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, ω, 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 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?
- Why is the wave equation different for electric fields and matter waves?
- Why is the Schrödinger equation linear in ψ?
- 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.
- Compare the classical and quantum transmission and reflection across a step potential where the energy is: a) less that the step potential; b) greater than the step.
- What is quantum mechanical tunneling? Give three examples tunneling effects or applications.
- Use separation of variables to solve for the energy values in a particle in a 2-d infinite square well (rectangular boundary $L \times L$).
- 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.
- 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?