Physics 214b-2008 Walter F. Smith

Exam 1 Coverage

Book: Chapters 1-2, omitting section 2.9. We also covered several topics in lecture which were not in the reading. One of these, relativistic momentum and energy, is covered fairly well in Tipler 3rd Ed., pp. 1122-1132. I have sent you a pdf of this. I do not expect you to read this; I hope that my lectures were sufficiently clear. However, I make it available in case you wish to see the presentation of a different author.

Assignments: 1-4, plus part one of assignment 5

Lectures: 1-12 (beginning of semester through and including Monday 2-18-08)

Equation sheet: You should prepare an equation sheet with up to 20 equations for use during the exam. No text or pictures allowed on this.

Topics we have covered in lecture, reading, or assignments:
(The most important topics are underlined, and so you should be absolutely certain to be solid on all of these. **However, there will certainly be some exam problems on the topics which are not underlined**, so you need to review those as well.)

Relativistic energy and momentum
- Understand and be ready to use:
  - $\mathbf{p}=\gamma m\mathbf{u}$, $E=\gamma mc^2=mc^2+KE$, and $E^2=p^2c^2+m^2c^4$
- Be able to solve relativistic collision / explosion problems in three dimensions using conservation of energy and momentum (e.g. problem 1E)

The equipartition theorem
- Know what it is, and how to use it to calculate thermal energy
- Heat capacity: know definition, be ready to calculate it for a system by starting with the equipartition theorm
- Know what a phonon is, and the expression for its energy
- Ultraviolet catastrophe: be ready to explain qualitatively what it is, and how it was solved by Planck
- Know and understand the Planck distribution, be ready to use it
- Know and understand the expression for the energy density in a cavity $\rho_T(\lambda)$, be ready to use it

Photons
- $E=h\nu$, $\mathbf{p}=\hbar\mathbf{k}$
- Photoelectric effect: be ready to explain in detail what it shows, and how Einstein explained it
- Compton scattering
  - Be ready to explain qualitatively what it is, and why it was important
  - Know the Compton formula (on p. 20), and be ready to use it
- Aspect anti-coincidence experiment: be ready to describe what it is and why it was important
- Aspect single-photon intereference experiment: be ready to describe what it is and why it was important
- Probability amplitude for photons:
  - Know what it means
  - Be ready for interference problems including effects of phase change upon reflection (such as problem 1.28)

Diffraction gratings
Principle of least time
Matter waves

- $E = h\nu$, $\mathbf{p} = \hbar\mathbf{k}$
- Davisson Germer experiment: qualitative understanding of what it was & why it was important
- Bragg diffraction

Schrödinger equation

- Know the starting points used for the plausibility argument. (I will not ask you to reproduce the argument itself.)
- Know and understand the equation
- Know the definition of the momentum operator
- Be ready to test a proposed Ψ to see if if is a solution for the SEQ
- Be ready to test a proposed Ψ to see if if is an eigenfunction of $\hat{p}$
- Know the free electron solution to the SEQ
- Normalization
- Probability density
- Probability current
- Arbitrariness of oscillation frequency

Wave packets & group velocity

- Understand that it is possible to create a wave packet by summing free electron wavefunctions
- Know the definition of group velocity
- Be ready to explain why the phase velocity of a matter wave is arbitrary

Heisenberg uncertainty principle

- Know what it is and how to use it for problems such as 2.24
- Be ready to reproduce either one (your choice) of the semi-quantitative derivations we did in class
- Energy-time uncertainty principle

Expectation values

- Know the definition
- Be ready to calculate given any wavefunction and operator. (Assume that I will provide you with any needed integrals.)
- Be ready to calculate Δx and Δp for a given wavefunction

Miscellaneous

- Know the form of a Gaussian. Understand that the *w* that appears in this form is the standard deviation of the Gaussian.