**GENERAL CHEMISTRY**

**LAB COMPONENT CHE101L**

**CONTENT: LAB 3**

**Dissolution Reactions: Heats of Dissociation**

**NAME** …… **SECTION** …….

**STUDENT ID** ……

**DATE & TIME** ……

**NAME OF THE INSTRUCTOR** ……

**SIGNATURE & DATE** ……

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## EXPERIMENT 3

## SESSION 1 (QUALITATIVE)

## DISSOLUTION REACTIONS: HEATS OF DISSOCIATION

Heats (exothermic or endothermic) are associated with chemical reactions. Quantity of heat evolved or absorbed is directly proportional to the amount reacted. Consider the reactions below:

$$MgSO4(s) + H_2O\ (l) \longrightarrow Mg^{2+}(aq.) + SO_4^{2-}(aq.) \pm \text{heat}$$

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

Heat could be generated or absorbed in this reaction. When heat is generated/released from a chemical reaction it is called exothermic reaction (you can feel it by touching the reaction container (warmer) and when heat is absorbed the reaction is called endothermic (colder). When reactions occur in a reaction vessel (*e.g.,* Beaker) in aqueous condition, formation and dissociation of chemical bonds occur simultaneously. Bond formation and dissociation involves heat energy of the system which is expressed by the term Q which is called enthalpy.

**PROBLEM STATEMENT:** **Is heat energy related to chemical reactions, how?**

This experiment is subdivided into two parts:

I. **QUALITATIVE**
II. **QUANTITATIVE**

## PART I. QUALITATIVE

**DATA COLLECTION:**

Place about 30 mL of distilled water into a 50 mL beaker. Suspend a thermometer (having $0.1^0$C division mark) into the beaker using thermometer clamp and ring stand. Please make sure that the thermometer is not touching the bottom of the beaker, as any movement of the beaker could break the thermometer. Record the temperature of water in the beaker in every 30 seconds for 180 seconds.

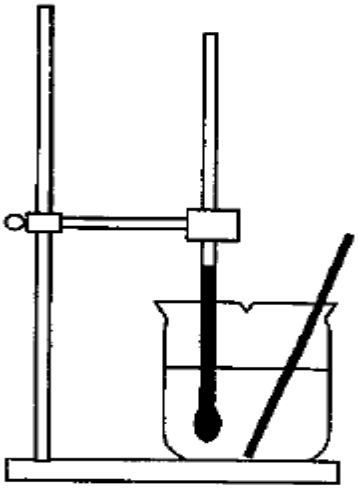

**FIGURE 1:** Experimental setup for dissolution reaction

Place a moderate amount (which would be 1 to 3 $cm^3$) of supplied anhydrous magnesium sulfate ($MgSO_4$) to the beaker. Mix vigorously with the glass rod for 2 minutes. Record your observations. **(2 points)**

Repeat this procedure with each of the following compounds with two different amounts (roughly 1:2): (**2 points)**

a. Sodium Nitrate, $NaNO_3$

b. Sodium Chloride, NaCl

c. Hydrated Calcium Chloride, $CaCl_2.2H_2O$

d. Ammonium Nitrate, $NH_4NO_3$

**DATA ANALYSIS:**

Compare and contrast the behaviors of these compounds. Identify any generalizations that can be made about the chemical reactions observed. What conclusions can be drawn from the data? (4 points)

## SESSION 2(QUANTITATIVE)

## PART II. QUANTITATIVE

### DATA COLLECTION:

a. Accurately weigh a 3 to 5 gm sample of $MgSO_4$ on the analytical balance. Record the exact mass here. For 4 different trials below measure four different weight samples (e.g., 1,2, 4 & 5 grams respectively).
b. Suspend the thermometer into a polystyrene cup/coffee cup. Make sure of the thermometer is not touching the bottom of the cup. Measure 20 mL of distilled water by a volumetric cylinder into the cup and stir for 240 second. Record the temperature in every 20 seconds. After 240 seconds add $MgSO_4$ with vigorous mixing while continuing to record data for 5 minutes.
c. Determine the temperature change, $\Delta T$, for the reaction. This can be done from the difference of the highest temperature minus the slope of the line go through the points from first 240 seconds of data.
d. Draw a temperature vs. time graph. Draw the best curve through the points and point out what is happing in each part of the curve.
e. Repeat the whole procedure with $NaNO_3$.

### DATA TABLE 1:

**TRAILS**

| **(I) Mass of $MgSO_4$ _0.5 gm** | | | **(II) Mass of $MgSO_4$_1.0 gm** | |
|---|---|---|---|---|
| Time (s) | Temp($^0$C) | | Time(s) | Temp($^0$C) |
| 20 | | | 20 | |
| 40 | | | 40 | |
| 60 | | | 60 | |
| 80 | | | 80 | |
| 100 | | | 100 | |
| 120 | | | 120 | |
| 140 | | | 140 | |
| 160 | | | 160 | |
| 180 | | | 180 | |
| 200 | | | 200 | |
| 220 | | | 220 | |
| 240 | | | 240 | |
| 260 | | | 260 | |
| 280 | | | 280 | |
| 300 | | | 300 | |

| (III) Mass of $MgSO_4$ _1.5 gm | | | (IV) Mass of $MgSO_4$_2.0 gm | |
|---|---|---|---|---|
| Time (s) | Temp($^0$C) | | Time(s) | Temp($^0$C) |
| 20 | | | 20 | |
| 40 | | | 40 | |
| 60 | | | 60 | |
| 80 | | | 80 | |
| 100 | | | 100 | |
| 120 | | | 120 | |
| 140 | | | 140 | |
| 160 | | | 160 | |
| 180 | | | 180 | |
| 200 | | | 200 | |
| 220 | | | 220 | |
| 240 | | | 240 | |
| 260 | | | 260 | |
| 280 | | | 280 | |
| 300 | | | 300 | |

**DATA TABLE 2:** **TRAILS**

| (I) Mass of $NaNO_3$ _0.5 gm | | | (II) Mass of $NaNO_3$_1.00 gm | |
|---|---|---|---|---|
| Time (s) | Temp($^0$C) | | Time(s) | Temp($^0$C) |
| 20 | | | 20 | |
| 40 | | | 40 | |
| 60 | | | 60 | |
| 80 | | | 80 | |
| 100 | | | 100 | |
| 120 | | | 120 | |
| 140 | | | 140 | |
| 160 | | | 160 | |
| 180 | | | 180 | |
| 200 | | | 200 | |
| 220 | | | 220 | |
| 240 | | | 240 | |
| 260 | | | 260 | |
| 280 | | | 280 | |
| 300 | | | 300 | |

| (III) Mass of $NaNO_3$ _1.5 gm | | | (IV) Mass of $NaNO_3$ _2.0 gm | |
|---|---|---|---|---|
| Time (s) | Temp($^0$C) | | Time(s) | Temp($^0$C) |
| 20 | | | 20 | |
| 40 | | | 40 | |
| 60 | | | 60 | |
| 80 | | | 80 | |
| 100 | | | 100 | |
| 120 | | | 120 | |
| 140 | | | 140 | |
| 160 | | | 160 | |
| 180 | | | 180 | |
| 200 | | | 200 | |
| 220 | | | 220 | |
| 240 | | | 240 | |
| 260 | | | 260 | |
| 280 | | | 280 | |
| 300 | | | 300 | |

**DATA ANALYSIS**

1. What do you understand form both data sets you recorded and from the other trials? **(4 points)**

2. Calculate the heat, Q & moles, n, of the reaction both data sets. Take help from the equitation Q = C x M x $\Delta$T. Assume C = 4.18 Joules/gram $^0$C and M is the mass of water (take the water density as 1.00 grams/cm$^3$). **(4 points)**

3. Plot the collected data as moles, n vs. Q both sets of data. Number of moles can be calculated as n = (mass of sample in gram) / (molecular weight in grams/mole). Try to find algebraic equations. **(4 points)**

**FIGURE:** plot here

**MENTAL MODEL:** Use the chemical equation given above to represent the dissolution reaction in this experiment. Draw a picture(s) which describes what is happening in atomic or in molecular level for either $MgSO_4$ or $NaNO_3$ system. How heat release or absorbed can be described from these pictures? **(5 points)**