Phys 741
Statistical Mechanics
Problem Set # 3

Dr. Gassem Alzoubi
The Hashemite University Department of Physics, Zarqa, Jordan

1. Pathria 3.6
2. Consider a system of N magnetic dipoles, each of which has an energy $+\varepsilon$ in the up state and $-\varepsilon$ in the down state.
   (a) Calculate the number of microstates $\Omega(N, E)$ accessible to the system at energy E and show that the entropy is given by Eq. (3.10.9) of Pathria page 80.
   (b) Find the occupation numbers N_+ and N_- in terms of the temperature of the system
   (c) Evaluate the total partition function for the N particles system in the canonical ensemble and show that $Q_N = Q_1^N$
   (d) Discuss what would happen to the occupation numbers, the energy, and the entropy of the system in the limits $T \to 0$ and $T \to \infty$
3. Pathria 3.7
4. Pathria 3.15
5. Consider a system of and ideal gas of N particles, each of mass m, that is confined to a 2D disk of radius R. Each particle is attracted to the center by a force that is proportional to its distance from the center. The Hamiltonian of the system is given by

$$H = \sum_{n=1}^{N} \left(\frac{p_i^2}{2m} + \frac{1}{2} k r_i^2 \right)$$

   where k is the effective spring constant of the central force
   (a) Caculate the partition function of the system.
   (b) Calculate the average energy, pressure, and heat capacity at constant volume of the system.
   (c) Using the single particle partition function, calculate the probability of finding a particle in the interval $a < r < b$, where a and b are less tha R
6. Pathria 3.31

Good Luck