PHYS 530: Problem Set 1   Due: 4:30 pm, 17 January 2013

If the answer is shown, all the marks will be given for the derivation not for writing down the answer.

1. [5] Find two examples of systems in which the energy would not be an extensive variable. In each case, explain why E does not scale with the size of the system.

2. [5] It was argued that with systems in internal thermodynamical equilibrium, equilibrium between different systems could be parametrised with a single scalar T. If we relax the assumption of internal equilibrium, then equilibrium between different systems may require the use of a multi-component (vector) temperature T_i, where $i = 1, \ldots, N$. Discuss under what conditions the use of a multi-component temperature might be appropriate, and what the limitations might be. Support your arguments with one or two concrete examples.

3. [5] Assuming a system with only one kind of particle species, and in which work can only be done by varying the volume, prove the Gibbs-Duhem relation

$$SdT - VdP + Nd\mu = 0 \,. \tag{1}$$

4. [10] In calculating the relation between C_V and C_P, the entropy was assumed to be a function of the independent variables T and V. Repeat the calculation with $S = S(T, P)$ instead.