General Physics II: Tutorial Material

Lecture 8 (Chapter 8 Entropy)

1) Lets us consider a very large heat reservoir at a temperature T_R, and a small thermal system at T_S. The heat capacity of the small system is C (note that C is simply the amount of heat required to raise the temperature of an *entire* object or system by one degree, i.e. $Q = C\Delta T$). By putting them into thermal contact, they reach a thermal equilibrium at T_R, since the heat reservoir has such a large heat capacity and stays at the same temperature.

1. Calculate the entropy changes of the heat reservoir
2. Calculate the entropy changes of the small system.
3. Calculate the entropy changes of the total system.
4. Show that the change of the entropy of the total system is $\Delta S \geq 0$.

2) Show that the entropy difference of an n-mol ideal gas, ΔS, when the state $A(P_1, V_1, T_1)$ is changed to $B(P_2, V_2, T_2)$ quasi-statically (i.e., reversible), is given by

$$\Delta S = nC_V \ln \frac{T_2}{T_1} + nR \ln \frac{V_2}{V_1} \tag{1}$$

Show that this leads to $\Delta S = 0$ for an adiabatic process, as expected from the definition.

3) The temperature of n-mol ideal gas has changed from T_1 to T_2 degrees. Determine the entropy change for 1) under constant pressure and 2) under constant volume. (Consider reversible processes.)

4) Thermalisation of two blocks: An isolated system consists of two homogeneous metallic blocks, labeled 1 and 2, that can be considered as rigid systems (V = const). These blocks contain n_1 and n_2 moles of a metal. The blocks, initially separated, have the temperatures T_1 and T_2. When they are brought into contact, they evolve asymptotically towards a thermal equilibrium at final temperature T_f. The internal energy $E_{int,i}$ of each block (i=1,2) is a function of its temperature T_i and the number of moles N_i of metal in each block:

$$E_{int,i} = 3n_i RT_i \tag{2}$$

where R is a positive constant.

1. Determine the final temperature T_f of the system.
2. Compute the entropy variation ΔS of the system during the process that leads to its thermal equilibrium.
3. What is the entropy variation in the particular case of $n_1 = n_2 = n$?