Register Number:
DATE:

ST. JOSEPH'S COLLEGE (AUTONOMOUS), BANGALORE-27
M.Sc. PHYSICS – II SEMESTER
SEMESTER EXAMINATION : APRIL 2018
PH 8315 : STATISTICAL PHYSICS

Time: 2 1/2 hours **Maximum Marks:70**

This question paper contains 2 printed pages and 2 parts
Use of Clark's tables and scientific calculators permitted.

Instructions : *Draw appropriate figures wherever necessary.*

PART – A

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

1. Consider a macroscopic system whose energy has a value between E and $E+\delta E$. Let $\Omega(E)$ be the number of accessible states available to the system. Derive the functional relationship between $\Omega(E)$ and E .
(10)
2. What does equipartition theorem say? Discuss about its validity in the classical and quantum limits. Apply the theorem to find
(i) the mean dispersion in velocity of a molecule in a system of gas.
(ii) the total energy of a system of N one dimensional harmonic oscillators.
(3+3+2+2)
3. What is meant by a canonical ensemble of systems? Derive the probability distribution for a canonical ensemble. Suppose y is a parameter which characterizes the system, write an expression to obtain the mean value of y using the result obtained above for the canonical ensemble.
(2+6+2)
4. Which are the different statistics employed to study systems of identical particles? Differentiate among them. From the symmetry requirements of the total wave function, discuss about the occupation number for the respective single particle states.
(3+3+4)
5. Discuss Debye approximation for specific heat of solids. Compare the result obtained with that given by equipartition theorem.
(7+3)
6. Using appropriate quantum distribution function, derive an expression for the molar specific heat of electrons in metals. Is it different from the specific heat of solids? Justify your answer.
(7+3)

7. Consider a system of ideal monoatomic gas containing N number of atoms. The system's energy is between E and $E+\delta E$. Write an expression for the total energy of the system. What will be the dimensionality of the phase space required to describe the system? How will you describe the state of the system in this phase-space? What will be the shape of the diagram in the momentum space? Identify the macrostate and microstates for this system.

(2+2+2+2+2)

PART – B

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

8. A material consists of N independent particles and is in a weak external magnetic field H. Each particle can have a magnetic moment $p\mu$ along the magnetic field, where the possible values for p are $p=j, j-1, j-2, ...-j;$ j being an integer and μ a constant. The system is at temperature T. Find the partition function for this system and express it as a ratio of hyperbolic functions. (use canonical ensemble)

9. a) In a firing event, the probability of a person hitting the target is 2/5. If the person fires at the target 10 times, what is the probability that he hits the target exactly 6 times?

b) In statistical physics, the counting factor N! Is very important. Approximate this for large N.

(2+3)

10. a) The internal energy E of a system is given by $E=\frac{bS^3}{VN}$, where b is a constant and other symbols have their usual meaning. Find an expression for the temperature of this system.

b) The free energy of a gas of N particles in a volume V at temperature T is $F=NkT\ln[\frac{(a_0V(kT)^{5/2})}{N}]$ where a_0 is a constant. Find the internal energy of the gas.

(2+3)

11. In an n-type semi conductor, the Fermi level lies 0.3 eV below the conduction band at 300 K. If the temperature is increased to 330 K, find the new position of the Fermi level.

12. The partition function for a photon gas is given by $\ln Z=\frac{\pi^2}{45}\frac{V(kT)^3}{\hbar^3c^3}$. Draw in your answer sheet, the variation of specific heat of the photon gas with temperature.

13. Consider a Maxwellian distribution of the velocity of the molecules of an ideal gas. Let v_{mp} and v_{rms} denote the most probable velocity and the root mean square velocity respectively. Find the magnitude of the ratio $\frac{v_{mp}}{v_{rms}}$.