Phy 410
Quiz #4, Feb 12, 2010

a) Thermal wave length (λ_{th}) associated with a particle of mass M at temperature τ is 20 Å.

(i) What is λ_{th} if the temperature is reduced by a factor of 100?

$$Since\ \lambda_{th} \propto \frac{1}{\sqrt{\tau}};\ \lambda_{th} = 200A^0$$

(ii) What is λ_{th} if the mass of the particle quadruples?

$$Since\ \lambda_{th} \propto \frac{1}{\sqrt{M}};\ \lambda_{th} = 10A^0$$

b) Partition function for a gas of N identical particles of mass M at temperature τ in volume V is given by

$$Z_N = \frac{(Z_1)^N}{(N)!}; Z_1 = \frac{V}{\lambda_{th}^3}$$

(i) What is the partition function for 2N such particles in a volume 2V? (State your answer in terms of λ_{th}, N and V)

$$Z_{2N} = \frac{(Z_1)^{2N}}{(2N)!};\ Z_1 = \left(\frac{2V}{\lambda_{th}^3}\right)$$

(ii) What is the partition function for an ideal gas mixture consisting of N_1 , A particles and N_2 , B particles confined in the same volume V? (State your answer in terms of $\lambda_{th,A}, \lambda_{th,B}$, N_1, N_2 and V)

$$Z_{Tot} = Z_A \bullet Z_B$$

$$Z_A = \frac{1}{N_1!}\left(\frac{V}{\lambda_{th,A}^3}\right)^{N_1}; Z_B = \frac{1}{N_2!}\left(\frac{V}{\lambda_{th,B}^3}\right)^{N_2}$$