Dougherty Valley HS AP Chemistry
Entropy of Reaction

Introduction:
When studying thermodynamics, the equation for free energy of a reaction, $\Delta G° = \Delta H° - T\Delta S°$, 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	$NaNO_3$	thermometer
	NH_4Cl	calorimeter
	NH_4NO_3, 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 (∆°C)	
Mass of solid (g)			$q_{cold\ water}$ (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 (∆°C)			Temp. change hot water (∆°C)	
Heat of reaction, J			$q_{hot\ water}$ (J)	
∆H, kJ/mole			$q_{hot} - q_{cold}$ (J)	
∆S, J/mole•K			C_{cal} (J/°C)	

Average Value for ∆S _____

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 ∆H? How do you know?

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

[5] What are the units for entropy, ∆S?

[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]