**PHY 293F – WAVES AND PARTICLES**
**DEPARTMENT OF PHYSICS, UNIVERSITY OF TORONTO**

**PROBLEM SET #6**

DUE: Monday 9 November 2009, by 5 PM in drop boxes in basement of Physics building. Problem sets submitted after 5:10 PM will not be accepted.

NOTES: Marks will be given for showing workings as well as for final answers. Provide sufficient detail to explain how you got your result to the marker.

1. Problem 2.11 on page 60 of Schroeder.

2. In class, we derived a formula for the multiplicity of a large Einstein solid in the "high temperature" limit by using Stirling's approximation. Using these same methods, derive a formula for the multiplicity of a large Einstein solid in the "low temperature" limit. In your derivation, remember to clearly state the approximations you made and justify why they could be made. Why is it sufficient to use the less exact form of Stirling's approximation?

3. For a single large two-state paramagnet, the multiplicity function is very sharply peaked about $N_\uparrow = N / 2$.
   a. Estimate the height of the peak in the multiplicity function using Stirling's approximation.

   b. Use the method that we used in class to derive a formula for the multiplicity function in the vicinity of the peak, in terms of $x \equiv N_\uparrow - N / 2$. Verify that your formula agrees with your result for part (a) when $x = 0$.

   c. Calculate the width of the peak in the multiplicity formula using the width definition given in class.

   d. Consider a case where you flipped 1,000,000 fair coins. Would you be surprised to get 501,000 heads and 499,000 tails? Would you be surprised to get 510,000 heads and 490,000 tails? Explain why.

4. Problem 2.29 on page 77 of Schroeder.