lecture 1 - equation of state

- nature of theories
  thermodynamics - phenomenological/axiomatic
  statistical mechanics - microscopic
  (derivation of thermodynamics)
- "systems" in "thermodynamic" "equilibrium"
  "systems" - macroscopic (issue of fluctuations)
  "thermodynamic" - averages of lasting quantities
  "equilibrium" - issue of relaxation/time scale
- extensive/intensive variables
- equation of state/examples
- 0th law - existence of temperature
- ideal gas equation of state from kinetic theory

$$PV = Nk_BT \tag{1}$$
$$\frac{1}{2}m\overline{v^2} \equiv \frac{3}{2}k_BT \tag{2}$$

- equipartition of energy
- units and constants
- phase diagrams, P-V/P-T, M-B
  paramagnet, $M = \mu N \tanh(\frac{\mu B}{k_BT})$
  light in a cavity, $P = (1/3)\sigma T^4$
- Van der Waals eq. of state

$$P = \frac{RT}{V-B} - \frac{A}{V^2}, \quad A = N^2a, \quad B = Nb \tag{3}$$

- law of corresponding states

$$(P/P_c) = \frac{8}{3}\frac{(T/T_c)}{(V/V_c) - 1/3} - \frac{3}{(V/V_c)^2} \tag{4}$$

- a theorem (that relates susceptibilities)
  $f(x, y, z) = 0$

$$\frac{\partial x}{\partial y}|_z \frac{\partial y}{\partial z}|_x = -\frac{\partial x}{\partial z}|_y \tag{5}$$