Physics 410 - 2004

Thermal Physics

Problem Set 1

1. A particle of mass m is confined in a cubic box of size L. The potential energy has the form

$$U(x,y,z) = \begin{cases} 0, & 0 < x,y,z < L \\ \infty, & \text{otherwise} \end{cases}$$

Find the 4th, 5th, and 6th energy levels in Fig. 1.2 of the textbook, p. 9 (3 pt). Consider a particle in a square box of size L. Find the lowest 4 energy levels and their multiplicities. (3 pt)

2. Consider the problem of flipping a coin. Prove that the probability that heads turn up n times if the coin is flipped N times is

$$p_n = 2^{-N} \frac{N!}{n!(N-n)!}, \quad n = 0, 1, \ldots, N$$

(6pt).

3. The probability density for a classical harmonic oscillator of mass m and angular frequency ω to be at a distance q from the minimum of the potential energy is

$$p(q) = C \exp[-m\omega^2 q^2 / 2k_B T],$$

where T is temperature and k_B is the Boltzmann constant. Find the constant C (4 pt). Find the probability for an oscillator to be within the interval $(2k_BT/m\omega^2)^{1/2} < q < (3k_BT/m\omega^2)^{1/2}$ (6 pt).

You need to have 20 points out of 22 (2 points are extra credit).