1. Suppose a ground state wave function solution of Schrodinger's time-independent wave equation is given by

$$\psi = \sqrt{\frac{2}{L}} \cos \frac{\pi x}{L}$$

on the interval $-L/2 < x < L/2$. The potential energy is zero on this interval, and infinite elsewhere. Let the energy levels be given by

$$E_n = \frac{n^2 \hbar^2 \pi^2}{2mL^2}$$

Assume further that $L = 10^{-15}\ m$, $m = 10^{-30}\ kg$.

(A) If the particle transits from the n=3 state to the n=2 state and (somehow) emits a photon, what is wavelength of that photon?

Dump into the energies. Use $\Delta E = hf = hc/\lambda$

(B) What's the probability of finding the particle in the interval $0 \le x \le L/4$?

Solution:

$$P = \int \psi\psi^* dx = \int \frac{2}{L} \cos^2 \frac{\pi x}{L} dx = \frac{2}{L} \int_0^{L/4} \frac{1}{2} + \frac{1}{2} \sin \frac{2\pi x}{L} dx =$$

$$= \frac{2}{L} \left(\frac{1}{2} x - \frac{1}{2} \frac{L}{2\pi} \cos \frac{2\pi x}{L} \right) \Big|_0^{L/4} =$$

$$\frac{2}{L} \left(\frac{L}{8} - \frac{1}{2} \frac{L}{2\pi} \left(\cos \frac{\pi}{2} - 1 \right) \right) = 0.409$$

Check that.