Physics 410 - 2002

Thermal Physics

Problem Set 1

This problem set is *simple*. Take advantage of it!

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

2. Flip a coin N times. Prove that the probability that heads turn up n times is

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

   (5pt).

3. The probability density for a classical molecule of mass m to have velocity v in a given direction is

$$p(v) = C \exp[-mv^2/2k_BT],$$

   where T is temperature and k_B is the Boltzmann constant. Find the constant C (5 pt). Find the probability for a molecule to have velocity lying between $(k_BT/m)^{1/2}$ and $3(k_BT/m)^{1/2}$ (6 pt).

You need to have 20 points out of 25 (5 points are extra credit).