Physics 417
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Problems for 15 May, 2006

1. Find the wavelength in nanometers of the photon emitted by a hydrogen atom going from the $n = 3$ level to the $n = 2$ level. (This is pretty easy, but you should try it without notes, then use your notes or book to check.)

2. A certain cathode ray tube, formerly attached to a computer, produces an electron beam with an energy per electron of 2 keV. There is a wavelength associated with the wave functions of these electrons. What is this wavelength in nanometers? (This is pretty easy, but you should try it without notes, then use your notes or book to check.)

3. Consider a particle in a state with a wave function

$$\psi(\vec{r}) = \frac{\mathcal{N}}{1 + (x+y)(y+z)/a^2 + 10(x^2+y^2+z^2)/a^2} \quad . \tag{1}$$

   where $\mathcal{N}$ and $a$ are fixed parameters. Suppose that we rotate this state through an angle $\pi/2$ about the $z$-axis. (Note that the convention is that if the $z$-axis is pointing toward you, then the positive direction is counter-clockwise.) What is the new wave function?

4. Find an integral for the scattering amplitude for scattering from a Yukawa potential

$$V(r) = \beta \, \frac{e^{-\mu r}}{r} \tag{2}$$

   in second order perturbation theory. That is, find the term in the expansion of the scattering amplitude that is second order in $V(r)$. Your formula should involve the Fourier transform of $V(r)$, which you should find explicitly. Then your formula should be expressed as an integral over a momentum $\vec{k}$. However, you don't need to perform the integration.