Supplemental Activities

Module: Thermodynamics

Section: Third Law of Thermodynamics

Absolute Entropy

ACTIVITY 1

The purpose of this activity is to recall your understanding of the concept of absolute entropy.

1. At absolute _________ Kelvin we can consider a perfectly ordered system. In this perfectly ordered system, there is no _________ disorder, temperature or _________ energy meaning no thermal disorder. In this perfect state we can define an absolute scale for _________. This theoretical system gives us an understanding of the _________ law of thermodynamics.

2. Which compound would you expect to have the lowest absolute entropy of the given pairs? Explain your choice.
   a. Br_2 (l) or Br_2 (g)?

   b. C (s) graphite or C (s) diamond?

   c. Fe_2O_3 (s) or Fe_3O_4 (s)?

   d. NH_3 (g) or NH_3 (aq)?

ACTIVITY 2

The purpose of this activity is to further develop your understanding of the concept of positional entropy from a molecular point of view.

1. A system with high positional entropy has _________ microstates, which are all the possible _________ of energy in a system

2. Consider a small amount of potassium bromide (white crystalline solid) and a beaker of water. Draw these images.

3. Now dissolve the KBr into the beaker of water. Describe what happened to your salt.

4. Are there more or less microstates available when the salt is dissolved? Please explain.

5. Would you consider the above process to be spontaneous? If so, what must be true about the ΔS_{univ}? What about the ΔS_{sys}? What about the ΔS_{surr}?

ACTIVITY 3

The purpose of this activity is to work with the equation associated with calculating absolute entropy.

1. What is the equation to calculate absolute entropy of a particular sample (not per mole)? Define each of the variables and give units for each.

2. What is the equation to calculate absolute entropy of a mole of a substance? Define each of the variables and give units for each.

3. Calculate the number of microstates **and** the number of molecules of a sample of a solid in which the molecules can take any one of three orientations with the same energy and the absolute entropy is 6.58051×10^{-22} J/K

Change in Entropy from Absolute Entropy

ACTIVITY 1

The purpose of this activity is to practice your ability to compute ΔS from $S°$ tabulated data.

1. Use the equation to determine the ΔS_{rxn} for the combustion of 1 mole of diamond (C (s, diamond)) at room temperature. You will need to look up the $S°$ values from a thermodynamic table.

ACTIVITY 2

The purpose of this activity is to practice your ability to compute ΔS_{rxn} from $S°$ tabulated data, compute the ΔS_{sur} and predict the spontaneity of a chemical change.

1. Consider the system in Activity 1, above. Given that $\Delta H_f°(CO_2(g))$l = −393.51 kJ/mol, determine the change in entropy for the surroundings for this change under standard conditions.

2. What is the ΔS_{univ} for this particular change, the combustion of 1 mole of diamond at room temperature?

3. Is this change spontaneous or nonspontaneous? Why or why not?