Achhruram Memorial College

Affiliated to Sidho-Kanho-Birsha University

Statistical Mechanics Examination

Question – 2

Date: 13-11-2017
Time: 12:30PM – 02.30PM
Full Marks: 50

All Questions are compulsory:

(1) Obtain the relation between the pressure 'P' and the volume 'V' of an ideal fermion gas at T=0 K. 2

(2) How many photons are there in 1 c.c. of radiation at 727°C? Find their average energy, $\left[\text{Given}\int_0^\infty \frac{x^2}{e^x-1}dx = 2.405\right]$ 2

(3) State and explain Gibbs' paradox? 2

(4) Write down Pauli's exclusion principle. 2

(5) Explain the terms: phase space, phase point and phase trajectory. 2

(6) Prove that at 0 *K (i)* the average kinetic energy is $\frac{3}{5}E_F$ and *(ii)* the average velocity is $\frac{3}{4}V_F$, where E_F Fermi energy and V_F the Fermi velocity. 5

(7) Established the relationship, S = K ln W, where S is entropy, W is function of probability, and K is Boltzmann constant 5

(8) What are basic postulates of Maxwell-Boltzmann statistics? Drive the expression of Maxwell-Boltzmann distribution. 5

(9) The three lowest energy levels of a certain molecule are $E_1 = 0$, $E_2 = \varepsilon$ and $E_2 = 10\varepsilon$. Show that at sufficiently low temperature; only E_1 and E_2 are populated. Find the average energy E of the molecule at temperature T and the contributions of these levels to molar specific heat C_v. Sketch C_v as function of T. 5

(10) (a) What are Fermion?

(b) State and prove Stirling formula for the factorial of a very large number.

(c) Write down the distribution law obeyed by electron gas and apply the same to derive Richardson-Dushman equation. 1+3+6

(11) (a) Define the following terms:

Macro state; Micro state; Phase space; Density of state and Distribution functions.

(b) State limitations of Maxwell-Boltzmann's classical statistics.

(b) Find the thermal capacity for a monatomic chain, assuming the potential energy is of the form $V(r)=\frac{1}{2}k_o x^2 - \frac{1}{3}\mu x^3$, where k_o and μ are constants of the chain.

3+3+4