PHYSICS PAPER–A

(Statistical Physics and Thermodynamics—I)

Time Allowed : 3 Hours **Maximum Marks : 22**

Note : (1) Attempt **five** questions in all, selecting **two** questions from each Sections A and B respectively.

(2) Section C is compulsory.

(3) Use of log table and non programmable calculator is allowed.

SECTION—A

1. Show that for distribution of n identical particles in 2 compartments with equal a priori probability, the deviation from a state of maximum probability is highly improbable. 4

2. (a) Describe the terms (i) microstate (ii) macrostate and give the distribution of 4 distinguishable particles in 2 compartments in a tabular form. 3

   (b) A system having 8 distinguishable particles distributed in 2 compartments with equal a priori probability. Calculate probability of macrostate (i) (4,4) (ii) (3,5). 1

3. (a) Prove that for a dynamic system the fraction of the total time that a system spends in any particular macrostate is proportional to the thermodynamic probability of that macrostate. 3

   (b) Eight distinguishable particles are distributed in 2 compartments of unequal sizes. The first compartment is further divided into 6 cells and 2nd into 2 cells of equal sizes. Calculate the probability of (i) macrostate (5,3) (ii) most probable macrostate. 1

SECTION—B

4. Give the assumptions of M–B statistics and using M–B distribution law for an ideal gas obtain the distribution law of molecular speeds. 4

5. (a) What is Fermi Energy ? Using F–D distribution law for electron gas—

$$n_u du = \frac{8\sqrt{2}\pi V m^{3/2}}{h^3} \times \frac{u^{1/2}}{e^{(u-u_f)/kT}+1}$$

   Find the expression for fermi energy. 3

   (b) Calculate the fermi energy of copper in ev. Given at no. of Cu = 29, and atomic mass of Cu =63.5 g mol^{-1} and density of Cu=8.94 g cm^{-3} 3

6. (a) What is Photon gas ? Using B–E distribution law deduce Planck's law for black body radiations in terms of wave length.

(b) Assuming the radius of sun to be 7×10^8 m and temperature of its surface to be 6000 K, find the amount of energy radiated by sun.

SECTION—C

7. Attempt any **SIX** parts—

(i) Calculate r.m.s. and average velocity for oxygen at N.T.P. Given $K = 1.38 \times 10^{-23}$ JK^{-1} and mass of oxygen molecule is 5.31×10^{-26} kg.

(ii) The temperature of ordinary electric bulb is around 3000 K. At what wavelength will it radiate maximum energy ? Will this wavelength be in visible region ? Given Wien's constant b=0.0029 mK.

(iii) The peak of v versus $\frac{n_v}{n}$ curve is sharper at low temperatures, why ?

(iv) What is phase space ? Why is phase space divided into cells ?

(v) Write occupation index $\frac{n_i}{g_i}$ of energy distribution of particles in 3 kinds of statistics and discuss it for (.) $u_i >> KT$ (ii) $u_i << KT$.

(vi) Give the similarities and dissimilarities between approach of B–E and F–D statistics.

(vii) A problem in Statistical Physics is given to three students where chances of solving are 1/2, 1/3 and 1/6. What is the probability that the problem will be solved ? 6×1=6