Lab #6: Molar Heat of Solution and Molar Heat of Fusion

Objectives:
1. Using the First Law of Thermodynamics, Conservation of Energy, determine the Heat of Solution of NaOH and the Molar Heat of Fusion of Water.
2. Evaluate the design of a simple calorimeter.

Hypothesis:
Comment on the level of accuracy of the Styrofoam Calorimeter.

Materials:

Graduated Cylinder	Ice	Electronic Balance	Hot Plate
2 Styrofoam Cups and 2 Plastic Lids	Distilled Water	2 Thermometers	
Scoopula	$NaOH_{(s)}$	Medium Beaker	

Procedure:

A. Determining the Specific Heat Capacity of the Styrofoam Calorimeter
1. Measure 25 mL of distilled water in the Styrofoam cup. Measure the actual mass of water used and record its temperature.
2. Measure 25 mL of distilled water into the small beaker. Measure the actual mass of water used. Place it onto the hot plate and gently heat it up to around 60°C. Record the actual temperature the water is heated up to.
3. Carefully pour the hot water into the Styrofoam cup containing the room temperature water.
4. Record the final temperature of the water.

B. Molar Heat of Solution of NaOH:
1. Get approximately 50 mL of distilled water and determine its temperature.
2. Put a Styrofoam cup on the electronic balance and calibrate.
3. Measure the mass of the distilled water added.
4. Leave the Styrofoam cup with the water on the balance and recalibrate.
5. Add about 6 g of $NaOH_{(s)}$ and measure the mass.
6. Cover the cup with the plastic lid and use a thermometer to observe the temperature of the solution continuously. Be sure the $NaOH_{(s)}$ is completely dissolved. Stir using a thermometer if necessary.
7. Record the final temperature once the lowest or highest temperature is reached.

C. Molar Heat of Fusion of Water:
1. Get approximately 50 mL of distilled water and determine its temperature.
2. Put a Styrofoam cup on the electronic balance and calibrate.
3. Measure the mass of the distilled water added.
4. Leave the Styrofoam cup with the water on the balance and recalibrate.
5. Add about 10 g of ice and place it in the water and measure the mass.
6. Measure the temperature continuously until the lowest final temperature is reached.

Observations:

Part A: Determining the Specific Heat Capacity of the Styrofoam Calorimeter

Initial Temperature of Cold Water	
Mass of Cold Water used	
Temperature of Warm Water on the Hot Plate	
Mass of Warm Water used	
Final Temperature of the Hot-Cold Water Mix	

Part B: Molar Heat of Solvation of NaOH

Initial Water Temperature	
Mass of Water used	
Mass of $NaOH_{(s)}$ added	
Final $NaOH_{(aq)}$ Temperature	

Part C: Molar Heat of Fusion of Water

Initial Water Temperature	
Mass of Water used	
Mass of Ice added	
Final Water Temperature	

Analysis:

Part A: Determining the Specific Heat Capacity of the Styrofoam Calorimeter

1. Using the Law of Conservation of Energy, determine the specific heat capacity (in kJ/°C) of the Styrofoam calorimeter. (Assuming the ΔT_{cal} is the same as that of the cold water.) Show all the steps involved and list all values used.

Part B: Molar Heat of Solution of NaOH

1. Using the Law of Conservation of Energy, determine the molar enthalpy of solution of NaOH (be sure to include the use of the specific heat capacity of the Styrofoam calorimeter from Part A). Show all the steps involved and list all values used.
2. Draw a detail potential energy diagram for the dissociation of $NaOH_{(s)}$ in water. Label all pertinent information and discuss the solution of NaOH in terms of an endothermic or exothermic process.

Part C: Molar Heat of Fusion of Water

1. Using the Law of Conservation of Energy and presume that the temperature of ice is 0°C, determine the water's molar enthalpy of fusion (be sure to include the use of the specific heat capacity of the Styrofoam calorimeter from Part A). Show all the steps involved and list all values used. (Hint: the ice underwent a potential change and a kinetic change.)

Evaluation:

1. What is the % error of the experiment if the theoretical value of the molar enthalpy of solution of NaOH is –44.51 kJ/mol?
2. Given the theoretical molar enthalpy of fusion for water is 6.01 kJ/mol, calculate the % error of this experiment.
3. Evaluate the effectiveness of the Styrofoam Calorimeter, and suggest some explanations why it might not be effective.

Conclusion:

1. Revisit your hypothesis and comment on your prediction.
2. Summarize what you have learned from this lab.