Physics 202H - Introductory Quantum Physics I **Homework #04**

Fall 2004 Due 5:01 PM, Tuesday 2004/10/12

[70 points total]

"Journal" questions. Briefly share your thoughts on the following questions:
– Give an example of a time you made use of physics knowledge you gained from a physics course, outside of schoolwork. What physics phenomena have you noticed outside of the classroom? Have you noticed or made use of *quantum physics* outside of class? In what context?
– Any comments about this week's activities? Course content? Assignment? Lab?

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1. (From Eisberg & Resnick, Q 2-23, pg 52) What is wrong with taking the geometrical interpretation of a cross section as literally true? Limit your discussion to about 50 words or so. [10]

2. (From Eisberg & Resnick, P 2-29, pg 54) A particular pair is produced such that the positron is at rest and the electron has a kinetic energy of 1.0 MeV moving in the direction of flight of the pair-producing photon.
   (a) Neglecting the energy transferred to the nucleus of the nearby atom, what is the energy of the incident photon? [5]
   (b) What percentage of the photon's momentum is transferred to the nucleus? [5]

3. (From Eisberg & Resnick, P 2-34, pg 54) What is the thickness of a lead slab which will attenuate a beam of 10 keV x rays by a factor of 100? Use the data of Eisberg & Resnick, Figure 2-17, pg 49. [10]

4. (From Eisberg & Resnick, Q 3-11, pg 80) Could crystallographic studies be carried out with protons? With neutrons? Limit your discussion to about 50 words or so. [10]

5. (From Eisberg & Resnick, P 3-2, pg 81) The wavelength of the yellow spectral emission of sodium is $\lambda = 5890\,\text{Å}$. At what kinetic energy would an electron have the same de Broglie wavelength? [10]

6. (From Eisberg & Resnick, P 3-7, pg 81) A particle of charge e and rest mass m_0 is accelerated to relativistic speeds by an accelerating potential V.
   (a) Show that the de Broglie wavelength of the particle is given by: [10]
   $$\lambda = \frac{h}{\sqrt{2m_0eV}}\left(1 + \frac{eV}{2m_0c^2}\right)^{-\frac{1}{2}}$$
   (b) Show how this agrees with $\lambda = h/p$ in the non-relativistic limit. [10]

Headstart for next week, Week 05, starting Tuesday 2004/10/12:
– Read Chapter 2.3 "Matter as a Wave" in "Simple Nature" by Crowellk
– Read Chapter 3 "De Broglie's Postulate – Wavelike Properties of Particles" in Eisberg & Resnick
– – Section 3.3 "The Uncertainty Principle"
– – Section 3.4 "Properties of Matter Waves"
– – Section 3.5 "Some Consequences of the Uncertainty Principle"
– – Section 3.6 "The Philosophy of Quantum Theory"
– Read Chapter 2.4 "The Atom" in "Simple Nature" by Crowellk
– Read Chapter 4 "Bohr's Model of the Atom" in Eisberg & Resnick
– – Section 4.1 "Thompson's Model"
– – Section 4.2 "Rutherford's Model"
– – Section 4.3 "The Stability of the Nuclear Atom"
– – Section 4.4 "Atomic Spectra"