Physics 202H - Introductory Quantum Physics I Homework #11

Fall 2004 Due 5:01 PM, Monday 2004/12/06

[65 points total]

"Journal" questions. Briefly share your thoughts on the following questions:
– How did the expectation for the course match with how the course actually went? Did you meet your own goals for the course? Did your goals or expectations for the course change through the semester? In what ways?
– Any comments about this week's activities? Course content? Assignment? Lab?

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1. (From Eisberg & Resnick, Q 6-22, pg 227) In the $n = 3$ state, the probability density function for a particle in a box is zero at two positions between the walls of the box. How then can the particle ever move across these positions? Limit your discussion to about 50 words or so. [10]

2. (From Eisberg & Resnick, P 6-7, pg 228) Consider a particle passing over a rectangular potential barrier. Write the general solutions, presented in Eisberg & Resnick, Section 6-5, which give the form of ψ in the different regions of the potential.
   (a) Find four relations between the five arbitrary constants by matching ψ and $\mathrm{d}\psi/\mathrm{d}x$ at the boundaries between these regions. (Hint: Use the same notation as Eisberg & Resnick, Section 6-5 for A, B, C, etc. to make it easier to compare results.) [10]
   (b) Use these relations to evaluate the transmission coefficient T, thereby verifying (Eisberg & Resnick, Equation 6-51, pg 201). (Hint: First eliminate F and G, the amplitudes in the centre region, leaving relations between A, B, and C. Then eliminate B the amplitude of the reflected wave.) [10]

3. (From Eisberg & Resnick, P 6-9, pg 228) A proton and a deuteron (a particle with the same charge as a proton, but twice the mass) attempt to penetrate a rectangular potential barrier of height 10 MeV and thickness 10^{-14} m. Both particles have total energies of 3 MeV.
   (a) Use qualitative arguments to predict which particle has the highest probability of succeeding. [5]
   (b) Evaluate quantitatively the probability of success for both particles.. [10]

4. (From Eisberg & Resnick, P 6-18, pg 229) A particle of total energy $9V_0$ is incident from the $-x$ axis on a potential given below. Find the probability that the particle will be transmitted on through to the positive side of the x axis, $x > a$. [10]

$$V(x) = \begin{cases} 8V_0, & x < 0, \\ 0, & 0 < x < a, \\ 5V_0, & a < x. \end{cases}$$

5. (From Eisberg & Resnick, P 6-20, pg 230) Two possible eigenfunctions for a particle moving freely in a region of length a, but strictly confined to that region, are shown in Eisberg & Resnick, Figure 6-37, pg 230. When the particle is in the state corresponding to the eigenfunction ψ_{I}, its total energy is 4 MeV.
   (a) What is its total energy in the state corresponding to ψ_{II}? [5]
   (b) What is the lowest possible total energy for the particle in this system? [5]

Headstart for next week, Week 12, starting Monday 2004/12/06:
– Read Chapter 6 "Solutions of Time-Independent Schroedinger Equation" in Eisberg & Resnick
– – Section 6.9 "The Simple Harmonic Oscillator Potential"
– – Section 6.10 "Summary"
– Review notes, review texts, review assignments, learn material, do well on exam