Quiz2: Statistical Thermodynamics: SCI205/405 - Spring 2020: 15 Apr 2020

Time: 30 mins Roll no. 2018113002, 2018113008, 2018113010 and 2018113012 Max. marks=25

Questions carry equal marks.

- 1. Consider a three-level single particle system with six microstates of energies $0, \varepsilon, \varepsilon, \varepsilon, 2\varepsilon$. What is the mean energy of the system if it is in equilibrium with a bath at temperature T? In the region where $\beta\varepsilon \to 0$, what will the graph of heat capacity of the system as a function of ε look like at a constant temperature?
- 2. The atomic energy states of F are given as follows: $E_{^2P_{\frac{3}{2}}} = 0$; $E_{^2P_{\frac{1}{2}}} = 404.0 \text{cm}^{-1}$. Show that less than three percent of F atoms occupy the first excited state at 200K. $[hc/k_B = 1.44 \text{ cm-deg (K)}]$ and degeneracy of the state 2P_j is 2j + 1.
- **3.** Obtain the value for: $\frac{\Theta_{x,H_2}}{\Theta_{x,D_2}}$, for x=v(vibrational) at high temperatures, without using the Tables.
- 4. Explain qualitatively why the pressure of an ideal Fermi gas is different from that of the classical ideal gas. Mention also if it is lower or higher.
- 5. Given that for a N-particle system of volume V, the number of energy states for an energy U is given by $\Omega(U, N, V) = \frac{V^N}{h^{3N}N!} \cdot \frac{(2\pi m U)^{\frac{3N}{2}}}{(\frac{3N}{2})!}$, express the entropy as a function of U and N, and obtain an expression for the temperature of the system (use microcanonical ensemble theory and Stirling's approximation).