REV-00
MSP/52/57

2018/06

# M.Sc. PHYSICS
## FOURTH SEMESTER
## STATISTICAL PHYSICS
## MSP-401

**(Use separate answer scripts for Objective & Descriptive)**

**Duration : 3 hrs.** Full Marks : 70

## [ PART-A : Objective ]

**Time : 20 min.** Marks : 20

***Choose the correct answer from the following:*** *1x20=20*

1. The probability of occurrence of a given macrostate is proportional to the number of:
   a. macrostates b. phase points
   c. microstates d. phase cells

2. The state of a system is represented by:
   a. $n$ independent position coordinates b. $2n$ combined coordinates
   c. $n$ independent momentum coordinates d. $n$ combined coordinates

3. The Γ-space may be considered as a superposition of:
   a. μ-space b. π-space
   c. phase-space d. none of these

4. The priori a probability G or the distribution is based upon the properties of the:
   a. phase-point b. representative point
   c. cell d. none of these

5. If the cells are of equal size then they have the same:
   a. thermodynamic probability b. a priori probability
   c. density d. none of these

6. The probability of a composite event is the product of the probabilities of the:
   a. individual events b. independent events
   c. Both individual and independent events d. none of these

7. The probability of finding a phase point in any particular region of phase space is directly proportional to the:
   a. accessible states b. density
   c. thermodynamic probability d. volume

8. If the zero point energy were not present, then such an oscillator is called:
   a. Plank's oscillator b. Harmonic oscillator
   c. Single oscillator d. none of these

9. In the presence of external magnetic field the dipoles experiences a
   a. torque b. momentum
   c. electric field d. none of these

10. When the ensemble has energy ranging till infinity then the ensemble is called a:
    a. Micro-canonical ensemble b. Canonical ensemble
    c. Grand-canonical ensemble d. None of these

11. The norm of state vector in Hilbert space is:
- a. 1
- b. 0
- c. depends on dimension
- d. infinity

12. The spin of fermions is:
- a. 0
- b. 1
- c. half integral
- d. none of the above

13. The chemical potential of photons is:
- a. finite but non zero
- b. zero
- c. infinity
- d. not defined

14. Symmetric wave functions are shown by:
- a. fermions
- b. classical particles
- c. bosons
- d. electrons

15. Conditions under which classical statistics can be applied are:
- a. low density and low temperature
- b. high density and high temperature
- c. any density and any temperature
- d. low density and high temperature

16. In thermal equilibrium, the probability distribution function is:
- a. dependent on time
- b. independent of time
- c. dependent on temperature
- d. none of the above

17. The critical exponent of volume is:
- a. 3
- b. 1
- c. 2
- d. 1.5

18. If the first derivative of free energy is discontinuous then the transition is known as:
- a. 2nd order transition
- b. 1st order transition
- c. 0th order transition
- d. None of the above

19. The slope of m-H graph at critical point is:
- a. 0
- b. infinity
- c. 1
- d. -1

20. In thermal equilibrium, the probability density is a function of:
- a. hamiltonian
- b. momentum
- c. position
- d. time

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## ( PART-B : Descriptive )

**Time : 2 hrs. 40 min.** **Marks : 50**

[ Answer question no.1 & any four (4) from the rest ]

1. a. Show that the probability that a phase point for a system chosen at random from an ensemble at time $t$ would be given by (5+5=10)

$$d\omega = \rho_N(q,p,t)\prod_{i=1}^{f} dq_i dp_i$$

b. Prove both the principles of Liouville's theorem.

2. a. Find the density matrix for one particle in a box. (5+5=10)
b. Find the partition function for one particle in a box.

3. a. Show that the 2nd virial coefficient reduces the pressure of a non degenerate fermionic gas. (5+5=10)
b. Starting from average occupation number find the expression of density of a degenerate fermionic gas.

4. a. Derive Planck distribution of black body radiation from Bose-Einstein statistics. (6+4=10)
b. Derive Rayleigh-jeans distribution from Planck distribution.

5. Discuss in details about Ising model. (10)

6. a. Show that for grand canonical ensemble, the Gibb's free energy is $G = \mu\bar{n}$ (4+6=10)
b. Obtain the Helmholtz free energy for a system of harmonic oscillator.

7. a. Explain Gibb's paradox. How is it resolved? (5+5=10)
b. Show that for a perfect gas represented by a grand canonical ensemble, the probability of finding the sub-system with $n$ atoms is given by Poisson's distribution.

$$w(n) = \frac{1}{n_!}(\bar{n})^n exp. - (\bar{n})^n$$

8. a. What is Partition function? (2+5+3=10)
b. Obtain the expression for Helmholtz free energy in terms of partition function for a canonical ensemble.
c. Show that entropy of a system in canonical ensemble can be expressed as

$$\sigma = -\sum_i \rho_i \log \rho_i$$

where $\rho_i$ is the probability of the system to be found in the ith state.

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