PHYSICS 210A : EQUILIBRIUM STATISTICAL PHYSICS
HW ASSIGNMENT #3

(1) For an ideal gas, find the difference $C_\varphi - C_V$ for the following functions φ. You are to assume N is fixed in each case.

(a) $\varphi(p,V) = p^3\,V^2$

(b) $\varphi(p,T) = p\,e^{T/T_0}$

(c) $\varphi(T,V) = VT^{-1}$

$(\mathbf{2})$ Consider a thermodynamic system for which $E(S,V,N) = aS^4/NV^2$.

(a) Find the equation of state $p = p(T,V,N)$.

(b) Find the equation of state $\mu = \mu(T,p)$.

(c) ν moles of this substance are taken through a Joule-Brayton cycle (see §2.6.7 of the Lecture Notes). The upper isobar lies at $p = p_2$ and extends from volume V_{A} to V_{B}. The lower isobar lies at $p = p_1$. Find the volumes V_{C} and V_{D}.

(d) Find the work done per cycle W_{cyc}, the heat Q_{AB}, and the cycle efficiency.

(3) Show that

$$\left(\frac{\partial\mu}{\partial T}\right)_{S,N} = \frac{C_p}{NT\alpha_p} - \frac{S}{N} \quad .$$

(3) A solution of $4.00\,\mathrm{g}$ of hemoglobin in 100 mL of water was prepared and its osmotic pressure was measured to be $\pi = 0.0130\,\mathrm{atm}$ at $T = 280\,\mathrm{K}$. Estimate the molecular mass of hemoglobin.