TEST 2. PHYS 321. November 27, 2007

From 2:00 to 3:15pm. Lecture Hall. Steinman Hall

NAME:

You are allowed to have a sheet with equations.

1. Photoelectric effect. The work function of Cesium is 1.9eV. What is the maximum wavelength of light that can eject photoelectrons from cesium? (b) If light with $\lambda = 500$ nm strikes cesium, what is the maximum kinetic energy of the ejected electrons?

2. Uncertainty Principle A baseball (0.15 kg) and an electron (9.1 10^{-31}kg) both have a speed of 43 m/s. Find the uncertainty in position of each of these objects, given that the uncertainty in their speed is 5.0 %.

3. Bohr's atom. (a) A hydrogen atom that is initially in the ground level absorbs a photon, which excites it to the $n = 3$ level. Determine the frequency of the photon.

(b) Find the upper and lower limit of the energies of photons that can be emitted by an hydrogen atom in eV.

4. Schrodinger equation. (a) Show that $\psi(x) = A \sin kx$ is a solution to the one-dimensional Schrodinger equation for a free particle with energy E and mass m and find the value of k.

$$-\frac{\hbar^2}{2m}\frac{d^2\psi}{dx^2} = E\psi. \tag{1}$$

(b) Explain why $\psi(x) = A \sin kx$ is an acceptable wave function for a particle in a one-dimensional (1D) rigid box with rigid walls at $x = 0$ and $x = a$, and find the value of k, A and E. (potential energy $U = \infty$ for $x \leq 0$ and $x \geq a$).

(c) Show that $\psi(x) = A \cos kx$ cannot be a solution for the particle in the rigid box of (b).

(d) Let the particle be in the ground state in the 1D rigid box of (b). Calculate the probability that the particle will be found in the interval x to $x + dx$ for $x = a/2$.

(e) Plot the wave function and the probability to find the particle as a function of x for the first three energy levels of the 1D particle in a box of rigid walls at $x = 0$ and $x = a$.