

## PHYSICS 429: Introduction to Biological Physics

April 2 2008

Problem Set 1 These problems are due on Tuesday April 9.

1. Please write a short paragraph describing your course work and other experience in Biology, and email it to me at miller@phys.washington.edu.

2. (a) Mr. and Mrs. Chance have two children. If they tell you that at least one of them is a girl, but you do not know the gender of the other child, what is the probability that they have two girls?

(b) If they have three children and told you again that at least one was a girl, what would be the probability that they would all be girls.

(c) Finally, suppose that they had  $N$  children (never mind how), and told you again that one was a girl, what would be the probability that they would all be girls.

3. Nelson problem 6.1

4. Nelson problem 6.2

5. Nelson your turn 6 F, page 219

6. Defects in a solid. Consider a lattice with  $N$  sites, each occupied normally by one atom. There are  $M$  interstitial locations where atoms can be misplaced and it costs an energy  $\Delta$  to misplace an atom. Suppose  $N, M$  each are very large  $N, M \rightarrow \infty$ , and the number of misplaced atoms is  $n$ . The given macroscopic parameters are  $N, M, n$ . The energy of the system is  $E = n\Delta$ .

(a) Show or argue that the number of available microstates is

$$\Omega(E) = \left[ \frac{N!}{n!(N-n)!} \right] \left[ \frac{M!}{n!(M-n)!} \right].$$

(b) Use Stirling's formula  $\ln N! = N \ln N - N$  to find an expression for the entropy of the system.

(c) Find a general expression for the temperature of the system as a function of  $N, M, n$ .

(d) Consider the limits of very high and very low temperatures to find simplified expressions.

(e) As a model for defects in a solid, take  $M = N$ , and  $\Delta = 1$  eV. Determine  $n/N$  for  $T = 300$  K and  $T = 1000$  K.