OBJECTIVE:

To calculate the heat of reaction of carbonates compound

INTRODUCTION:

Chemical reactions are always accompanied by energy changes. A chemical reaction that releases heat energy to the environment is said to be exothermic. One that absorbs heat from the environment is said to be endothermic. The heat change of a system at constant pressure is called the heat of reaction or enthalpy change. The enthalpy change of a system is given by symbol ΔH. The heat content of a system which undergoes an exothermic reaction is negative because the heat content is reduced.

Calorimetry is the basic technique for studying any process where heat energy is of interest. Calorimeters are designed to be well-insulated, so no heat is gained from or lost to the surroundings. The basic strategy in calorimetry is to use a temperature change and a heat capacity to determine the heat of reaction using the following equation:

$$q_{soln} = (m \times s \times \Delta T) + (C_p \times \Delta T) \qquad (6.1)$$

where, q_{soln} is the heat of reaction of the solution
m is the total masses of the reaction
s is the specific heat capacity of the final solution
$\Delta T = T_{final} - T_{initial}$
C_p is the heat capacity of calorimeter

The heat capacity of the calorimeter, C_p is often ignored such that equation 6.1 may be simplified as follows:

$$q_{soln} = (m \times s \times \Delta T) \qquad (6.2)$$

The molar enthalpy of a reaction, ΔH_{soln} is negative of the heat of reaction, q_{soln} per mole of limiting reagent, *n*

$$\Delta H_{soln} = \frac{-q_{soln}}{n} \qquad (6.3)$$

The objective of this experiment is to determine the heat of reaction (q_{rxn}) and calculate the molar enthalpy ΔH of following reactions:

$$Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2 \qquad \Delta H_1 = x \text{ kJ} \qquad (6.4)$$

$$NaHCO_3 + HCl \rightarrow NaCl + H_2O + CO_2 \qquad \Delta H_2 = y \text{ kJ} \qquad (6.5)$$

The calculations are simplified by assuming the value of *s* as equal to 4.18 J/ g °C and the density of the final solution as equal to 1.0 g/mL. The heat capacity of the calorimeter can be ignored.

LAB EQUIPMENT

Thermometer
20 mL pipette
50 mL beaker
100 mL beaker
200 mL beaker
Glass stirrer
Small towel
Large filter paper or cardboard (calorimeter covering)

CHEMICALS AND MATERIALS

Hydrochloric acid, HCl 2.0 M
Sodium carbonate, Na_2CO_3
Sodium bicarbonate, $NaHCO_3$

EXPERIMENTAL PROCEDURE:

1. Construct a simple calorimeter (see figure 6.1) using the 100 mL and 200 mL beakers and a small towel. Be sure to dry the inner beaker thoroughly before use.
2. Using the inner beaker, weigh 1.80 – 2.20 g of Na_2CO_3. Record the exact weight of the solid. Place the inner beaker inside the larger beaker as shown in the figure.
3. Pipet 20 mL of the HCl solution into another beaker and measure initial temperature, $T_{initial}$ (to one decimal place)
4. Pour the acid into the calorimeter and immediately replace the calorimeter covering. Stir the solution and determine the highest temperature (if temperature rises) or lowest temperature (if the temperature decreases). Record this temperature as the final temperature of the reaction, T_{final}.
5. Thoroughly clean the inner beaker (of the calorimeter) and repeat step 2 – 4, this time weight 2.5 – 3.0 g of $NaHCO_3$.
6. Calculate ΔT, q_{soln} and ΔH_1 and ΔH_2

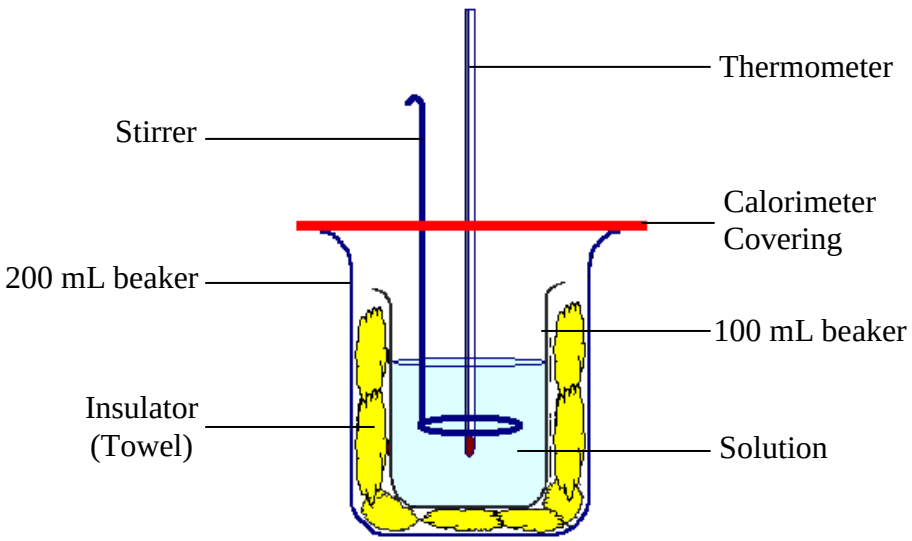

Figure 6.1: A Simple Calorimeter