# Physics 202H - Introductory Quantum Physics I Homework #12

Fall 2004 Due 5:01 PM, Monday 2004/12/13

[70 points total]

"Journal" questions. Briefly share your thoughts on the following questions:
– What aspects of this course do you think you are most likely to use in the future, both in your "physics" existence and in your "day-to-day" life?
– Any comments about this week's activities? Course content? Assignment? Lab?

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1. Please complete the anonymous end of course survey online on WebCT. Constructive feedback will hopefully allow us to have the best possible courses in the future, and provide the instructor and department with useful information about student reactions to many aspects of the program. In addition to the bonus assignment marks, survey participation may count towards overall class participation scores. [5.01-bonus]

2. (From Eisberg & Resnick, Q 5-28 and 5-29, pg 169) Why is $\psi$ necessarily an oscillatory function if $V(x) < E$? Why does $\psi$ tend to go to infinity if $V(x) > E$? Limit your discussion to about 50 words or so. [10]

3. (From Eisberg & Resnick, P 5-4, pg 169) By evaluating the classical normalization integral in Example 5-6, show that the value of the constant $B^2 = \sqrt{(C/m\pi^2)}$ which satisfies the requirement that the total probability of finding the particle in the classical oscillator somewhere between its limits of motion must equal one. [10]

4. (From Eisberg & Resnick, P 5-7, pg 170)
   (a) Use the particle in a box wave function verified in Example 5-9, with the value of $A^2 = 2/a$ determined in Example 5-10, to calculate the probability that the particle associated with the wave function would be found in a measurement within a distance of $a/3$ from the right-hand end of the box of length $a$. The particle is in its lowest energy state. [10]
   (b) Compare with the probability that would be predicted classically from a simple calculation related to the one in Example 5-6, for a particle with constant speed bouncing back and forth from the ends of the box. [5]
   (c) Compare with the probability that would be predicted classically for a particle undergoing simple harmonic motion in the box with the value of $B^2 = \sqrt{(C/m\pi^2)}$. [5]

5. (From Eisberg & Resnick, P 6-11 and 6-12, pg 229)
   (a) Verify by substitution that the standing wave general solution, (Eisberg & Resnick, Equation 6-62, pg 211), satisfies the time-independent Schroedinger equation, (Eisberg & Resnick, Equation 6-2, pg 178), for the finite square well potential in the region inside the well. [5]
   (b) Verify by substitution that the exponential general solution, (Eisberg & Resnick, Equation 6-63 and 6-64, pg 212), satisfy the time-independent Schroedinger equation, (Eisberg & Resnick, Equation 6-13, pg 186), for the finite square well potential in the regions outside the well. [5]

6. (From Eisberg & Resnick, Q 6-15, pg 227) A particle is incident on a potential barrier of width $a$, with total energy less than the barrier height, and it is reflected. Does the reflection involve only the potential discontinuity facing its direction of incidence? If the other discontinuity were moved by increasing $a$, is the reflection coefficient changed? What if the other discontinuity were removed, so that the barrier was changed into a step? Limit your discussion to about 50 words or so. [10]

7. (From Eisberg & Resnick, Q 6-34, pg 231) Verify the eigenfunction and eigenvalue for the $n = 2$ state of a simple harmonic oscillator by direct substitution into the time-independent Schroedinger equation, as in (Eisberg & Resnick, Example 6-7, pg 224). [10]

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Headstart for next week, Week 13, starting Monday 2004/12/13:
– Review notes, review texts, review assignments, learn material, do well on exam