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, ε, ε, ε, 2ε, 2ε. 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. $[hc/k_B = 1.44$ 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 $\Omega(U, N, V) = \frac{V^N}{h^{3N}N!} \cdot \frac{(2\pi mU)^{\frac{3N}{2}}}{(\frac{3N}{2})!}$, 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).