4.1 Consider two ideal gases with volumes V_A and V_B, respectively, separated by a partition that allows energy to pass through. The system is isolated from the rest of the universe, thus giving a constant total energy U_{total}. If each gas has N molecules (of the same species), show that the multiplicity as a function of U_A, has a sharp peak centered at $U/2$ with a width of peak = $\frac{U_{total}}{\sqrt{3N/2}}$. (Hint: Starting from the equation $\Omega(U,V,N) = f(N)V^N U^{3N/2}$.)

4.2 Apply the Stirling's approximation to the multiplicity function of an ideal gas and verify the Sackur-Tetrode equation: $S = Nk\left[\ln\left(\frac{V}{N}\left(\frac{4\pi mU}{3Nh^2}\right)^{3/2}\right) + \frac{5}{2}\right]$.