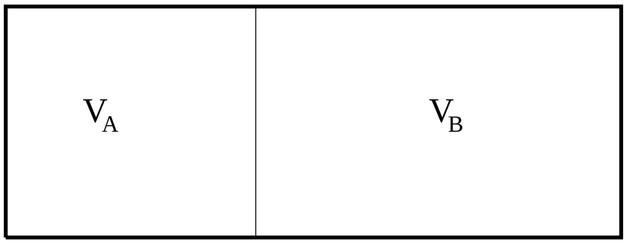
Physics 214A

Midterm

October 30, 1997

I. The entropy and energy of some substance satisfy the equations $S^3 = N^3 T f(V/N)$ and $E = PV$. Determine the most general form of the function $f(V/N)$ and the entropy as a function of E, V and N.

II. A volume is divided into two sub-volumes, V_A and V_B, by a fixed membrane; atoms of type 1 cannot move across this membrane, while atoms of type 2 can move freely, in either direction, across it. The system is kept at temperature T.



There are N_1 atoms of type 1, all in A, and N_2 atoms of type 2.

a. What is the number of type 2 atoms in A and in B?

b. What is the pressure in A and in B?

III. Show that in the grand canonical ensemble

$$\langle NE \rangle - \langle E \rangle \langle N \rangle = k_B T \frac{N}{V} \left(\frac{\partial E}{\partial P} \right)_{V,T} .$$