935 STATISTICAL MECHANICS - Homework #6. Due: TH, 5/4/2006.

1. This problem is about Blackbody Radiation. Find the entropy S and specific heats C_V and C_P for blackbody radiation at temperature T in a volume V.

2. This problem is about Phase Transitions. Consider a mixture of two materials A and B. Let n denote the density of A in B: $0 \leq n \leq 1$. Suppose that the free energy of a homogeneous mixture of A and B is

$$F \;=\; \epsilon\, n \;+\; (T-1)n^2 \;+\; n^4 \;, \tag{1}$$

   where ϵ may be taken to be very small (treat it to first order), and T is the temperature. Calculate the phase diagram as a function of n and T, including the boundaries of local as well as global stability.

3. This problem is about Virial Coefficients. (See, for example, Pathria Ch.9)

   (a) Sketch the potential

$$\phi(r) \;=\; \begin{cases} V_0 & \text{for } r < a \\ V_1 \, \ln(r/b) & \text{for } a < r < b \\ 0 & \text{for } r > b \end{cases} \;, \tag{2}$$

   where V_0 and V_1 are positive. Calculate the second virial coefficient $B(T)$ and sketch its variation with T.

   (b) Continue the development of the Mayer expansion and find an expression for the third virial coefficient $C(T)$, which is the coefficient of ρ^3 in an expansion of βP in powers of the density. You should express the answer in terms of diagrams, and should find that the answer depends only on multiply connected diagrams.