Physics 224 **Fall 2001**

Discoveries and Inventions of Modern Physics **due 11:00 am Tuesday Oct. 2**

PROBLEM SET 1

1. Eisberg and Resnick: Problem 6.19 (Note the difference between "Questions" and "Problems" in Eisberg and Resnick.)

2. Eisberg and Resnick: Problem 6.20

3. In class we counted the states in a 3D box. Do the same for a 2D box with periodic boundary conditions. In particular find

   (a) the energy eigenstates $E(n_x, n_y)$

   (b) the density of states $N(\omega)$ for photons that have only *one* polarization

4. Consider a nonrelativistic free particle in a cubic container of edge length L and volume $V = L^3$. Assume that the particle is confined in the container so that the potential is zero inside the container and infinite outside.

   (a) Each quantum state s of this particle has a corresponding kinetic energy ε_s which depends on V. What is $\varepsilon_s(V)$?

   (b) Find the contribution to the gas pressure $p_s = -(\partial\varepsilon_s/\partial V)$ of a particle in this state in terms of ε_s and V.

   (c) Use this result to show that the mean pressure $< p >$ of any ideal gas of particles is always related to its mean total kinetic energy $< E >$ by $< p >= \frac{2}{3} < E > /V$.

5. Consider the case of the orbital angular momentum quantum number $\ell = 2$ and the spin angular momentum number $s = 1/2$.

   (a) What are the possible values of the total angular momentum number j? ($\vec{J} = \vec{L} + \vec{s}$)

   (b) For each value of j, what are the possible values of j_z?