Phy 410
Quiz #4, Feb 13, 2009

a) Thermal wave length associated with a particle of mass M at temperature τ is 10 Å.

(i) What is the thermal wave length if the temperature is reduced by a factor of 100?

$$\lambda_{th} = \sqrt{\frac{2\pi\hbar^2}{M\tau}} \propto \frac{1}{\tau^{1/2}} or \frac{1}{M^{1/2}}$$

λ_{th}=100 Å

(ii) What is the thermal wave length if the mass of the particle doubles?

λ_{th}=10/√2 = 7.07Å

b) Partition function for a gas of identical particles of mass M at temperature τ confined in a 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 confined in a volume 2V? (Express your answer in terms of λ_{th} , N and V)

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

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

$$Z = Z_A \bullet Z_B \ (NOT\ Z_A + Z_B)$$

$$Z_A = \frac{(Z_{1,A})^{N_1}}{N_1!}; Z_{1,A} = \frac{V}{\lambda_{th,A}^3}$$

$$Z_B = \frac{(Z_{1,B})^{N_2}}{N_2!}; Z_{1,B} = \frac{V}{\lambda_{th,B}^3}$$