HW #2
Due September 26 (Monday) in class

1. Consider the following laser:
   Wavelength = 1.55 μm
   Optical power = 1 mW
   Optical beam size = 1 μm x 1 μm (assume uniform intensity distribution)
   Refractive index of the laser media = 3.4
   a. Find the photon flux of the laser beam inside the laser media (number of photons per cm^2 per second).
   b. Find the photon flux in air (assume 100% of the laser power is transmitted to air).

2. A "quantum box" has a dimension of 10 nm x 10 nm x 10 nm.
   a. Find its ground state (n = 1) and first excited energy (n = 2). Express your answers in eV.
   b. Find the spatial wavefunction, $\phi(x, y, z)$, for each state.
   c. Using the dipole approximation, calculate the matrix element $\left|\hat{e} \cdot \vec{\mu}_{21}\right|$ corresponding to the transition 1 → 2 when the quantum box is illuminated by a laser beam with energy equal to the difference between these two states and polarization in $\hat{x}$.
   d. Assume the n = 1 state is completely filled, and the n = 2 state is completely empty. What is the net upward transition rate for the quantum box (in 1/sec) when it is illuminated by a laser beam with an intensity of 1 W/cm^2? Assume the refractive index of the media is 3.5.
   e. For a media with 10^{18} quantum boxes per cm^3, what is the absorption coefficient of the media?