Enthalpy lab background

Science, Chemistry

Enthalpy, represented by the sign ? H in kJ/mol, is the heat change in a reaction. It shows whether how much heat is released or absorbed during the reaction. If the reaction is endothermic, the enthalpy would be positive and if the reaction is exothermic, the enthalpy would be negative. During a chemical reaction, which consists of breaking and creating bonds, heat is either absorbed or released. In this lab, the reaction uses the disassociation of an ionic compound ammonium nitrate shown in the equation #1 below into ions.

In order to disassociate ammonium nitrate into ions, energy is required. Both NH4 and NO3 are always soluble, therefore the ionic compound disassociates completely. Through equation #2, heat absorbed or released can be measured. In equation #2, q stands for the heat change in joules, m for the mass of the water in grams, C for the specific heat of water, and ? T for the change in temperature. By using the calorimeter with a stir rod, change in temperature is found. 1. NH4NO3(s) NH4(aq) + NO3(aq) 2. q= mC? T

Free energy is a thermodynamic function that shows the available energy that can be converted into work. By using the Gibbs-Helmholtz equation, which uses free energy and is shown in equation #3, spontaneity of the reaction can be found using enthalpy, temperature, and entropy. Free energy, unlike entropy, is an absolute way to determine whether the reaction is spontaneous or not. If the free energy is negative, then the reaction is spontaneous, whereas if the free reaction is positive, then the reaction is not spontaneous.

If free energy is neither, meaning if the free energy is zero, the reaction has reached equilibrium, therefore not shifting to left or right. In this lab, the reaction shown in equation #1 reaches equilibrium, so the free energy of this reaction would be zero. Entropy, shown by the sign S, is the measurement of molecular randomness or disorder. It is given in J/K*mol and it determines the disorder by the number of molecular arrangements that are possible in the state, whether it is solid, liquid, or gas.

The more arrangements there can be, or larger amount of mole there is, the higher the entropy. If the change in entropy of a given reaction is negative, it means that the reaction is increasing in order, or decreasing in disorder. If the change in entropy of a given reaction is positive, it means that the reaction is increasing in disorder. Generally, negative entropy of a given reaction means that the reaction is spontaneous, but not always. Both equation #3 and #4 can be used to find entropy. 3. ? G = ? H-T? S 4.? Sreaction=? pSproducts - ? nrSreactants In equation #4, if the entropies of the molecules involved in the reaction are known, then change of entropy in the overall reaction can be found by subtracting the sum of the entropy of the products by the sum of the entropies of the reactants. If the entropies of the molecules aren't known like this lab, than equation #3 can be used to find the entropies of the reaction, where T represents temperature in Kelvin, ? G is the change in the free energy in kJ/mol, ? H is the change in enthalpy in kJ/mole, and ?

S is the change in entropy in J/K*mol. The enthalpy of the reaction shown in equation #1 can be calculated by the third equation using arithmetic because ? G is zero. And in this equation, the formula number 3, where ? G = ? H-T? S, Enthalpy must be greater that Entropy if the equation is to be positive. This is reason why this value is set to zero, because then by subtracting the enthalpy the value of entropy can be found. And through these methods, the value of G can be substituted in and to find the accepted value of ? H and ? S.

The Kelvin is the accepted value, and the ? S can be found when plugged in ? H and ? G to be found as the zero value. The calculated entropy should match or be very close to the accepted entropy value for the dissolving of ammonium nitrate if the ionic compound is dissolved in water and the enthalpy determined by the calorimeter because the calorimeter shouldn't have lost any heat to surrounding and all of the solid should have been dissolved. Through this method, the absorbance rate of FeCl3 can be estimated, just like how NH4NO3 can be found.