27.3 | 470 | 32.2 |
| 200 | 26.3 | 420 | 28.4 | 240 | 27.5 | 480 | ~~32.3~~<br>32.3 |
| 210 | 26.4 | 430 | 28.4 | 250 | 27.7 | 490 | 32.3 |
| 220 | 26.5 | | | 260 | 27.8 | 500 | 32.3 |
| 230 | 26.5 | | | 270 | 27.9 | 510 | 32.3 |
| 240 | 26.6 | | | 280 | 28.2 | 520 | 32.3 |
| 250 | 26.7 | | | 290 | 28.5 | | |

Table-2: Observation of Temperature of $NaNO_3$ over time

| Mass of $NaNO_3$(0.5g) | | Mass of $NaNO_3$(0.5g) | | Mass of $NaNO_3$(1.0gm) | | Mass of $NaNO_3$ | |
|---|---|---|---|---|---|---|---|
| Time(s) | Temp(°C) | Time(s) | Temp(°C) | Time(s) | Temp(°C) | Time(s) | Temp |
| 0 | 24.1 | 210 | 23.9 | 0 | 24.5 | 190 | 23.8 |
| 20 | 24.1 | 220 | 23.9 | 20 | 24.6 | 200 | 23.8 |
| 40 | 24.1 | 230 | 23.9 | 40 | 24.6 | 210 | 23.7 |
| 60 | 24.1 | 240 | 23.9 | 60 | 24.5 | 220 | 23.7 |
| 80 | 24.1 | 250 | 23.9 | 80 | 24.5 | 230 | 23.7 |
| 100 | 24.0 | 260 | 23.9 | 90 | 24.4 | 240 | 23.6 |
| 120 | 23.8 | 270 | 23.9 | 100 | 24.2 | 250 | 23.6 |
| 130 | 23.8 | 280 | 24.0 | 110 | 24.1 | 260 | 23.6 |
| 140 | 23.8 | 290 | 24.0 | 120 | 24.0 | 270 | 23.6 |
| 150 | 23.8 | 300 | 24.0 | 130 | 24.0 | 280 | 23.6 |
| 160 | 23.7 | 310 | 24.1 | 140 | 24.0 | 290 | 23.6 |
| 170 | 23.8 | 320 | 24.1 | 150 | 24.0 | 300 | |
| 180 | 23.8 | | | 160 | 24.0 | | |
| 190 | 23.8 | | | 170 | 23.9 | | |
| 200 | 23.8 | | | 180 | 23.9 | | |

| Mass of $NaNO_3$(1.5gm) | | Mass of $NaNO_3$(1.5gm) | | Mass of $NaNO_3$(2.0gm) | Mass of $NaNO_3$(2.0g |
|---|---|---|---|---|---|
| Time(s) | Temp(°C) | Time(s) | Temp(°C) | Time(s) | Temp (°C) |
| 0 | 23.3 | 230 | 23.2 | 0 | 22.8 |
| 20 | 24.4 | 240 | 23.1 | 20 | 24.1 |
| 40 | 24.5 | 250 | 23.1 | 40 | 24.3 |
| 60 | 24.5 | 260 | 23.1 | 60 | 24.5 |
| 80 | 24.5 | 270 | 23.1 | 80 | 24.5 |
| 90 | 24.5 | 280 | 23.1 | 90 | 24.3 |
| 100 | 24.4 | 290 | 23.1 | 100 | 23.5 |
| 110 | 24.3 | 300 | 23.1 | 110 | 23.3 |
| 120 | 24.1 | | | 120 | 23.1 |
| 130 | 23.8 | | | 130 | 22.8 |
| 140 | 23.8 | | | 140 | 22.6 |
| 150 | 23.6 | | | 150 | 223 |
| 160 | 23.6 | | | 160 | 22.1 |
| 170 | 23.5 | | | 170 | 22.1 |
| 180 | 23.3 | | | 180 | 22.1 |
| 190 | 23.3 | | | 190 | 22.1 |
| 200 | 23.3 | | | 200 | 22.1 |
| 210 | 23.2 | | | 210 | 22.1 |
| 220 | 23.2 | | | | |

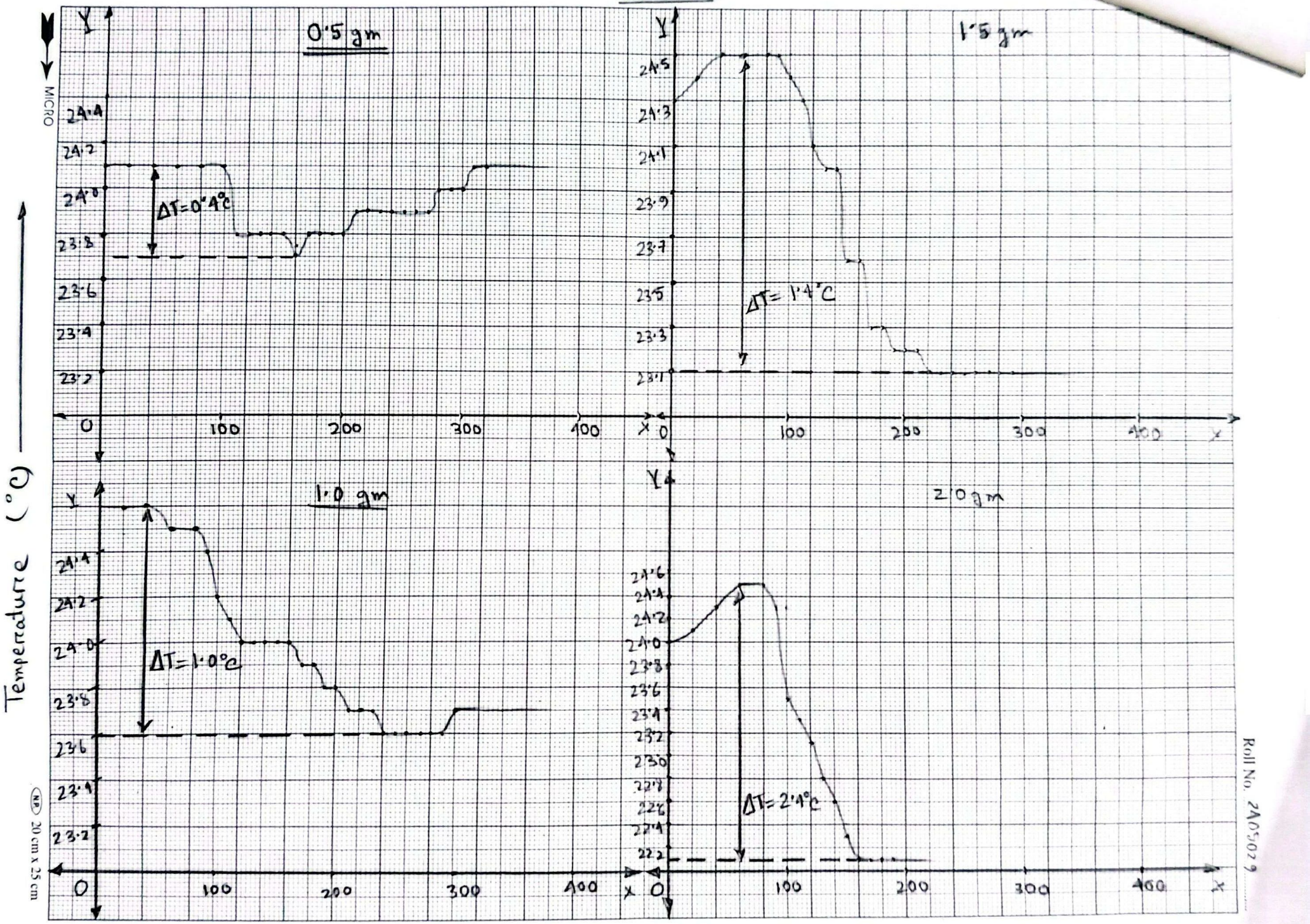



Roll No. 2405029

MICRO

20 cm x 25 cm

$NaNO_3$




Roll No. 2A05029

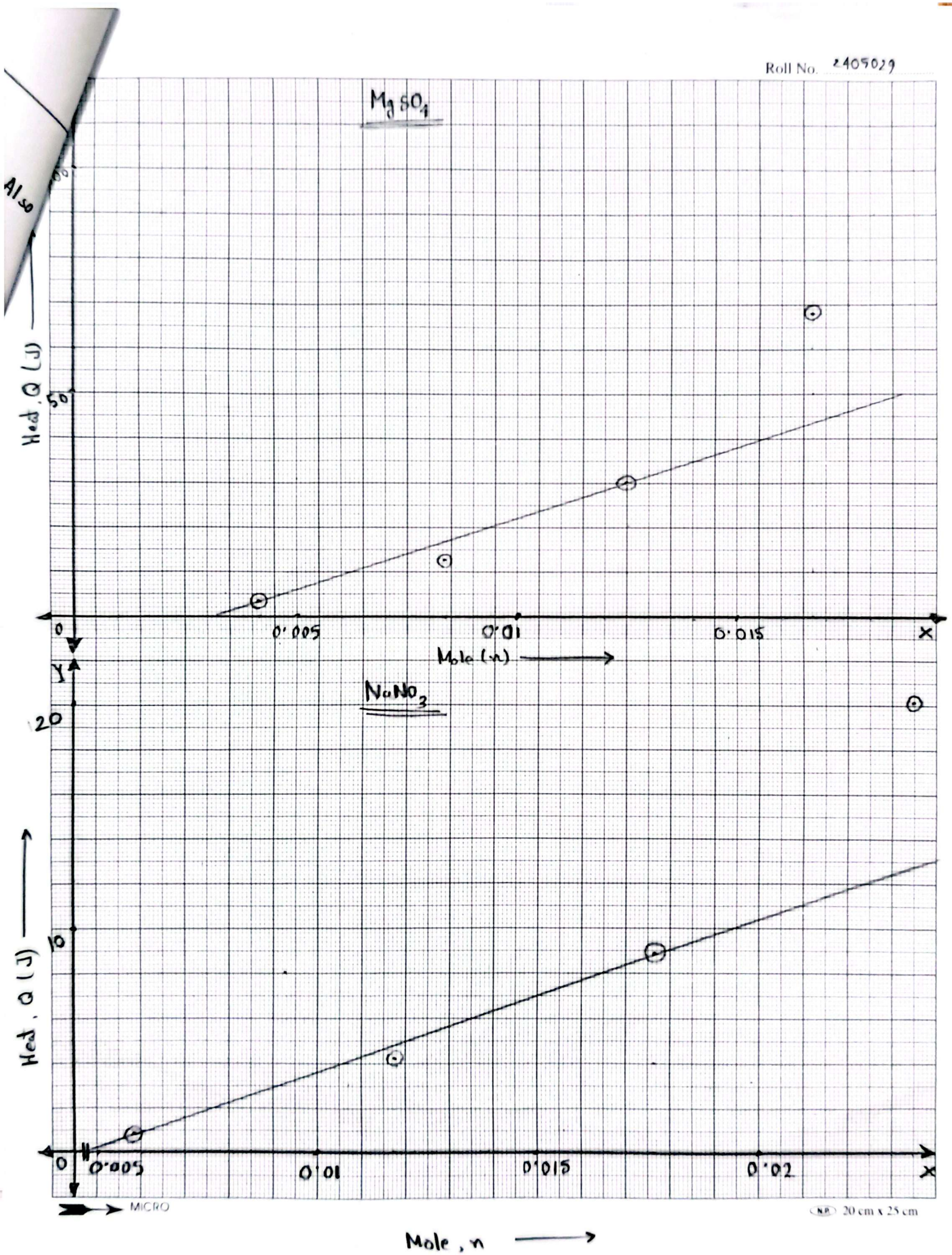
Table – 3 : Heat and Mole for $MgSO_4$ ($M_A$ = 120 g/mole)

| Mass, M ($\times 10^{-3}$ kg) | Heat, $Q = CM\Delta T$ (J) | Moles, $n = \frac{M}{M_A}$ |
|---|---|---|
| 0·5 | $Q = 0{\cdot}5 \times 10^{-3} \times 4200 \times 1{\cdot}7 = 3{\cdot}57$ | ~~0·003125~~ 0·004167 |
| 1·0 | $Q = 1 \times 10^{-3} \times 4200 \times 3{\cdot}3 = 13{\cdot}86$ | 0·00833 |
| 1·5 | $Q = 1{\cdot}5 \times 10^{-3} \times 4200 \times 4{\cdot}8 = 30{\cdot}24$ | 0·0125 |
| 2·0 | $Q = 2{\cdot}0 \times 10^{-3} \times 4200 \times 8{\cdot}1 = 68{\cdot}04$ | 0·0167 |

Table-4: Heat and mole calculation for $NaNO_3$ ($M_B$ = 85g/mole)

| Mass, M ($\times 10^{-3}$ kg) | Heat, $Q = CM\Delta T$ (J) | Moles, $n = \frac{M}{M_B}$ |
|---|---|---|
| 0·5 | $Q = 0{\cdot}5 \times 10^{-3} \times 4200 \times 0{\cdot}4 = 0{\cdot}84$ | 0·005882 |
| 1·0 | $Q = 10 \times 10^{-3} \times 4200 \times 1 = 4{\cdot}2$ | 0·011765 |
| 1·5 | $Q = 1{\cdot}5 \times 10^{-3} \times 4200 \times 1{\cdot}4 = 8{\cdot}82$ | 0·01765 |
| 2·0 | $Q = 2 \times 10^{-3} \times 4200 \times 2{\cdot}4 = 20{\cdot}16$ | 0·02353 |

Roll No. 2405029




N.B. 20 cm x 25 cm

## Discussion:

The room temperature varied a little in every experiment. Also the time to stir the salts properly was not same everytime, which may have resulted in the Q vs n graph error. The graph was supposed to be a pure straight Line but it missed one point greatly, because of experimental error or wrong amount of substances used or faulty measuring systems.

Name of E

No. of Exp: 04

Name of Experiment: CALORIMETRIC DETERMINATION OF HEAT OF DISSOLUTION REACTIONS (HEATS OF DISSOCIATION)

Name: Sajut Arafin Khan; ID: 2405027; Section: A1

Course: CHE 116 Date: 26/01/26

$MgSO_4$ (0.5 gm)

| Time(s) | Temperature (°C) | Time (s) | Temperature (°C) |
|---|---|---|---|
| 0 | 23.3 | 170 | 25.4 |
| 20 | 23.8 | 180 | 25.5 |
| 40 | 23.9 | 190 | 25.6 |
| 60 | 23.9 | 200 | 25.6 |
| 80 | 23.9 | 210 | 25.5 |
| 100 | 23.9 | 220 | 25.5 |
| 110 | 24.0 | 230 | 25.5 |
| 120 | 24.3 | | |
| 130 | 24.6 | | |
| 140 | 24.8 | | |
| 150 | 25.0 | | |
| 160 | 25.2 | | |

$\Delta T = 1.7$ °C

[illegible]
26.01.26

Name: Rakibul Hasan Ritat Roll: 2405019 Date: 26/01/2026

Exp name: calorimetric determination of heat of dissolution reactions (Heats of Dissolation)

DATA TABLE 1: Observation of temperature over time interval

| Mass of $MgSO_4$ .05gm | |
|---|---|
| Time (s) | Temp (°C) |
| 220 | 26 |
| 230 | 26.1 |
| 240 | 26.1 |
| 250 | 26.2 |
| 260 | 26.2 |
| 270 | 26.3 |
| 280 | 26.3 |
| 290 | 26.3 |
| 300 | 26.3 |
| 310 | 26.3 |
| 320 | 26.3 |
| 330 | 26.3 |
| 340 | 26.3 |

$\Delta T = 3.3°C$

for PH TW 26-01-26

| Mass of $MgSO_4$ 1.0gm | |
|---|---|
| Time(s) | Temp(°C) |
| 0 | 23.1 |
| 20 | 23.0 |
| 90 | 23.0 |
| 60 | 23.0 |
| 80 | 23.0 |
| 100 | 23.0 |
| 110 | 23.1 |
| 120 | 23.2 |
| 130 | 24.2 |
| 140 | 24.6 |
| 150 | 24.8 |
| 160 | 25 |
| 120 | 25.3 |
| 180 | 25.5 |
| 190 | 25.3 |
| 200 | 25.8 |
| 210 | 25.9 |

No of Exp : 04

Name of Experiment: Calorimetric determination of heat of decomposition reactions. (Heats of Dissociation)

D.

Table: Observation of Temperature Overtime Interval

Mass of $MgSO_4$ ~~[illegible]~~

| Time (s) | Temp (°C) |
|---|---|
| 250 | 26.6 |
| 260 | 26.7 |
| 270 | ~~26~~ 26.8 |
| 280 | 26.9 |
| 290 | 27 |
| 300 | 27.1 |
| 310 | 27.2 |
| 320 | 27.3 |
| 330 | 27.5 |
| 340 | 27.6 |
| 350 | 27.7 |
| 360 | 27.8 |
| 370 | 27.9 |
| 380 | 28 |
| 390 | 28.1 |
| 400 | 28.2 |
| 410 | 28.3 |
| 420 | 28.4 |
| 430 | 28.4 |

$\Delta T = 4.8^{\circ}C$

for 1.5 g

26.01.26

(1.5 g) Mass of $MgSO_4$

| Time (s) | Temp (°C) |
|---|---|
| 0 | 23.6 |
| 20 | |
| 40 | |
| 60 | |
| 80 | |
| 100 | |
| 110 | |
| 120 | |
| 130 | |
| 140 | |
| 150 | |
| 160 | |
| 170 | |
| 180 | |
| 190 | |
| 200 | |
| 210 | |
| 220 | |
| 230 | |

Name: Ahmad Taquie Abir ID: 2405018

Course: CHE-116 Section: A1

Date: 26.01.2026

No. of Exp: 04

Name of Exp: CALORIMETRIC DETERMINATION OF HEAT OF DISSOLUTION REACTIONS (HEATS OF DISSOCIATION).

2.0 gm

| Mass of $MgSO_4$ (2.0g) | | Mass of $MgSO_4$ (2.0g) | |
|---|---|---|---|
| Time (s) | Temp (°C) | Time (s) | Temp (°C) |
| 0 | 22.7 | 340 | 28.8 |
| 20 | 23.9 | 350 | 28.9 |
| 40 | 24.1 | 360 | 29.6 |
| 60 | 24.1 | 370 | 29.3 |
| 80 | 24.2 | 380 | 29.8 |
| 100 | 24.2 | 390 | 30.1 |
| 120 | 24.2 | 400 | 30.6 |
| 140 | 24.2 | 410 | 31.0 |
| 130 | 25.0 | 420 | 31.3 |
| 160 | 25.6 | 430 | 31.5 |
| 170 | 26.2 | 440 | 31.8 |
| 180 | 26.6 | 450 | 31.9 |
| 190 | 26.8 | 460 | 32.1 |
| 200 | 27.0 | 470 | 32.2 |
| 210 | 27.1 | 480 | 32.3 |
| 220 | 27.2 | 490 | 32.3 |
| 230 | 27.3 | 500 | 32.3 |
| 240 | 27.5 | 510 | 32.3 |
| 250 | 27.7 | 520 | 32.3 |
| 260 | 27.8 | | |
| 270 | 27.9 | | |
| 280 | 28.2 | | |
| 290 | 28.5 | | |
| 300 | 28.5 | | |
| 310 | 28.6 | | |
| 320 | 28.6 | | |
| 330 | 28.7 | | |

$\delta T = 8.1°C$

26.01.26

No. of Exp: 04

Name of Experiment: CALORIMETRIC DETERMINATION OF HEAT OF DISSOLUTION REACTIONS (HEATS OF DISSOCIATION)

Name: Md. Shabil Zaman; ID: 2405013; Section: A1; Course No: CHEM116

Date: 26/01/2026

## Mass of $NaNO_3$ (0.5g)

| Time(s) | Temperature(°C) | Time(s) | Temperature(°C) |
|---|---|---|---|
| 20 | 24.1 | ~~280~~ 220 | 23.9 |
| 40 | 24.1 | ~~290~~ 230 | 23.9 |
| 60 | 24.1 | ~~300~~ 240 | 23.9 |
| 80 | 24.1 | ~~310~~ 250 | 23.9 |
| 100 | 24.0 | ~~320~~ 260 | 23.9 |
| 120 | 23.8 | ~~330~~ 270 | 23.9 |
| ~~140~~ 130 | 23.8 | 340 280 | 24.0 |
| ~~160~~ 140 | 23.8 | 350 290 | 24.0 |
| ~~180~~ 150 | 23.8 | 360 300 ~~370~~ | 24.0 |
| ~~200~~ 160 | 23.7 | 310 ~~380~~ ~~370~~ | 24.1 |
| ~~220~~ 170 | 23.8 | 320 ~~390~~ 380 | 24.1 |
| ~~240~~ 180 | 23.8 | ~~400~~ 390 | |
| 250 190 | 23.8 | ~~410~~ ~~400~~ | |
| ~~260~~ 200 | 23.8 | 410 | |
| ~~270~~ 210 | 23.9 | | |

0.4

for DMTA
26.01.26

EXP: 04

EXP: CALORIMETRIC DETERMINATION OF HEAT OF DISSOLUTION REACTIONS

Name: Swapnil Das ID: 2405016

Data Table: Observation of temperature over time intervals

| Mass of $NaNO_3$ - 1.0 gm | | | Mass of $NaNO_3$ - 1.0 gm | |
|---|---|---|---|---|
| Time (s) | Temp (°C) | | Time (s) | Temp (°C) |
| 0 | ~~24.2~~ 24.5 | | 170 | 23.9 |
| 20 | ~~24.2~~ 24.6 | | 180 | 23.9 |
| 40 | ~~24.1~~ 24.6 | | 190 | 23.8 |
| 60 | 24.5 | | 200 | 23.8 |
| 80 | 24.5 | | 210 | 23.7 |
| 90 | 24.4 | $\Delta T = 0.9$ | 220 | 23.7 |
| 100 | 24.5 | | 230 | 23.7 |
| 110 | 24.5 | | 240 | 23.6 |
| 120 | 24.5 | | 250 | 23.6 |
| 130 | 24.6 | | 260 | 23.6 |
| 140 | 24.5 | | 270 | 23.6 |
| 150 | 24.6 | | 280 | 23.6 |
| 160 | 24.5 | | 290 | 23.6 |

26.01.26

Expt no - 9

Expt name: CALORIMETRIC DETERMINATION OF HEAT OF DISSOCIATION REACTION

Name : MD. Sifat Mondal
ID: 2405008
Section : A1
Dept : CSE

Table: Observation of temperature over time interval

| Mass of $NaNO_3$ (1.5gm) | | | Mass of $NaNO_3$ (1.5gm) | |
|---|---|---|---|---|
| Time (s) | Temp (°c) | | Time (s) | Temp (°c) |
| 0 | 23.3 | | 190 | 23.3 |
| 20 | 24.4 | | 200 | 23.3 |
| 40 | 24.5 | | 210 | 23.2 |
| 60 | 24.5 | | 220 | 23.2 |
| 80 | 24.5 | | 230 | 23.2 |
| 90 | 24.5 | | 240 | 23.1 |
| 100 | 24.4 | | 250 | 23.1 |
| 110 | 24.3 | | 260 | 23.1 |
| 120 | 24.1 | | 270 | 23.1 |
| 130 | 23.8 | | 280 | 23.1 |
| 140 | 23.8 | $\Delta T = 1.4$ | 290 | 23.1 |
| 150 | 23.6 | | | |
| 160 | 23.6 | | | |
| 170 | 23.5 | | | |

Sifat Mondal
26.01.26

Name : Md Ratul Hasan  Date: 26.01.26

Roll: 2405009

Exp. Name : Calorimetric determination of heat of dissolution reactions (heats of dissociation)

Data table: Observation of temperature over time intervals

① Mass of $NaNO_3$ ~~$MgSO_4$~~ ~~2g~~ 2.0gm ~~0.5gm~~

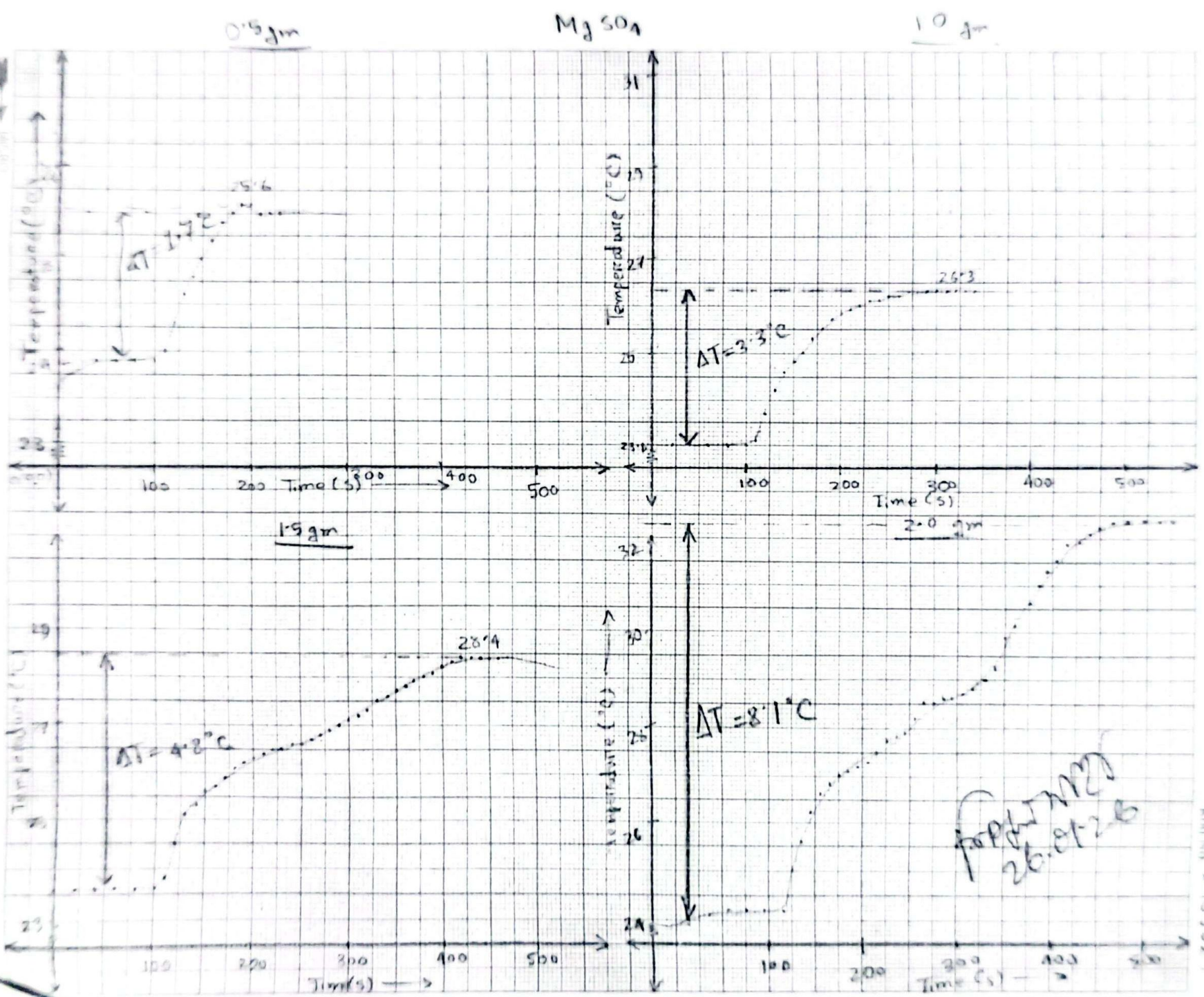
| Time (s) | Temp (°c) |
|---|---|
| 0 | ~~22.5~~ 22.8 |
| 20 | ~~23.4~~ 24.1 |
| 40 | ~~23.6~~ 24.3 |
| 60 | ~~23.4~~ 24.5 |
| 80 | ~~23.4~~ 24.5 |
| 90 | ~~23.3~~ 24.3 |
| 100 | ~~23.1~~ 23.5 |
| 110 | ~~22.1~~ 23.3 |
| 120 | ~~23.0~~ 23.1 |
| 130 | ~~22.9~~ 22.8 |
| 140 | ~~22.8~~ 22.6 |
| 150 | ~~22.8~~ 22.3 |
| 160 | ~~22.6~~ 22.1 |
| 170 | ~~22.6~~ 22.1 |
| 180 | ~~22.1~~ ~~22.5~~ ? |
| 190 | ~~22.1~~ ~~22.6~~ |
| 200 | ~~22.1~~ ~~22.1~~ |
| 210 | ~~22.1~~ |

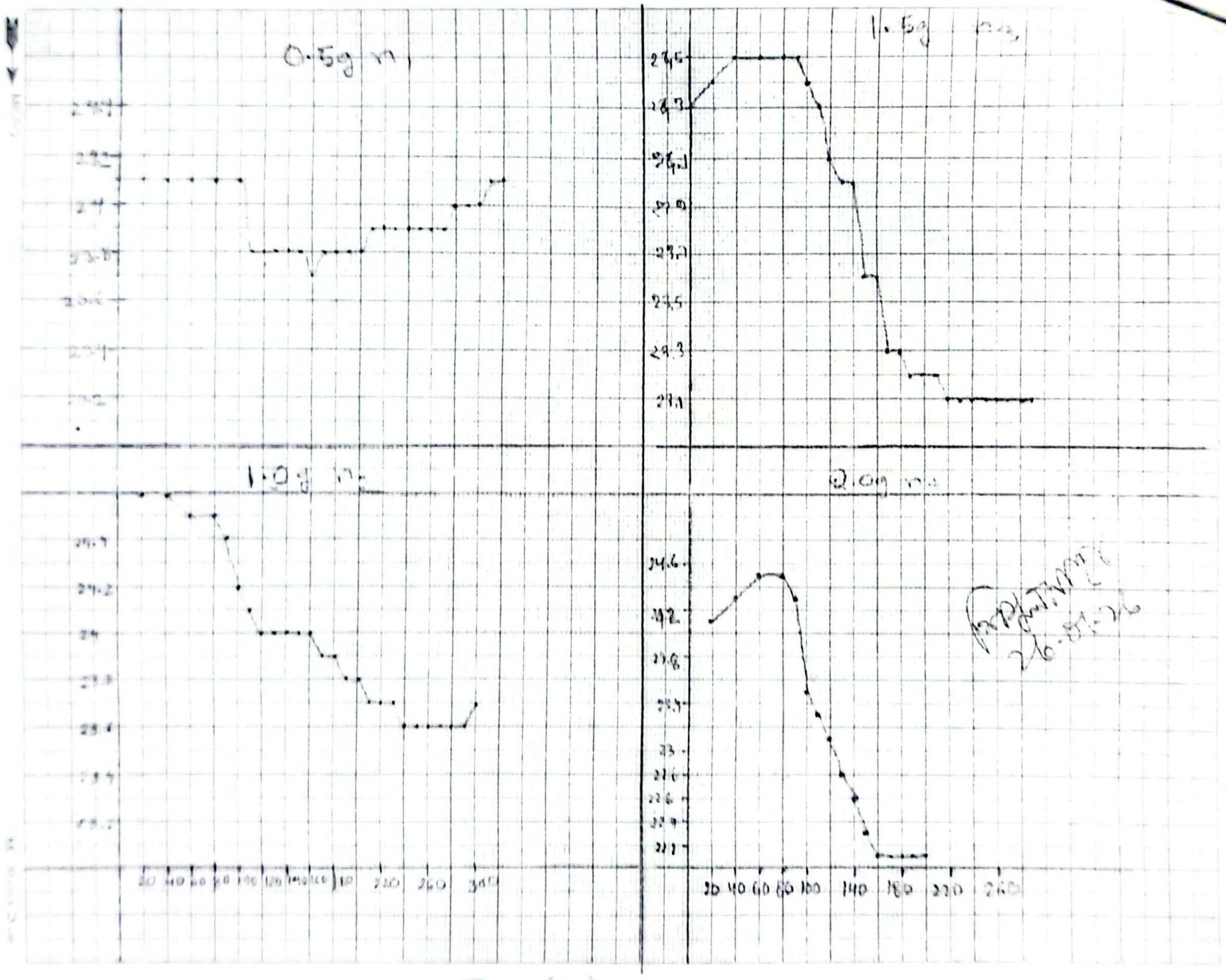
$\Delta T = 2.4$

For myself
26.01.26

② Mass of $NaNO_3$ ~~$MgSO_4$~~ – 1.0gm

| Time (s) | Temp (°c) |
|---|---|
| ~~220~~ | ~~22.6~~ |
| ~~230~~ | ~~22.6~~ |
| ~~240~~ | ~~22.6~~ |


0·5 gm
MgSO4
1·0 gm
Temperature (°C)
ΔT = 1·7°C
25·6
ΔT = 3·3°C
26·3
100
200
Time (s)
300
400
500
1·5 gm
2·0 gm
ΔT = 4·8°C
28·4
ΔT = 8·1°C
Time (s) →


0.5g
1.0g
1.5g
2.0g
Time (s) →