Chemistry 163C Problem Set #2
Due Thursday, 4/17 at the beginning of class

1) If you roll five dice at the same time, how much more likely are you to roll the numbers {1 2 3 4 5} than {2 2 4 4 4}? (You can assume that it is equally probable to observe any one of the six sides of a single die.) Why is this so? We showed in class that entropy S is given by the expression $S = k \, ln \, W$, where k is Boltzmann's constant and W is the weight of the most probable configuration. What is the "entropy" for each of the two outcomes?

2) Consider a two level system where the ground state is nondegenerate and the excited state of energy ε is four fold degenerate. Write down the partition function and mathematical expressions for the populations of the two levels. Plot the partition function and the populations as a function of temperature from $T = 0$ to $T \rightarrow \infty$. What value do you get for q at $T \rightarrow \infty$?

3) Given N dice, show that the number of ways of observing n_1 ones, n_2 twos, etc. is given by the formula:

$$W = \frac{N!}{n_1!\,n_2!\,n_3!\,n_4!\,n_5!\,n_6!}$$

Hint: Consider a product of binomial expressions $\dfrac{N!}{n!(N-n)!}$

for n_1 ones from N dice, n_2 twos from $N - n_1$ dice, n_3 threes from $N - n_1 - n_2$ dice, etc.

4) Look up Stirling's approximation for N! in your text. Compute ln(N!) and Stirling's approximation for ln(N!) for N = 10, 20, 30, 40, 50 and 60 and plot the outcomes against each other. Does the approximation work for large N?

From Engel & Reid 3rd Edition, Chapter 13: 2, 7, 8, 9, 12, 13, 15, 20, 21, 25