Example Questions for Exam #2
PHY361

- The exam will cover sections 5-3 to 7-2, inclusive.

- What is the difference between standing and traveling waves? How do you construct a standing wave from traveling waves?

- Write down the four relations between $E$, $\omega$, $p$, and $k$: a) for a photon; b) for an electron matter wave. For each, calculate the group velocity and phase velocity. For the electron, compare these with the classical velocity.

- What are the probability amplitude, probability density, and probability (in terms of the wave function)? What does it mean to normalize a wave function?

- What is an operator? (what does it do?) Give 2 examples.

- When are the wave-like properties of matter used? When are the particle-like properties used?

- What is the physical interpretation of a wave function?

- What are degenerate states? Give an example.

- For a given energy value, and potential function, show where the classical turning points are. Label the kinetic energy for three separate points on the potential.

- What quantities are needed to specify: a) the classical state of a particle? b) the quantum state? How is the position of a particle represented in wave mechanics? How is the momentum represented?

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- Why is the wave equation different for electric fields and matter waves?

- Why is the Schrödinger equation linear in $\psi$?

- Explain the Heisenberg uncertainty principle in terms of wave packets and amplitudes? What happens to a wave packet if the distribution of amplitudes is shifted to higher values of $k$? Explain how the superposition of different frequency waves produces wave packets.

- What does $(2+3i)^*$ equal? What does $|2+3i|^2$ equal? Express $(2+2i)$ in terms of $r e^{i\theta}$.

- What is the correspondence principle? Give an example.

- List three pairs of conjugate variables.

- Be able to sketch the wave function for the 4-th energy state a) in a finite square well, in a harmonic oscillator.

- Describe the qualitative behavior of the wave function in regions where a) $V(x)<E$, b) $V(x)>E$.

- What is the relation between de Broglie matter waves and the Schrödinger equation?

- List 5 requirements for wave functions.

- Use separation of variables to derive the TISE from the TDSE.

- Use separation of variables to solve for the energy values in a particle in a 2-d infinite square well (rectangular boundary $L \times L$).

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- Describe the qualitative behavior of the wave function in regions where a) $V(x)<E$, b) $V(x)>E$.

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- Use separation of variables to derive the TISE from the TDSE.

- For a given energy value, and potential function, show where the classical turning points are. Label the kinetic energy for three separate points on the potential.

- What are degenerate states? Give an example.

- Write down the formula of the expected value of $x^2$ for the ground state of the harmonic oscillator, but do not evaluate the integral. Save for the expected value of $p$.

- Draw node lines for the first 9 wave functions for the 2-D infinite square well. (rectangular boundary $L \times L$). Also for the circular infinite square well.

- Why does the ground state for any binding potential have a zero-point energy?

- Be able to solve Schrödinger equation for infinite square well.

- Why is angular momentum quantized?