Physics 4153: Statistical Physics & Thermodynamics
Course Goals and Topic Outline

Version 5.7: August 16, 2004

Course Goals

I. To understand the most important physical quantities that characterize the bulk properties of (macroscopic) matter and the relationships between these quantities.
II. To understand the laws of thermodynamics and how they regulate macroscopic physical processes, with special attention to energy, volume, and particle exchange between systems and to transformations of energy.
III. To develop tools for characterizing bulk matter at the macroscopic level.
IV. To understand the relationship between the microscopic view (statistical mechanics) and the macroscopic view (thermodynamics) of matter.

Course Outline

I. **Fundamental Concepts and Tools of Thermodynamics and Statistical Mechanics**

A. *Basic concepts and tools for isolated systems*
1. Review of basic thermodynamics (heat, work, and the First Law) (Chap. 2)
2. Introduction to key concepts and tools of statistical mechanics (Chap. 3)
3. Entropy, the Second Law, temperature, and the concept of equilibrium (Chap. 4)

B. *Extensions of basic tools and concepts*
1. The thermodynamics and statistical mechanics of a constant-temperature system (Chap. 5)
2. Extension of statistical mechanics to systems with continuous energy states (Chap. 6)
3. Extension of thermodynamics and statistical mechanics to systems in which the number of particles is *not* conserved (Chap. 7)

II. **Applications.**

A. *"Classical" and quantum gases*
1. Introduction to the three most common types of gases (Chap. 8)
2. "Ideal classical gases" (§9.1–9.7) (development of § 8.4)
3. "Bose" gases in which particles are not conserved (the photon gas) (Chap. 10) (development of § 8.3)
4. "Bose" gases in which particles are conserved (Bose-Einstein condensation) (Chap. 11) (development of § 8.3)
5. "Fermi gas" (Chap. 12) (development of § 8.4)

B. *Amazing transformations of matter: phase transitions* (Chap. 14)