(i) Printed Pages: 4 Roll No. .....

(ii) Questions : 7 Sub. Code : 0 2 4 7

Exam. Code : 0 0 0 3

B.A./B.Sc. (General) 3rd Semester

1128

PHYSICS

Paper—A : Statistical Physics and Thermodynamics—I

Time Allowed : Three Hours] **[Maximum Marks : 22**

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

(2) Section C is compulsory.

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

SECTION—A

1. (a) Prove that the probability of a macrostate is equal to the product of the thermodynamic probability of a macrostate and the probability of a microstate. 3

(b) Derive the expression $P(f) = P_{max}\, e^{\frac{-f^2 n}{2}}$ for a macrostate having a fractional deviation f from the most probable macrostate for a distribution of n distinguishable particles in two identical compartments. 4

(c) What are inaccessible macrostates ? What is the cause of these states ? 2

2. (a) A bag contains 4 white and 5 black balls. Two balls are drawn in succession from the bag. Calculate the probability that two balls drawn both are white. 3

(b) Define thermodynamic probability and priori probability. Discuss the distribution of n distinguishable particles in k compartments which are further sub divided into g cells of equal apriori probability. 6

3. (a) Write down in tabular from the various microstates and macrostates of a system of 3-particles arranged in 3-compartments assuming the particles to be :

(1) Distinguishable

(2) Indistinguishable. 4

(b) 5×10^{14} gas molecules are enclosed in a cubical volume. Imagine the volume be divided into equal halves. Calculate the probability of the state in which the number of molecules are 0.01 % different from the equilibrium state. 5

SECTION—B

4. (a) Show that Maxwellian distribution of speed ν amongst n molecules per cm^3 enclosed in a chamber at temperature T is given by :

$$n_\nu d_\nu = 4\pi n \left(\frac{m}{2\pi kT}\right)^{3/2} e^{\frac{-m\nu^2}{2kT}} \nu^2 d\nu. \quad 6$$

(b) Root mean square speed of hydrogen at N.T.P. is 1840 ms^{-1}. Calculate the rms speed of oxygen molecule at N.T.P. Molecular weight of hydrogen and oxygen at 2 and 32 respectively. 3

5. (a) Derive Planck's law for black body radiation. Obtain Wein's displacement law and Stefan's law from this law. 6

(b) The radius of Sun is 6.96×10^5 km. Its surface temperature is 6000 K. Find the amount of energy radiated by it in one second. Given $\sigma = 5.67 \times 10^{-8}$ Wm^{-2} K^{-4}. 3

6. (a) Define Fermi energy and derive an expression for it for free electrons in the conductor. 5

(b) Calculate the fermi energy of the electrons in a metal of atomic weight 'w', density 'ρ' and each atom of which gives out of 'p' free electrons. Given that $h = 6.63 \times 10^{-34}$ Js ; mass of electron $= 9.1 \times 10^{-31}$ kg. Avogadro's number is 6.02×10^{-23}. 4

SECTION—C

7. Attempt any **eight** parts :

(i) Explain the term constraint on a system.

(ii) A system consists of 5 distinguishable particles to be distributed in two equal sized compartments. Calculate the probability of macrostate (2, 3).

(iii) What is meant by (a) meaningful and (b) meaningless arrangements ?

(iv) Calculate the probability of drawing a king out of pack of 52 cards.

(v) What is the minimum size of phase space cell in classical and quantum mechanics ?

(vi) Explain the concept of phase space.

(vii) Distinguish between BE and FD statistics.

(viii) What is the energy of the electrons in metals at 0K ?

(ix) Show that occupation index can be more than 1 only for the BE statistics and not for FD statistics.

(x) Define Rayleigh Jean's law. 8×1=8