

University of Oklahoma
Department of Physics and Astronomy
Qualifying Exam Study Guide

(revised 11/08/07)

1 Reading List

This list is meant to be a guide to help you in your studying and is by no means meant to be complete and exhaustive. The nature of the qualifier is such that you are likely to see a problem that is different from any that you have done before.

A good first year physics text, such as "Physics for Scientists and Engineers" by Tipler, "Fundamentals of Physics Textbook" by Halliday, Resnick and Walker, or "University Physics," by Reese, is an excellent resource for undergraduate level material.

- Classical and Statistical Mechanics Qualifier (see below):
 1. Stephen T. Thornton and Jerry B. Marion, *Classical Dynamics of Particles and Systems*
 2. Donald T. Greenwood *Classical Dynamics*
 3. Herbert Goldstein, Charles P. Poole, and John L. Safko, *Classical Mechanics*, Chapters 1–10
 4. Herbert B. Callen *Thermodynamics and an Introduction to Thermostatistics*, 2nd Edition
 5. F. Reif, *Statistical and Thermal Physics*

- Electricity and Magnetism: (see below)
 1. P. Lorrain and D. R. Corson, *Electromagnetic Fields and Waves*
 2. J. Reitz, F. Milford, and R. Christy, *Foundations of Electromagnetic Theory*
 3. D. Griffiths, *Introduction to Electrodynamics*
 4. J. D. Jackson, *Classical Electrodynamics*, Chapters 1–8, 11–12
 5. W. Panofsky and M. Phillips, *Classical Electricity and Magnetism*, Chapters 1–13, 15–18
 6. J. Schwinger, L. L. DeRaad, Jr., K. A. Milton, and W.-y. Tsai, *Classical Electrodynamics*
 7. Stratton, *Electromagnetic Theory*
 8. Landau and Lifshitz, *Classical Theory of Fields and Electrodynamics of Continuous Media*

- Quantum Mechanics: (see below)

1. Morrison, *Understanding Quantum Mechanics*
2. Bransden & Joachain, *Quantum Mechanics*
3. Robbinett *Quantum Mechanics*
4. Liboff *Introductory Quantum Mechanics*
5. Griffiths *Introduction to Quantum Mechanics*
6. Gaziorowicz *Quantum Physics*
7. Shankar *Principles of Quantum Mechanics*
8. Cohen-Tannoudji, *Quantum Mechanics*, Volume 1

- Astronomy: (see below)

The basic reading for the qualifier consists of the following books:

1. An Introduction to Modern Astrophysics, Carroll & Ostlie
2. Introduction to Stellar Atmospheres and Interiors, Novotny (this book is out of print but the P&A library has a copy).

Additional texts: These have been suggested by one or more faculty as being at the advanced undergraduate / beginning graduate level:

1. The New Cosmos (3rd ed.) by A. Unsold
2. Astrophysical Concepts (2nd ed.) By M. Harwit
3. The Physical Universe, F. Shu
4. Introductory Astronomy and Astrophysics (3rd ed.) by Zelik, Gregory, and Smith

Standard graduate texts: The exam will not be at the general level of these books, but you should be aware of their existence! Listed by subject and author, they are:

1. Solar system - Landstreet
2. Stellar atmospheres - Mihalas; Rutten (available on the web)
3. Stellar interiors - Clayton; Kippenhahn & Weigert; Hansen & Kawaler
4. Interstellar medium - Osterbrock & Ferland; Kwok
5. Cosmology - Peebles
6. Galaxies - Binney and Merrifield

2 Study Guide for Individual Exams

The examinations are at the level of the texts listed in Part 1. We list some *representative* topics below. These are meant to be indicative of the nature of the exams; however, the student should note that questions concerning other topics will be included on the actual examinations.

2.1 Classical and Statistical Mechanics Qualifier

- Undergraduate Mechanics: Representative Topics
 - Newtonian Mechanics, including equations of motion, and conservation laws (e.g. linear and angular momentum, energy)
 - Oscillation
 - * Simple harmonic motion: undamped, damped and driven systems.
 - * Normal modes.
 - Rigid bodies, including Euler angles.
 - Non-inertial (e.g. rotating) reference frames
 - Central force motion: (e.g. r^{-1} or r^2 potentials).
 - Lagrangians and Hamiltonians (Undergraduate Level)
 - Special relativity, especially the relativistic form of energy and momentum.
- Graduate Mechanics: Representative Topics
 - Calculus of variations.
 - Lagrangians and Hamiltonians (Graduate Level)
 - Holonomic and nonholonomic (differential) constraints.
 - Hamilton-Jacobi theory.
 - Canonical transformations.
 - Poisson brackets.
- Statistical Mechanics: Representative Topics
 - Basic thermodynamic variables and their meaning: e.g. Entropy, temperature, and chemical potential.
 - Three laws of thermodynamics.
 - Heat engines.
 - Thermodynamic potentials (e.g. Enthalpy, Helmholtz free energy).
 - Kinetic theory (e.g. ideal gas theory, Maxwell-Boltzmann distribution)
 - Classical statistical mechanics and the Boltzmann distribution.
 - Quantum Statistical distributions: Fermi-Dirac, Bose-Einstein distributions.
 - Phase transitions and mean field theory.

2.2 Electricity and Magnetism Qualifier

- Undergraduate E & M: Representative Topics
 1. Electrostatics, Dielectrics
 2. Magnetostatics, Magnetization
 3. Maxwell's equations
 4. Energy and momentum in the E & M field
 5. Interaction forces and energies of two or more point sources, wires, dipoles, etc.
 6. Plane waves in vacuum and dielectrics
 7. Electrodynamics in media (dispersion, etc.)
 8. Radiation
- Graduate E & M: Representative Topics
 1. Special Relativity in 4-dimensional form
 2. Maxwell's equations in 4-dimensional form
 3. Gauges and 4-potentials
 4. The stress-energy-momentum tensor
 5. Stationary Principles in Statics and Dynamics

2.3 Quantum Mechanics Qualifier

- Undergraduate Material
 1. Stationary and Time-dependent Solutions to Schrödinger's Equation
 2. Piece-wise Constant Potentials (Square Well, Barrier, etc.)
 3. Harmonic Oscillators—solutions plus methods of solutions.
 4. 2D and 3D Potentials in various coordinate systems.
 5. Hydrogen-like Atoms
 6. Perturbation Theory—Constant and Time Dependent Perturbations.
 7. Spin
- Graduate Material
 1. Topics 1 to 5 above in More Detail
 2. Postulates of quantum mechanics
 3. Mathematics of Hilbert Space and Vector Spaces
 4. Matrix Mechanics, Dirac formulation of Quantum Mechanics
 5. Measurement Theory

6. Generalized Uncertainty Principle
7. Operator Techniques (Harmonic Oscillators and Angular Momentum)
8. Clebsch-Gordon coefficients,
9. General properties of angular momentum.

2.4 Astronomy Qualifier

Subjects covered on the astronomy qualifier include stellar atmospheres and interiors, galaxies, gaseous nebulae and the interstellar medium, cosmology, and solar system astronomy. Students should also be very familiar with basic astronomical concepts such as the magnitude system, radiation laws, and distance-determining techniques.