

## Physics 603     Some important ideas since the midterm

General ideas: Dependence on spatial dimension and energy dispersion relation

Density of states (DOS)

Doable models: 2-state/Ising, SHO, ideal gas

Homework problems and tweaks thereof

How to calculate canonical and grand canonical partition functions  $Z_N$  and  $\mathcal{Z}$ ; then how to get  $U$ ,  $\beta pV$ ,  $F$ ,  $S$ ,  $C_v$ , etc. from them. How to calculate number of configurations of certain energy, etc., to get  $W$  (or  $\Omega$ ) and then  $S$  from it.

Why/how the Boltzmann factor arises

Liouville theorem and its implications; Legendre transformations: how to do them and what they accomplish

Extensive and intensive thermodynamic variables

Meaning, role, and importance of  $\lambda_T$

How to go from discrete sums over momentum or wavevectors to integrals over them, and why this can fail for

Bose condensates

Equipartition and generalizations, meaning of negative temperature

Properties of ideal gas

Diatomic gases: vibrational, rotational degrees of freedom, freeze-out, nuclear-spin & rotational angular mom.

Chemical equilibrium, writing down the reaction constant from the chemical equation

Bose gas, Bose-Einstein distribution

Role of polylogarithm and what happens in Bose-Einstein condensation

Behavior of chem. pot.  $\mu$  and fugacity  $z$

How Planck formula explains blackbody radiation

Einstein & Debye models and what they mean

Fermi gas and Fermi-Dirac distribution function

Sommerfeld expansion to lowest order and applications to  $U$ ,  $C_v$ , Pauli paramagnetic susceptibility  $\chi_p$

Virial expansion,  $B_2(T)$  and  $B_3(T)$  for simple interactions

Phase transitions, van der Waals equation of state and Maxwell construction; phase diagrams

Ising model results: mean field/Bragg-Williams, quasichemical/Bethe-Peierls-Weiss, 1D, results of exact 2D

Applications of Ising model: 2-state systems, lattice gas, binary alloy

Landau theory of phase transitions