**Dougherty Valley HS AP Chemistry**

**Entropy of Reaction**

**Introduction**:

When studying thermodynamics, the equation for free energy of a reaction, **ΔG° = ΔH° - TΔS°**, is often encountered. In this experiment, you will use this equation to estimate the minimum entropy change required to bring about a reaction. The enthalpy change, ΔH, and the initial temperature will be determined for a reaction. From these values and the equation for free energy, the minimum entropy change to bring about a *spontaneous reaction* will be estimated.

**Purpose**:

The purpose of this experiment is to estimate the minimum entropy change required for a reaction.

**Equipment/Materials:**

solid sample NaNO3 thermometer

NH4Cl calorimeter

NH4NO3, etc. distilled water

**Safety**:

An apron and goggles must be worn at all times in the lab.

**Procedure**:

[1] Obtain a microcalorimeter (Styrofoam Cup) and thermometer. The calorimeter is made up of two styrofoam cups separated by a rubber band. A lid punched with a hole for the thermometer should also be used. Weigh and record the mass of the calorimeter.

* We will be determining the Calorimeter Constant for this experiment. Using known amount of Hot and Cold Water. **Look up a procedure for this process and include it in your procedure as part of the Pre-lab.**

[2] Place about 50 mL of distilled water in the calorimeter. Reweigh and subtract to determine the mass of the water. Measure the temperature of the water.

[3] Calculate the mass of solid needed to prepare 50.0 mL of a 1.00 M solution of the solid you will be using. Weigh the sample, and record the mass in the data table.

[4] Add the stir bar to the calorimeter. Turn the stir knob to #1. Make sure it is stirring gently before you move to the next step.

[5] Add the solid to the water, and place the lid on the calorimeter. Stir gently, and record the temperature when the entire solid has dissolved.

[6] Calculate the heat of the reaction. *The heat capacity of the calorimeter will be included in the calculation*.

[7] Calculate the ΔH for the reaction using the heat of reaction and the number of moles of the solid used.

[8] Repeat the procedure two more times.

[9] Average the data for your trials.

**Entropy of Reaction**

**Data: [**fill in title**] –** recreate in your lab notebook

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Trials**  **[2 per cmpd]** | | **Calorimeter Constant** | |
| **1** | **2** | Mass of cold water (g) |  |
| Mass of calorimeter (g) |  |  | Initial Temp of cold water (°C) |  |
| Mass of water (g) |  |  | Final Temp of mixed water (°C) |  |
| Solid used: \_\_\_\_\_\_\_\_ |  |  | Temp. change cold water (Δ°C) |  |
| Mass of solid (g) |  |  | qcold water (J) |  |
| Moles of solid (mol) |  |  | Mass of hot water (g) |  |
| Initial temperature (°C) |  |  | Initial Temp of hot water (g) |  |
| Final temperature (°C) |  |  | Final Temp of mixed water (°C) |  |
| Temp. change (Δ°C) |  |  | Temp. change hot water (Δ°C) |  |
| Heat of reaction, J |  |  | qhot water (J) |  |
| ΔH, kJ/mole |  |  | qhot – qcold (J) |  |
| ΔS, J/mole•K |  |  | Ccal (J/°C) |  |

Average Value for ΔS \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Sample Calculation**: [This will be shown in your lab notebook]

You must show all calculations for at least one trial. You may show all if you like

**Discussion Questions**: [individual]

[1] Write a balanced equation for the reaction you studied (including the heat).

[2] Was the reaction spontaneous? How do you know this?

[3] From the temperature change of your trials, what must be the sign for ΔH? How do you know?

[4] From question 3, what must be true about the sign for ΔS? Explain why with support?

[5] What are the units for entropy, ΔS?

[6] Many students believe that a reaction must be exothermic to be spontaneous. Comment on this in terms of this experiment. [Looking for detailed thought here for you to support both sides]