Register Number:
Date:

ST. JOSEPH'S COLLEGE (AUTONOMOUS), BANGALORE-27
M.Sc. PHYSICS - II SEMESTER
SEMESTER EXAMINATION: APRIL 2019.
PH 8318: STATISTICAL MECHANICS

Time: $2\frac{1}{2}$ hours **Max Marks: 70**

This paper contains two printed pages & two parts.

Constants:

1. Planck's constant h= 6.625×10^{-34} Js.
2. Boltzmann constant K_B =1.38×10^{-23} J/K.
3. Avogadro's number N =6.023×10^{23} atoms/mol.

PART-A (5x10=50)

Answer any 5 questions. Each carries 10 marks

1. (a) Define: (i) Symmetric wave function (ii) Anti-symmetric wave function.

   (b) Write the postulate of equal a priori probability of eigen states.

   (c) Does Femi energy depend on size of the metal? Explain.

   (d) What is the meaning of classical limit of quantum statistics? (4+2+2+2)

2. (a) Deduce Bose-Einstein statistics distribution formula

   (b) Explain the phenomenon of Bose-Einstein Condensation. (8+2)

3. (a) Derive and explain Maxwell velocity distribution function.

   (b) Derive and explain the application of equipartition energy theorem using Maxwell- Boltzmann distribution. (5+5)

4. Explain the fluctuations in the number of particles of a system in the grand canonical ensemble.

5. Explain Brownian motion? Discuss Langevin's theory of translational Brownian motion.

6. (a) Give statistical interpretation of the chemical potential in equilibrium state.

   (b) Based on the Fermi-Dirac statistics, state the nature of the Fermi distribution function. Explain how does it vary with temperature? (6+4)

7. Explain the method of evaluation of Lagrange's undetermined multiplier α and β that appears in three statistical distributions.

PART-B

Answer any 4 questions. Each carries 5 marks. (4x5=20)

8. Two vessels of volume V_1 and V_2 contain molecules of the same gas at temperature T_1 and T_2 respectively, their pressures being the same. The two vessels are then connected with each other. The gases mix with each other and attain a state of equilibrium. Find the change in entropy during the process.

9. (i) Four distinguishable molecules are distributed in energy levels E_1 and E_2 with degeneracy of 2 and 3 respectively. If three molecules in energy level E_1 and one in energy level E_2, calculate the number of available microstates.

   (ii) Calculate the total number of microstates corresponding to the electronic configuration of d^2. (3+2)

10. Draw the phase space trajectories of a particle moving in a one-dimensional potential $V(x) = \frac{-1}{2}x^2 + \frac{1}{4}x^4$.

11. The Debye temperature for diamond is 2230K. Calculate the highest possible vibrational frequency and the molar specific heat capacity of diamond at 10 K.

12. There are 2.54×10^{22} free electrons per cm^3 in sodium. Calculate its Fermi energy and Fermi temperature.

13. A system consists of 8000 particles distributed in three energy states with equal spacing. The energy of the three states are E_1=0, E_2= x and E_3 = 2 x . All the three states have the same intrinsic probability g. At a certain instant there are 4000 particles in the lower level, 3000 particles in the middle level and 1000 particle in the upper level. Compare the relative probabilities with the distribution obtained by the transfer of one particle from middle to the lower level and one particle from the middle to the upper level and the original distribution.