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

Answer any 5 questions. Each carries 10 marks. (5x10=50)

1. Derive Liovilles's theorem for the change of density of distribution with time and show that the density of phase points is conserved.

2. (i) Deduce Maxwell's Boltzmann's statistics distribution formula.
   (ii) Write the difference between Fermi-Dirac and Bose-Einstein statistics. (8+2)

3. Show that the energy fluctuation in the canonical distribution is proportional to the specific heat.

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

5. (a) State and prove Equipartition theorem using classical statistical mechanics.
   (b) What is Gibb's paradox? (8+2)

6. (a) Obtain Planck's formula for the distribution of energy in the spectrum of a black-body from statistical consideration applied to an assembly of photons.

   (b) What is the difference between monoatomic ideal gas and diatomic ideal gas with respect to the degrees of freedom? (8+2)

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. A Bose-Einstein gas has two particles in the i th state whose degeneracy is 3. Show that the number of independent ways of selecting the particles in the state is 6.

9. Copper initially at absolute Zero is added with 10^{-7} joule of heat. Calculate the rise in temperature and change in entropy. Find also the number of microstates accessible to the Copper. The molar heat capacity of Copper is 7×10^{-4} JK^{-1} and volume of the Copper is kept constant.

10. The density of zinc ($1s^2 2s^2 3s^2 3p^6 3d^{10} 4s^2$) is 7.13g/cm^3 and its atomic weight is 65.4. Calculate its Fermi energy. The effective mass of a free electron in zinc crystal is 7.7×10^{-31} kg.

11. Four identical particles can be in any five states. What are the number of possible ways distributing them in various states according to Maxwell-Boltzmann, Bose Einstein and Fermi-Dirac statistics?

12. An inelastic ball of mass m has been thrown vertically up-ward from the ground. The initial kinetic energy of the ball is E. Draw the Phase space trajectory of the ball.

13. (a) For Copper Einstein frequency $\nu_E = 2.49 \times 10^{12}$ hertz. Calculate the characteristic temperature θ_E.

    (b) For Copper the value C_V is 23.8 J/mol K while for diamond the value of C_V is only 6.1 J/mol K (both values are at T=300 K). How do account for this difference?

    (c) Calculate the total number of ways of arranging four fermions in six cells. (2+2+1)