Review Problems

Physics 234 Spring Quarter 2004 H.J.Frisch HEP320 (702-7479)
May 26, 2004 Office Hours: Wednesday, Friday, or by appointment

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Reading: I recommend looking for additional problems to solve in the recommended texts. Reviewing the key concepts in Shankar is also enormously useful.

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Final: The final will be the normal 2-hour closed-book exam at 10:30 am on June 9, in our normal room (KPTC 120). You are welcome to make one double-sided sheet of formulae, mnemonics, etc. (though it often pays better to read the question carefully, and then think, instead of madly searching through this).

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Problems: These are some problems that might help you review for the final. I am more concerned that you know how to set them up than you know how to do all the integrals, so please focus on setting them up. These do *not* have to be handed in. PLEASE discuss these with your working group.

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1. Consider a particle of energy E incident on a *pair* of identical barriers of width $2a$ and height V, separated by a distance b. Take the case where the barriers are thin, i.e $\hbar^2/(2me) >> a^2$. At what values of b is there maximum transmission?

2. Consider a particle in an infinite square well, in an energy eigenstate of energy E. Calculate the expectation value of x, x^2, p_x, and ${p_x}^2$.

3. A measurement of the above particle in the square well shows that it is not in the right-hand half of the well. What is the minimum energy compatible with this measurement?

4. Two identical noninteracting electrons are placed in an infinite square well of width L. Draw an energy level diagram showing the four lowest energy states of the system.

5. Solve for the eigenfunctions and energy eigenvalues of a particle moving freely in a 2-dimensional square box.

6. Consider a one-dimensional simple harmonic quantum oscillator in some general state (i.e., most likely not in an energy eigenstate). Find the expectation values of x and p_x.

7. Write a Hermitian operator for the product of the momentum and displacement of a one-dimensional simple harmonic oscillator. Find the expectation value for any stationary state of the oscillator.

8. Construct an interesting, non-trivial, but appropriately easy spin-1/2 problem. (Feel free to use neutrino oscillations, the neutral kaon system, the ammonia molecule, etc.).

9. Find the Legendre Polynomial series representation of the function $\sin^2(\theta)$ on the interval $-1 \leq \cos(\theta) \leq 1$. r

10. Consider a hydrogen atom in a state with $< L_z >= m\hbar$ and $< L^2 >= l(l+1)\hbar^2$. Find the expectation values for L_x,L_y, and L_x^2 and L_y^2.

11. Explicitly calculate the expectation values of L_z and L^2 for the n=1 and n=2 states (all of them) for the hydrogen atom.