AP LAB Calculation of Gibbs Free Energy

Aim To indirectly determine a value for $\Delta G°_{rxn}$

Apparatus Coffee-cup calorimeter, thermometer, weighing boat, spatula, goggles, electronic balance

Chemicals Water, solid ammonium nitrate, NH_4NO_3

Method

1. Measure 50.0 mL of deionized water into a coffee-cup calorimeter, and record the temperature of the water. (Allow a few minutes for the temperature to become constant before recording.)

2. Record the exact mass of approx. 8.00 g of ammonium nitrate.

3. Carefully add the ammonium nitrate crystals to the water in the calorimeter.

4. Insert a thermometer into the solution, and gently stir the contents of the calorimeter monitoring the temperature constantly. **Record the lowest temperature reached.**

5. Repeat the experiment, with a similar volume of water (anywhere between 30.0 and 50.0 mL), and with a similar mass of ammonium nitrate (anywhere between 4.00 and 6.00 g).

Results

	Trial 1	Trial 2
Initial temperature of water in °C		
Final temperature of solution in °C		
Mass of ammonium nitrate in g		

Calculations/Conclusions

Make the assumption that the specific heat capacity of the solution is 4.18 J g^{-1} °C^{-1}, and that the density of the solution is 1.00 g mL^{-1}. You may ignore the heat capacity of the calorimeter.

1. Write an equation that summarizes the process. Do NOT include H_2O in your equation, rather use state symbols to help show the change that the ammonium nitrate has undergone. Write any soluble, hydrated ionic species as being separated.

2. Calculate the change in energy of the surroundings, $q_{surroundings}$, in units of Joules for each trial, and then average the two values.

3. Use your answer in Q2 to calculate a value for the q_{system} in kJ/mol$_{rxn}$, i.e., calculate $\Delta H°$ for the equation that you have written in Q1. **(Use the average number of moles of the solid in your calculation).**

4. Given the following absolute entropies (S°) in units of J K^{-1} mol^{-1}, calculate the value of $\Delta S°$ for the reaction.

$NH_4NO_{3(s)}$ = 151, $NH_4^+{}_{(aq)}$ = 113, $NO_3^-{}_{(aq)}$ = 146.

5. Calculate a value for $\Delta G°$ for the reaction, and calculate a percentage error, given that the accepted value is -6.48 kJ/mol_{rxn}.

6. Comment on the value of $\Delta G°$ as it relates to $\Delta H°$ and $\Delta S°$.