Department of Physics
University of California San Diego

Modern Physics (2D)
Prof. V. Sharma
Quiz # 5 (Feb 11 2005)

Some Relevant Formulae, Constants and Identities

$$\Delta\lambda = \frac{h}{m_e c}(1-\cos\theta)$$

hc=1.99×10^{-25}J.m = 1240 eV.nm

$$\lambda = \frac{h}{p} \quad ; \quad \Delta x.\,\Delta p \geq \frac{h}{4\pi} \quad ; \quad \Delta E.\,\Delta t \geq \frac{h}{4\pi}$$

Bohr radius for ground state H atom, $a_0 = \frac{\hbar^2}{mke^2} = 0.529$ Å

Quantized orbit in Hydrogenlike atom $r_n = \frac{n^2 a_0}{Z}$

Energy in Hydrogen atom $E_n = \frac{-ke^2}{2a_0}\left(\frac{1}{n^2}\right) = \left(\frac{-13.6\text{ eV}}{n^2}\right)$

Coulomb's constant k = 8.988×10^{9}N.m^2/C^2

Planck's constant h = 6.626×10^{-34}J.s=4.136×10^{-15}eV.s

1 J = 1.60 $\times$ 10^{-19} eV, Electron rest mass = 9.1×10^{-31} Kg = 0.511 MeV/c^2

Proton rest mass =1.673×10^{-27}kg = 938.3 MeV/c^2

Speed of light in vaccum c = $2.998\times$ 10^{8}m/s

Electron charge = 1.602 $\times$ 10^{-19} C

Pl. write you answer in the Blue Book in indelible ink. Make sure your code number is prominently displayed on each page. Consult the proctors if you have difficulty understanding the text of a problem.

	Department of Physics University of California San Diego	Modern Physics (2D) Prof. V. Sharma Quiz # 5

Problem 1: Quantum Cowboy [10 pts]

A bullet weighing 12g leaves a rifle at a speed of 150 m/s in the horizontal direction. (a) What is the wavelength of this bullet? (b) If the vertical (direction perpendicular to bullet's flight) position of the bullet is known to an accuracy of 0.001 cm, what is the minimum uncertainty in its vertical momentum? (c) If the accuracy of the bullet were determined only by the uncertainty principle, by how far, vertically, might the bullet miss a pinpoint target 300 m away? It would be helpful to first draw a diagram of the setup.

Problem 2: Seeing Is Believing [10 pts]

Suppose we wish to test the possibility that electrons in the Hydrogen atom move in circular orbits (as postulated by Bohr) by "viewing" them by shining light (photon) on it (a) From the "resolving power" standpoint, which of the two photon wavelengths, $\lambda=10^{-11}$ m or $\lambda=10^{-6}$ m would appear more appropriate and why? (b) What is the energy E of the appropriately chosen photon? (c) How much energy E_e would such a photon transfer to a free electron in a **head-on** Compton collision? (d) What does this tell you about the possibility of verifying the orbital motion by "viewing" an atomic electron at two or more points along its "circular" path? Can this be accomplished? Justify your assertion in 3 sentences or less.