

Topic List for Final Exam

PHYS-410, Statistical Mechanics

The final exam is cumulative – it covers the entire semester. More emphasis, however, will be placed on material we have covered since the first exam (roughly the second half of the course). Below you will find the list of topics we have covered this semester.

Aside from all the other topics you should have committed to memory the values of certain physical constants to about 10% accuracy. These include:

- Speed of light c
- Fundamental unit of charge e
- Mass of a proton m_p
- Mass of an electron m_e
- Molar masses for H, He, C, N, O
- Boltzmann's constant k_B
- Planck's constant h
- Avagadro's number N_0
- Values for room temperature T and atmospheric pressure p_0
- Conversion from calories to joules
- Density and specific heat for liquid water

First Third

- 1st and 2nd Laws of Thermodynamics
- Classical thermodynamics
- state variables
- extensive versus intensive variables
- equation of state
- ideal gas law
- heat capacities at constant volume and constant pressure
- classical equipartition theorem
- reversible and irreversible processes
- Carnot cycle
- entropy

- Fundamental postulate of Statistical Mechanics
- microcanonical ensemble
- number of accessible states, Ω
- $S = k_B \log(\Omega)$
- temperature parameter $\beta = \frac{\partial \log \Omega}{\partial U} = \frac{1}{kT}$
- pressure and chemical potential
- external parameters
- equilibrium means a maximum in entropy S

Second Third

- Density of States
- Free Energy (or Helmholtz Free Energy)
- Partition Function

Two-level system
Maxwell-Boltzmann speed and velocity distributions
(the above topics appeared on the last exam, but have also continued since)

Classical equipartition theorem
Entropy, magnetization, and free energy of a paramagnet
Negative temperature
Enthalpy
Gibbs Free Energy
Clausius-Clapeyron Equation
Grand Sum
Gibbs Factor
Chemical and phase equilibria
Sievert's Law
Quantum Distribution Functions
F-D distribution function
Fermi energy, temperature, wave-vector
Degenerate Fermi Gas
Degeneracy pressure
Temperature dependence of the chemical potential
Mean energy of a Fermi Gas
Linear heat capacity
Classical limit for the F-D and B-E distributions

Last Third

photon gas
blackbody radiation
harmonic approximation and normal modes
phonons
Debye model
ideal Bose gas
Bose condensation

kinetic theory
golden rule
scattering cross-section
mean lifetime and Poisson statistics
mean free path
thermal conductivity