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

(ii) Questions : 7 Sub. Code : 0247

Exam. Code : 0003

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

(2123)

PHYSICS

Paper–A (Statistical Physics & Thermodynamics–I)

Time Allowed : Three Hours] [Maximum Marks : 44

Note :— (1) Attempt **five** questions in all, selecting **two** questions each from Unit-I and Unit-II. Unit-III is compulsory.

(2) Use of logarithmic tables and non-programmable calculator is allowed.

UNIT—I

1. (a) For N distinguishable particles to be distributed in two compartments, prove that thermodynamic probability of microstate (N_1, N_2) is :

$$W(N_1, N_2) = \frac{N_1!}{N_1! N_2!} \text{ where } N = N_1 + N_2$$ 7

(b) A bag contains 10 white and 8 black balls. Two balls are drawn in succession from the bag. Calculate the probability that the two balls drawn are both white. 2

2. (a) What do you mean by most probable macrostate ? Derive an expression for the probability of this state corresponding to distribution of N particles in two identical compartments. 6

(b) 5×10^{10} gas molecules are enclosed in a cubical volume. Imagine the volume to be divided into two equal halves. Calculate the probability for a state in which the number of molecules in a given state are only 0.001% different from that of equilibrium state. 3

3. (a) Explain in detail about total no. of microstates contained in a macrostate (3, 1) corresponding to distribution of 4 particles in 2 compartments in tabular form assuming particles to be :

(i) Distinguishable

(ii) Indistinguishable. 6

(b) 8 distinguishable particles are distributed in 2 compartments of unequal sizes. The first compartment is further divided into 2 cells of equal sizes. Calculate probability of :

(i) Macrostate (5, 3)

(ii) Most probable macrostate. 3

UNIT—II

4. (a) Explain in detail about experimental verification of Maxwell-Boltzmann Distribution of molecular speeds. 6

(b) Derive an expression for phase space volume of energy compartment. 3

5. (a) Derive Fermi-Dirac distribution law. 7

(b) Calculate :

(i) Most probable speed

(ii) Average speed of Nitrogen at 300 K

Given $K = 1.38 \times 10^{-16}$ erg K^{-1}

Avogadro No. $= 6 \times 10^{23}$ molecules/mole. 2

6. (a) What is Stefan's Law ? Show that total energy density of radiation inside container is proportional to T^4. 6

(b) Difference between Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics. 3

UNIT—III

7. Attempt any **eight** questions. Each question carries **1** mark :

(a) How does classical statistics differ from quantum statistics ?

(b) Do electrons have zero energy at 0 K ? If not, explain why ?

(c) What is effect of Pauli Exclusion Principle on Macrostate ?

(d) What is occupation index ? What is its functional form at $T = 0$ K for a system of fermions ?

(e) Why there is need to divide compartments into cells if we take the concept of phase space ?

(f) What is difference between Macrostate and Microstate ?

(g) What is difference between static and dynamic system ?

(h) Distinguish between position, momentum and phase space.

(i) What is the importance of most probable macrostate ?

(j) What determines the distribution of molecular speeds in ideal gas ? $8 \times 1 = 8$