**M.Sc. PHYSICS
FOURTH SEMESTER
STATISTICAL PHYSICS
MSP – 401
[USE OMR FOR OBJECTIVE PART]**

SET

B

Duration: 3 hrs.

Full Marks: 70

(**PART-A: Objective**)

Time: 30 min.

Marks: 20

Choose the correct answer from the following:

1X20=20

1. The spin of a photon is
    a. zero
    b. $\dfrac{h}{2}$

    c. h
    d. $\dfrac{3h}{2}$

2. At what temperature, He-4 becomes a superfluid?
    a. 2.17 K
    b. 2.0 K
    c. 4.2 K
    d. 5.2 K

3. What is the value of occupation index of fermions at T = 0 K and energy greater than the Fermi energy?
    a. 0
    b. 1
    c. infinity
    d. any value between 0 and 1

4. The specific heat of a metal at low temperature, Cv divided by the temperature T is proportional to
    a. T
    b. T^2
    c. T^3
    d. $T^{3/2}$

5. The number of meaningful ways in which 4 fermions can be arranged in 5 compartments is
    a. 3
    b. 4
    c. 5
    d. 6

6. Which of the following is a second order phase transition?
    a. Liquid water to ice
    b. Water vapour to liquid water
    c. Ice to water vapour
    d. Normal to superconductor

7. Which of the following is the point where all phases of a water coexist?
    a. Double
    b. Triple
    c. Unique
    d. Critical

8. Which of the following heats is required for phase transition?
    a. Latent
    b. Fusion
    c. Vaporization
    d. Absorption

[1]

). Partition function of an equilibrium system is given by
a. $\sum_i g_i e^{\alpha - \beta E_i}$ b. $\sum_i g_i e^{-\beta E_i}$
c. $\sum_i e^{-\beta E_i}$ d. $\sum_i g_i e^{\alpha + \beta E_i}$

0. In canonical ensemble, the r.m.s fluctuation in energy is

a. $\dfrac{\sqrt{kT^2}}{U}$ b. $\dfrac{\sqrt{kTC_v}}{U}$

c. $\sqrt{\dfrac{kT^2 C_v}{U}}$ d. $\dfrac{\sqrt{kT^2 C_v}}{U}$

1. Which of the following statement is false?
In classical statistics, the particles   Maxwell-Boltzmann statistics
a. have a certain degree of togetherness   b. describes the distribution of gas
as well as separateness.   molecules.
Liouville's theorem gives the   In Grand canonical ensemble, the
c. principle of conservation of energies   d. system is separated by rigid,
of particles.   permeable and conducting walls.

12. In case of Maxwell-Boltzmann velocity distribution curve, which one of the following is correct?

a. As T increases, the distribution becomes narrow.   b. As T increases, the distribution spreads out.

c. As T increases, the distribution gets sharper.   d. As T decreases, the distribution spreads out.

13. In case of Maxwell-Boltzmann statistics, the molecular size is
a. Negligible   b. Equal to the intermolecular distance
c. Less than the intermolecular distance   d. More than the intermolecular distance

14. The thermodynamic probability of Maxwell-Boltzmann distribution is
a. $N! \dfrac{g_i}{n_i!}$ b. $N! \dfrac{g_i^{n_i}}{n_i}$
c. $N \dfrac{g_i^{n_i}}{n_i!}$ d. $N! \dfrac{g_i^{n_i}}{n_i!}$

15. Langevin's function is
a. $L(x) = Coth(x) + \dfrac{1}{x}$ b. $L(x) = Coth(x)$

c. $L(x) = Cot(x) + \dfrac{1}{x}$ d. $L(x) = Coth(x) - \dfrac{1}{x}$

16. Curie's law of paramagnetism is
a. $\chi = \dfrac{N_0 \mu^2}{3kT}$ b. $\chi = \dfrac{N_0 \mu^2}{kT}$

c. $\chi = \dfrac{N_0 \mu^2}{3kT^2}$ d. $\chi = \dfrac{N_0 \mu^2}{2kT}$

17. Maxwell-Boltzmann distribution function is given by $n_i =$

   a. $\dfrac{g_i}{e^{\alpha+\beta E_i}-1}$

   b. $\dfrac{g_i}{e^{\alpha+\beta E_i}+1}$

   c. $\dfrac{g_i}{e^{\alpha-\beta E_i}}$

   d. $\dfrac{g_i}{e^{\alpha+\beta E_i}}$

18. In canonical ensemble, which of the following is true?

   a. Energy can vary from 0 to infinity

   b. Energy does not vary at all

   c. Energy can vary from 0 to 1

   d. Energy is restricted

19. The difference between fermions and bosons is that bosons do not obey _____

   a. Aufbau principle

   b. Pauli's exclusion principle

   c. Hund's rule of maximum multiplicity

   d. Heisenberg's uncertainty principle

20. Fermi-Dirac statistics cannot be applied to _____

   a. Electrons

   b. Photons

   c. Fermions

   d. Protons

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[3]

$$\boxed{\textbf{Descriptive}}$$

Time : 2 hrs. 30 mins.   Marks : 50

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

1. Derive Maxwell-Boltzmann velocity distribution function and draw the graph showing the dependence on temperature.   6+4=10

2. Explain the theory of paramagnetism using classical statistics.   10

3. Find out the energy and density fluctuation in grand canonical ensemble.   4+6=10

4. Discuss the Simple Harmonic Oscillator in classical statistics along with thermodynamic properties.   8+2=10

5. a. What is Bose-Einstein condensation?   3+7=10
   b. Calculate the fraction of Bosons that will occupy the ground state in a condensate with graphical representation.

6. a. Explain the need for quantum statistics.   5+5=10
   b. Mention some features of Bose-Einstein statistics.

7. a. What is a degenerate Fermi gas?   3+7=10
   b. Obtain an expression for energy distribution of free electrons from F.D. distribution law.

8. How does the Ising model explain ferromagnetic phase transition?   10

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[4]