Physics 202H - Introductory Quantum Physics I Homework #07

Fall 2004 Due 5:01 PM, Monday 2004/11/08

[80 points total]

"Journal" questions. Briefly share your thoughts on the following questions:
– What physics material do you recall from your elementary school experiences (up to about age 12)? How was it presented? What was your perception of the instructor's attitude to the material? What about other non-physics sciences? Math?
– Any comments about this week's activities? Course content? Assignment? Lab?

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1. (From Eisberg & Resnick, P A-11, pg A-18) With modifications.
   (a) What potential difference will accelerate an electron to the speed of light according to classical (non-relativistic) physics? [5]
   (b) With this potential difference, what speed will an electron acquire relativistically? [5]
   (c) What would its relativistic momentum be at this speed? [5]
   (d) What would its relativistic kinetic energy be at this speed? [5]

2. (From Eisberg & Resnick, P 1-9, pg 23) Assuming that $\lambda_{\max}$ is in the near infrared for red heat and in the near ultraviolet for blue heat, approximately what temperature in Wien's displacement law corresponds to red heat? To blue heat? [10]

3. (From Eisberg & Resnick, P 2-20, pg 53) What fractional increase in wavelength leads to a 75% loss of photon energy in a Compton collision? [10]

4. (From Eisberg & Resnick, P 2-31, pg 54) An electron-positron pair at rest annihilate, creating two photons. At what speed must an observer move along the line of the photons in order that the wavelength of one photon be twice that of the other? [10]

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

6. (From Eisberg & Resnick, P 3-27, pg 83) The velocity of a positron is measured to be: $v_x = (4.00 \pm 0.18) \times 10^5\,\mathrm{m/s}$, $v_y = (0.34 \pm 0.12) \times 10^5\,\mathrm{m/s}$, $v_z = (1.41 \pm 0.08) \times 10^5\,\mathrm{m/s}$. Within what minimum volume was the positron located at the moment the measurement was carried out? (Note: I think that the answer in the back of the text is incorrect for this problem - it is out by a factor of about 16) [10]

7. (From Eisberg & Resnick, Q 5-5, pg 168) Why is the Schroedinger equation not valid for relativistic particles? Limit your discussion to about 50 words or so. [10]

Headstart for next week, Week 08, starting Monday 2004/11/08:
– Review Section 2.3.6 "The Schrödinger equation" in "Simple Nature" by Crowellk
– Read Chapter 5 "Schroedinger's Theory of Quantum Mechanics" in Eisberg & Resnick
– – Section 5.4 "Expectation Values"
– – Section 5.5 "The Time-Independent Schroedinger Equation"