سوال های پیشنهادی برای درس مکانیک آماری کارشناسی ارشد از فصل ۱

(Reference: Statistical Mechanics, Third Edition, R. K. Pathria)

1.3. Two systems A and B, of identical composition, are brought together and allowed to exchange both energy and particles, keeping volumes V_A and V_B constant. Show that the minimum value of the quantity (dE_A/dN_A) is given by

$$\frac{\mu_A T_B - \mu_B T_A}{T_B - T_A},$$

where the μ's and the T's are the respective chemical potentials and temperatures.

1.4. In a classical gas of hard spheres (of diameter D), the spatial distribution of the particles is no longer uncorrelated. Roughly speaking, the presence of n particles in the system leaves only a volume $(V - n v_0)$ available for the $(n+1)$th particle; clearly, v_0 would be proportional to D^3. Assuming that $N v_0 \ll V$, determine the dependence of $\Omega(N, V, E)$ on V (compare to equation (1.4.1)) and show that, as a result of this, V in the ideal-gas law (1.4.3) gets replaced by $(V - b)$, where b is four times the actual volume occupied by the particles.

1.7. Study the statistical mechanics of an extreme relativisitic gas characterized by the single-particle energy states

$$\varepsilon(n_x, n_y, n_z) = \frac{hc}{2L}\left(n_x^2 + n_y^2 + n_z^2\right)^{1/2},$$

instead of (1.4.5), along the lines followed in Section 1.4. Show that the ratio C_P/C_V in this case is 4/3, instead of 5/3.

1.8. Consider a system of quasiparticles whose energy eigenvalues are given by

$$\varepsilon(n) = nh\nu; \quad n = 0, 1, 2, \ldots.$$

Obtain an asymptotic expression for the number Ω of this system for a given number N of the quasiparticles and a given total energy E. Determine the temperature T of the system as a function of E/N and $h\nu$, and examine the situation for which $E/(Nh\nu) \gg 1$.