Homework Assignment 1 - PHY 4604 - Fall 2002
(due Friday September 6 at the **beginning** of class)

This assignment focuses on computing the size of different physical quantities and on a review of complex numbers. We will be using complex numbers throughout the the course so now is the time to learn this material if you do not know it already.

Since everyone does not have a text book yet, I am writing out these problems. In the future I will refer to problems in the book when I assign them.

1. Using a computer, plot Planck's energy density, $u(\nu, T)$, as a function of frequency for $T = 300K$. Where is the peak in the spectrum? Do the same for $T = 3K$. Where is the peak in the spectrum now? Make sure to clearly label your axes including units where necessary.

2. What is the De Broglie wavelength of (a) a 1 eV electron, (b) a 10 MeV proton, (c) a 100 MeV electron (use relativistic energy formula), (d) a thermal neutron (a neutron whose kinetic energy is $3kT/2$ with $T = 300K$)?

3. The smallest separation resolvable by a microscope is of the order of magnitude of the wavelength used. What energy electrons would one need in an electron microscope to resolve separations of (a) 150 Åand (b) 5 Å?

4. If one assumes that in a stationary state of the hydrogen atom the electron fits into a circular orbit with an integral number of wavelengths, one can reproduce the results of the Bohr theory. Work this out.

5. The distance between adjacent planes in a crystal are to be measured. If X rays of wavelength 0.5 Åare detected at an angle of 5^o, what is the spacing? At what angle will the second maximum occur?

6. Use the Bohr quantization rules to calculate the energy levels for a harmonic oscillator, for which the energy is $p^2/2m + m\omega^2 r^2/2$, that is , the force is $m\omega^2 r$. Restrict yourself to circular orbits. What is the analog of the Rydberg formula? Show that the correspondence principle is satisfied for all values of the quantum number n used in quantizing the angular momentum.

7. Let $z_1 = 1 + 2i$ and $z_2 = 3 - 4i$. Compute the following:

   (a) $z_1 + z_2$
   (b) $z_1 - z_2$
   (c) $z_1 * z_2$
   (d) z_1/z_2
   (e) z_1^*
   (f) $|z_1|^2$
   (g) $|z_1|$
   (h) $\exp(z_1)$
   (i) $\sin(z_1)$

8. By comparing the Taylor series for exp, sin, and cos show the relation $e^(i\theta) = \cos(\theta) + i\sin(\theta)$. Using this relation, express sin and cos in terms of $\exp(\pm i\theta)$.