PHGN 480: Laser Physics due 12 Sept 2012
Homework 2

1) Review/practice with quantum: Consider a mixture of two states of a particle in a one-dimensional infinite square well, so that $\psi(x,t) = C\left(3\psi_2(x,t) + 4\psi_3(x,t)\right)$. Using Mathematica,
   a. Calculate the normalization constant C. Assume the eigenfunctions are normalized. If you use Dirac notation, so that $u_n(x) \rightarrow |n\rangle$, this problem is much easier.
   b. Calculate an expression for the charge density and make a plot of it at 3 representative times to illustrate the motion of the charge.
   c. Calculate an expression for the time-dependent dipole moment.

2) Einstein inferred the existence of stimulated emission by comparing the blackbody radiation spectral energy density with the incident spectral energy density that would be consistent with the equilibrium population levels in an atom. Suppose there was no stimulated emission, only absorption and spontaneous emission.
   a. Write the rate equation for the population in level 2, set it to zero (for steady state), and solve for $\rho(\omega_{21})$. Compare this with the blackbody expression to show mathematically why we need the stimulated emission term.
   b. For a given temperature, in what frequency limit are the two expressions similar. Make a plot of the two functions together to show in a graph the shape of the two curves. For simplicity, you can let $k_B T = c = \hbar = 1$.

3) H&W problem 2.3

4) H&W problem 3.2