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 and thermometer. The calorimeter is made up of two plastic 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.

2. Place about 10 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 10.0 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 solid to the water, and place the lid on the calorimeter. Stir gently, and record the temperature when all the solid has dissolved.

5. Calculate the heat of the reaction. The heat capacity of the calorimeter will not be included in the calculation.

6. Calculate the ΔH for the reaction using the heat of reaction and the number of moles of the solid used.

7. Repeat the procedure two more times.

8. Average the data for your trials.

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Data:

	Trial 1	Trial 2	Trial 3
Mass of calorimeter			
Mass of water			
Solid used			
Mass of solid			
Moles of solid			
Initial temperature			
Final temperature			
Temp. change			
Heat of reaction, J			
ΔH, kJ/mole			
ΔS			

Average Value for ΔS _____

Sample Calculation:

Questions:

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?

4. From question 3, what must be true about the sign for ΔS? Why?

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.