Reg. No ..... Name **23P2044**

M. Sc. DEGREE END SEMESTER EXAMINATION : MARCH 2023

SEMESTER 2 : PHYSICS

COURSE : **21P2PHYT08: STATISTICAL MECHANICS**

(For Regular - 2022 Admission and Supplementary - 2021 Admission)

Duration : Three Hours Max. Weights: 30

PART A

Answer any 8 questions **Weight: 1**

1. Represent Pressure and chemical potential as a function of entropy. (U)
2. What does the term "Thermodynamic limit" in Statistical mechanics convey to you? (U, CO 1)
3. What is meant by postulate of "equal a priori probabilities " (U, CO 1)
4. Write down the partition function in terms of Quantum statistics in the case of a grand-canonical ensemble (U)
5. What are the major importance of using Density matrix in Quantum statistics? What is its equivalent term in classical statistics? (U)
6. Write down the ensemble average of a physical quantity G in quantum statistics language under the canonical case. (U)
7. Write down the unnormalized two particle wavefunction, in terms of the single particle wavefunction, that satisfies Bose particle symmetry requirement. (U)
8. Differentiate between FD and BE statistics. (U)
9. Graphically explain 1^{st} order and 2^{nd} order Phase transitions? (U)
10. Define the term *Phase*? (U, CO 4)

(1 x 8 = 8)

PART B

Answer any 6 questions **Weights: 2**

11. H A solid containing non-interacting paramagnetic atoms, each having a magnetic moment equal to one Bohr magneton, is placed in a magnetic induction field of strength 3 Tesla. Assuming that the atoms are in thermal equilibrium with the lattice, find the temperature to which the solid must be cooled so that more than 660%of the atoms are polarized with their magnetic moments parallel to the magnetic field. (1 Bohr magneton = 9.27×10^{-24} JT^{-1}) (A)
12. Obtain the expression for Entropy, under canonical ensemble, in terms of Boltzmann's probability distribution. (A)
13. Discuss the condition for equilibrium when 2 systems are brought in mechanical contact. (U)
14. Consider Ideal gas moving in a gravitational field. Evaluate the Average energy in the high temperature limit. (A)
15. Show that when the system is in pure state square of the density matrix will be the same as the density matrix. (A)
16. Show that if the density matrix of the system is constant, then the system is in equilibrium. (A)

17. Obtain the expression for Fermi energy and fermi momentum associated with a fermi system. (U)

18. Write True or False and support the answer for the statement – "chemical potential associated with a photon gas is zero" (U)

(2 x 6 = 12)

PART C

Answer any 2 questions **Weights: 5**

19. Obtain the EOS for an ideal classical gas. (U)

20. Obtain the expression for the Probability of a Grand canonical system by considering Equilibrium between system and energy-particle reservoir. (U)

21. Derive the EOS for an Ideal gas (free monoatomic particles) starting from the grand partition function show that PV=2E/3 holds well irrespective of the statistics it obeys. (U)

22. Discuss the specific heat capacity as a result of lattice vibration (do the analysis assuming that all atoms vibrate with the same frequency). (An)

(5 x 2 = 10)

OBE: Questions to Course Outcome Mapping

CO	Course Outcome Description	CL	Questions	Total Wt.
CO 1	Understand the concepts of Statistical Mechanics, Phase Space idea, Microcanonical and Canonical Ensemble	U	2, 3	2
CO 4	Understand the basics of phases and phase transitions	U	10	1

Cognitive Level (CL): Cr - CREATE; E - EVALUATE; An - ANALYZE; A - APPLY; U - UNDERSTAND; R - REMEMBER;