Thermodynamics

Do two of the following three problems, each on a separate sheet (or sheets). Staple together the sheets for each problem, if using multiple sheets, but do not staple all problems together. Write at the top of the first sheet of each problem your name, subject, and problem number.

Problem 1

Consider a *two dimensional* monatomic classical ideal gas composed of N particles. The gas is confined to area A and kept at temperature T.

(a) Find the translational partition function $Q(N, A, T)$ of this gas.

(b) Calculate the internal thermal energy, heat capacity, and entropy of this gas.

Problem 2

The virial expansion of the equation of state is an expansion in the low-density limit, i.e., it organizes the deviations from the ideal gas equation of state in powers of N/V. Consider a gas obeying the Dieterici equation of state,

$$Pe^{aN/(VkT)}(V - bN) = NkT$$

where a and b are positive constants. Give the leading correction to the ideal gas equation of state in the virial expansion. What might the physical meaning of the constants a and b be?

Problem 3

This room is initially at temperature T_0. A heater is turned on until the temperature increases to T_1. What is the change in the *total energy of all the air inside the room?*