

Assignment #2 PY 541 Week of Sept. 11–15, 2006

Notes: I've scheduled office hours for Mondays at 1pm and Thursdays after class. Please feel free to make an appointment to see me if these hours are not convenient. Also the discussion section will start meeting **this** week. It will be held Wednesdays starting at **3:15 pm** in PRB 261.

Reading: This week we will be discussing the microscopic basis of thermodynamics, fundamental thermodynamics relations, and the connection between thermodynamics and statistical mechanics. Please finish reading chapter 2 of Pathria, complete chapter 3, and begin chapter 4.

Problems: Due Tuesday September 19 in class.

1. Pathria 1.8. *Note:* For this problem you will likely find it helpful to read ahead to pages 70–71 of the text in which an approach is given to compute the relevant combinatoric factor.

2. (adapted from Huang 6.3) Consider a system of N free particles in which the energy of each particle can assume only two distinct values, 0 and $E > 0$. Denote by n_0 and n_1 the occupation numbers of the energy levels 0 and E , respectively.

If the system is isolated (microcanonical ensemble) and has total energy U , find:

- (a) the entropy of the system.
- (b) the temperature as a function of U and show that it can be negative.
- (c) What happens when a system of negative temperature is brought into thermal contact with a system of positive temperature?

Now suppose that the system is in thermal contact with a very large reservoir at temperature T (canonical ensemble).

- (d) In this situation, find the most probable values of n_0 and n_1 and their mean-square fluctuations.

3. Pathria 2.4.

4. Pathria 2.8.