Department of Materials Science and Engineering
Pohang University of Science and Technology



**AMSE205 Thermodynamics I**

due Date: Apr. 22, 2006 Prof. Byeong-Joo Lee

Problem Set #3

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1. A rigid container is divided into two compartments of equal volume by a partition. One compartment contains 1 mole of ideal gas A at 1 atm, and the other compartment contains 1 mole of ideal gas B at 1 atm.

   (a) Calculate the entropy increase in the container if the partition between the two compartments is removed.
   (b) If the first compartment had contained 2 moles of ideal gas A, what would have been the entropy increase due to gas mixing when the partition was removed?
   (c) Calculate the corresponding entropy changes in each of the above two situations if both compartments had contained ideal gas A.

2. A system containing 500 particles and 15 energy levels is in the following macrostate:

   {14, 18, 27, 38, 51, 78, 67, 54, 32, 27, 23, 20, 19, 17, 15}

   This system experiences a process in which the number of particles in each energy level changes by the following amounts:

   {0, 0, -1, -1, -2, 0, +1, +1, +2, +2, +1, 0, -1, -1, -1}

   Estimate the change in entropy for this process

3. 길이가 $a$인 $N$개의 막대꼴 분자가 쇠사슬과 비슷한 모양으로 연이어 이어져 있다. 이때 이웃한 두 분자의 상태는 완전히 겹쳐서 두 분자의 길이가 $a$ 가 되거나 완전히 펴져서 길이가 $2a$가 되는 두 가지 상태만 가능하다고 하자. 이웃하는 두 분자의 겹친 상태에서의 상호작용 에너지는 $\varepsilon$ ($\varepsilon$>0)이고, 펴졌을 때는 0이라 하고, 이웃하지 않는 분자 사이에는 상호작용이 없다고 가정하자. 온도가 $T$일 때 이 분자들의 평균 길이는 얼마인가?
   (hint: 가장 짧을 때의 길이는 $a$ 이고 에너지는 (N-1) $\varepsilon$이다.)

4. Text (Gaskell), Problem 4-3.

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5. Derive the following, widely used thermodynamic equations.

(a) First *TdS* equation : $$TdS = C_V dT + T\left(\frac{\partial P}{\partial T}\right)_V dV$$

(b) Second *TdS* equation : $$TdS = C_P dT - T\left(\frac{\partial V}{\partial T}\right)_P dP$$

(c) First energy equation: $$\left(\frac{\partial U}{\partial V}\right)_T = T\left(\frac{\partial P}{\partial T}\right)_V - P$$

(d) Second energy equation: $$\left(\frac{\partial U}{\partial P}\right)_T = -T\left(\frac{\partial V}{\partial T}\right)_P - P\left(\frac{\partial V}{\partial P}\right)_T$$