

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

**SET
B**

Duration: 3 hrs.

Full Marks: 70

Time: 30 min.

Marks: 20

Choose the correct answer from the following:

1X20=20

[PART-A: Objective]

- The spin of a photon is
 - zero
 - $\frac{h}{2}$
 - h
 - $\frac{3h}{2}$
- At what temperature, He-4 becomes a superfluid?
 - 2.17 K
 - 2.0 K
 - 4.2 K
 - 5.2 K
- What is the value of occupation index of fermions at $T = 0$ K and energy greater than the Fermi energy?
 - 0
 - 1
 - infinity
 - any value between 0 and 1
- The specific heat of a metal at low temperature, C_v divided by the temperature T is proportional to
 - T
 - T^2
 - T^3
 - $T^{3/2}$
- The number of meaningful ways in which 4 fermions can be arranged in 5 compartments is
 - 3
 - 4
 - 5
 - 6
- Which of the following is a second order phase transition?
 - Liquid water to ice
 - Water vapour to liquid water
 - Ice to water vapour
 - Normal to superconductor
- Which of the following is the point where all phases of a water coexist?
 - Double
 - Triple
 - Unique
 - Critical
- Which of the following heats is required for phase transition?
 - Latent
 - Fusion
 - Vaporization
 - Absorption

9. Partition function of an equilibrium system is given by
- $\sum_i g_i e^{\alpha - \beta E_i}$
 - $\sum_i g_i e^{-\beta E_i}$
 - $\sum_i e^{-\beta E_i}$
 - $\sum_i g_i e^{\alpha + \beta E_i}$
10. In canonical ensemble, the r.m.s fluctuation in energy is
- $\frac{\sqrt{kT^2}}{U}$
 - $\frac{\sqrt{kT C_v}}{U}$
 - $\sqrt{\frac{kT^2 C_v}{U}}$
 - $\frac{\sqrt{kT^2 C_v}}{U}$
11. Which of the following statement is false?
- In classical statistics, the particles have a certain degree of togetherness as well as separateness.
 - Maxwell-Boltzmann statistics describes the distribution of gas molecules.
 - Liouville's theorem gives the principle of conservation of energies of particles.
 - In Grand canonical ensemble, the system is separated by rigid, permeable and conducting walls.
12. In case of Maxwell-Boltzmann velocity distribution curve, which one of the following is correct?
- As T increases, the distribution becomes narrow.
 - As T increases, the distribution spreads out.
 - As T increases, the distribution gets sharper.
 - As T decreases, the distribution spreads out.
13. In case of Maxwell-Boltzmann statistics, the molecular size is
- Negligible
 - Equal to the intermolecular distance
 - Less than the intermolecular distance
 - More than the intermolecular distance
14. The thermodynamic probability of Maxwell-Boltzmann distribution is
- $N! \frac{g_i^{n_i}}{n_i!}$
 - $N! \frac{g_i^{n_i}}{n_i}$
 - $N \frac{g_i^{n_i}}{n_i!}$
 - $N! \frac{g_i^{n_i}}{n_i!}$
15. Langevin's function is
- $L(x) = \text{Coth}(x) + \frac{1}{x}$
 - $L(x) = \text{Coth}(x)$
 - $L(x) = \text{Cot}(x) + \frac{1}{x}$
 - $L(x) = \text{Coth}(x) - \frac{1}{x}$
16. Curie's law of paramagnetism is
- $\chi = \frac{N_0 \mu^2}{3kT}$
 - $\chi = \frac{N_0 \mu^2}{kT}$
 - $\chi = \frac{N_0 \mu^2}{3kT^2}$
 - $\chi = \frac{N_0 \mu^2}{2kT}$

17. Maxwell-Boltzmann distribution function is given by $n_i =$
- a. $\frac{g_i}{e^{\alpha + \beta E_i - 1}}$ b. $\frac{g_i}{e^{\alpha + \beta E_i + 1}}$
c. $\frac{g_i}{e^{\alpha - \beta E_i}}$ d. $\frac{g_i}{e^{\alpha + \beta E_i}}$
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
- --- --

(Descriptive)

Time : 2 hrs. 30 mins.

Marks : 50

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

- 1) ① Derive Maxwell-Boltzmann velocity distribution function and draw the graph showing the dependence on temperature. 6+4=10
- 2) 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
- 1) ④ Discuss the Simple Harmonic Oscillator in classical statistics along with thermodynamic properties. 8+2=10
- 2) ⑤ ⑧ What is Bose-Einstein condensation?
⑨. Calculate the fraction of Bosons that will occupy the ground state in a condensate with graphical representation. 3+7=10
6. a. Explain the need for quantum statistics. 5+5=10
b. Mention some features of Bose-Einstein statistics.
- 30) ⑩ What is a degenerate Fermi gas? 3+7=10
⑪ Obtain an expression for energy distribution of free electrons from F.D. distribution law.
- 7) ⑧ How does the Ising model explain ferromagnetic phase transition? 10

== *** ==

1.962 + hν ln EF / kT