What to expect

The exam will consist of 20 multiple choice questions. Only one submission attempt is allowed. The exam will be graded electronically, and the grade returned to you upon submission. Questions will be based on content covered in class and will be primarily pulled from lecture material and the textbook, although some questions may also come from supplemental material such as class videos, homework, or class quizzes.

Instructions

The exam will begin at the start of the scheduled class period through the Respondus Browser and you will have 1 hour and 15 minutes to complete the exam. You will need to have your camera on during the exam and show your TAMU Student ID before you begin.

The exam will be open notes, open computer (within the limits described below), and open book (allows use of the textbook, notes, and google). Using a secondary electronic device such as a tablet, advanced calculator, or computer is allowed, as long as the screen is turned so that it is visible to the camera.

The exam is **NOT** open friend (i.e. you are not allowed to work with other classmates or receive outside help from tutors, study services, other students, etc.) and any form of external help is not allowed (i.e. the use of answer key services such as Chegg, Quizlet, etc. are also explicitly not allowed). Extra time will only be given for exceptional circumstances beyond the students' control.

Note: In the event that you are unable to take the exam at the scheduled time, or an external event beyond your control interferes with your ability to take the examination, you ***MUST*** notify

me as soon as possible so that alternate arrangements can be made (within reason). It is your responsibility to notify me of issues occurring on your end, lack of communication is not a viable excuse for incomplete or missing work.

Recommendations for studying

- Study chapters 5, 6, 7.
- Review lectures 8-11.
- Review hw assignments 5-7.
- Prepare a quick guide sheet for use during the exam. This sheet should include information such as relevant formulas and constants, examples of solved problems, and self-written explanations of the concepts covered. While the exam is open-book, searching for the needed information will whittle away your time; having everything you need in one location will greatly help.
- A calculator is highly recommended

Outline of study

- Braggs Law and Bragg Planes
    - $n\lambda = 2d \sin\theta$
      (n = integer)
- De Broglie waves
    - $\lambda = \frac{h}{p}$
- Properties of Wave motion
- Phase and Group Velocity
    - Phase Velocity: $v_{\text{ph}} = \frac{\lambda}{T} = \frac{\omega}{k}$
    - Group Velocity: $u_{\text{gr}} = \frac{dE}{dp} = \frac{pc^2}{E}$
- Uncertainty Principle
    - Position-Momentum: $\Delta p_x \, \Delta x \geq \frac{\hbar}{2}$
    - Energy-Time: $\Delta E \, \Delta t \geq \frac{\hbar}{2}$
- The Copenhagen Interpretation
    - The uncertainty principle of Heisenberg
    - The complementarity principle of Bohr
    - The statistical interpretation of Born, based on probabilities determined by the wave function
- All aspects of a particle in a box
    - Energy of n-th level: $E_n = n^2 \frac{\hbar^2 \pi^2}{2ml^2}$
- General form of the Schrodinger Wave Equation
    - $\Psi(x,t) = Ae^{i(kx-\omega t)} = A[\cos(kx-\omega t) + i\sin(kx-\omega t)]$
- What is Normalization and why it is needed
- How to Normalize an equation.

Preparation for Exam

- Boundary Conditions for Wave Equations
    - In order to avoid infinite probabilities, the wave function must be finite everywhere.
    - In order to avoid multiple values of the probability, the wave function must be single valued.
    - For finite potentials, the wave function and its derivative must be continuous. This is required because the second-order derivative term in the wave equation must be single valued. (There are exceptions to this rule when V is infinite.)
    - In order to normalize the wave functions, they must approach zero as x approaches infinity.
- Time-Independent Schrodinger Equation
    - $$-\frac{\hbar^2}{2m}\frac{d^2\psi(x)}{dx^2}+V(x)\psi(x)=E\psi(x)$$
- What is an expectation value and how to find it
- The various Operators
    - Position
    - Momentum
    - Energy
    - Hamiltonian
- Solutions to 1-D Infinite and Finite Square Wells
- Degeneracy
    - Degeneracy is when multiple wave functions have the same energy.
- Simple Harmonic Oscillator
- Purpose of Radial and Angular Equations

- $R_{n,l}(r)$
- $Y_{l,m}(\theta,\varphi)$

- Quantum Numbers, what they represent, and their Boundary Conditions
  - $n = 1, 2, 3, 4, \ldots$ Integer
  - $\ell = 0, 1, 2, 3, \ldots, n - 1$ Integer
  - $m_\ell = -\ell, -\ell + 1, \ldots, 0, 1, \ldots, \ell - 1, \ell$ Integer
- What is the Normal Zeeman Effect
- Intrinsic Spin
  - $m_s = \pm\frac{1}{2}$
- Selection Rules
  - Δn = anything
  - $\Delta\ell = \pm 1$
  - $\Delta m_l = \pm 1,0$
- Principle of equivalence
  - There is no experiment that can be done in a small confined space that can detect the difference between a uniform gravitational field and an equivalent uniform acceleration.