PY 410 Homework Spring 2017 Due: Thursday March 30

You can directly turn in Python notebooks for coding assignments

1. A gas of cold atoms obeying Bose-Einstein statistics undergoes a phase transition at a very low temperature (so-called BEC condensation) The equation of state and the heat capacity are described by the formulas:

$$P(T,V) = aT^{5/2} + bT^3 + cV^{-2} \quad (1)$$
$$C_V(T,V) = gT^{3/2}V + eT^2V + fT^{1/2}, \quad (2)$$

with a, b, c, g, e, f all constants. We will now practice using the Fundamental Thermodynamic Relation $dE = TdS - PdV$ and Maxwell's Relation's. In our problem, the variables we can manipulate in the lab are temperature T and volume V. These are the variables that describe the state of the system.

a) Use these expressions to find expressions for $\left(\frac{\partial E}{\partial T}\right)_V$ and $\left(\frac{\partial E}{\partial V}\right)_T$. [Hint: this is similar to Problem 7 in last HW]

b) Find a relationship between a through g by comparing second derivatives of $E(T,V)$ (i.e find relationship between all the coefficients)

c) Find $E(T,V)$ as a function of T and V.

d) Find $S(T,V)$ as a function of T and V function

2. Sethna 5.2

3. Sethna 5.4
4. Read problem 5.7. You do not have to do it. However, it is a proof that the entropy of an isolated Hamiltonian system never increases. Then do problems Sethna 5.8-5.9.

5. Setha 5.12