Problem Set 2
Chemistry 448
Cynthia J. Jameson

1. Consider a system of 7 distinguishable particles distributed among the following energy levels: 0, ω, 2ω, 3ω only. What distributions are associated with a total energy 3ω of the system? Assuming equal accessibility of all the non-degenerate energy levels to all the particles, find the probabilities of each of these distributions. Suppose the energy levels are degenerate such that $g_0 = 1$, $g_1 = 2$, $g_2 = 3$, and $g_3 = 4$. What are the distributions? What is the probability of each distribution? Which one is the most probable distribution?

2. In the land of Oz a die is a regular octahedron instead of a cube, with faces numbered 1 to 8. Find the number of possible outcomes of throwing a pair of dice. What is the normalized probability for the most probable throw?

3. Consider a mixed crystal containing N_A molecules of A and N_B molecules of B arranged randomly in the crystal lattice sites. Calculate the number of ways W in which the molecules can occupy the sites. If $N_A = N_B = N/2$, what is the number of ways W in which the molecules can occupy the sites? Now, use Stirling's approximation and find an approximate W. If $N_A = N_B = 2$, what is W? What is Stirling's approximate W? Why the discrepancy? For N = 100, how large is the discrepancy?

4. Given the nuclear spins

nucleus	spin I
^{1}H	1/2
^{35}Cl	3/2
^{37}Cl	3/2
^{14}N	1
^{15}N	1/2
^{7}Li	3/2

Determine the degeneracy of the four lowest energy levels of a diatomic molecule with the following characteristics:

molecule	electronic term symbol
$H^{35}Cl$	$^{1}\Sigma$
$^{35}Cl_2$	$^{1}\Sigma_g^+$
$^{35}Cl^{37}Cl$	$^{1}\Sigma^+$
$^{14}N_2$	$^{1}\Sigma_g^+$
$^{15}N_2$	$^{1}\Sigma_g^+$
$^{7}Li_2$	$^{1}\Sigma_g^+$
$^{7}Li_2$	$^{1}\Sigma_u^+$
$^{35}Cl_2^+$	$^{2}\Pi$