Physics 206 – Spring 2019
Unit T Exam Study Guide

- The Laws of Thermodynamics
  - **Zeroeth Law:** If system A is in thermal equilibrium with system C, and system B is in thermal equilibrium with system C, then system A is in thermal equilibrium with system B.
  - **First Law:** An amount of work W done on a system, or heat Q added to it ,changes the system's internal energy changes according to conservation laws:
  $$\Delta\mathcal{U} = W + Q$$
  - **Second Law:** The total entropy of interacting systems always increases, $\Delta S_{\text{tot}} = \Delta S_A + \Delta S_B > 0$
  - **Third Law:** The entropy of a system cooled to absolute zero approaches a constant (approximately 0).
- The classical kinetic theory of gases [T1,T5]
- The Ideal Gas Law [T5]
- Einstein solids [T2]
  - 3-D QHOs and energy levels
  - Microstates
  - Macrostates
  - Multiplicities $\Omega(\mathcal{U}, N)$
  - Two Einstein solids in contact; macropartitions
  - Thermal equilibrium defined by multiplicities / microstates
  - Irreversibility and multiplicities
- Entropy: $S = k_B \ln \Omega$ [T3]
- Definition of temperature: $\frac{1}{T} = \frac{dS}{d\mathcal{U}}$ [T3]
- The Boltzmann factor and Boltzmann distribution [T4]
- Thermal energy of an Einstein solid [T4]
- The partition function [T4]
- Heat reservoirs [T4]

- Average energy of a particle in a thermal system [T4]
- Gases as particles in a box (average energy) [T6]
- Photon gases and black body radiation [T6]
  - The Rayleigh-Jeans Law and quantum (Planckian) correction
  - The Stefan-Boltzmann Law
- Black hole thermodynamics [Handout]
  - Hawking temperature from quantum tunneling + Boltzmann factor
  - Problems with Hawking temperature for small black holes
  - Radiative power / evaporation rate and lifetime
  - Entropy: Bekenstein-Hawking area-entropy law