2024/07

SET A

B.Sc. PHYSICS
SIXTH SEMESTER
STATISTICAL MECHANICS
BSP – 602 [SPECIAL REPEAT]
[USE OMR FOR OBJECTIVE PART]

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

Objective

Time: 30 min. **Marks: 20**

Choose the correct answer from the following: *1X20=20*

1. A Γ – space is a representation of ---?
   a. 6 D
   b. 6N D
   c. 3 D
   d. 3N D

2. The classical statistics failed to explain---?
   a. Temperature
   b. Pressure
   c. Energy
   d. Electron gas

3. The equilibrium state is the state of ---?
   a. Minimum entropy and maximum thermodynamic probability
   b. Maximum entropy and maximum thermodynamic probability
   c. Minimum entropy and minimum thermodynamic probability
   d. Maximum entropy and minimum thermodynamic probability

4. The bosons have a spin of----?
   a. 1/2
   b. −1/2
   c. 0 or integral
   d. Random

5. Which of the following statement is true?
   a. When bosons are cooled to a low enough temperature, their behavior changes.
   b. Bose-Einstein statistics is applicable to electrons.
   c. BE statistics is obeyed by gas molecules.
   d. BE statistics is for half integral spin particles.

6. Higgs boson has a spin ---?
   a. 0
   b. 1
   c. -1
   d. 1/2

7. Root mean square speed is given by
   a. $\sqrt{\frac{kT}{2m}}$
   b. $\sqrt{\frac{kT}{m}}$
   c. $\sqrt{\frac{3kT}{2m}}$
   d. $\sqrt{\frac{3kT}{m}}$

8. In classical statistics, which of the following statement is true?
   a. The wave functions overlap.
   b. The wave functions do not overlap.
   c. There is no wave function.
   d. The wave functions vanish.

9. The Kirchoff's law of black body radiation is E_λ =?
   a. $\frac{e_\lambda}{a_\lambda}$
   b. $\frac{a_\lambda}{e_\lambda}$
   c. $\frac{e_{\lambda+1}}{a_\lambda}$
   d. $\frac{e_{\lambda-1}}{a_\lambda}$

10. For Bose-Einstein condensation to occur, which of the following is correct?
   a. $T < T_B$
   b. $T > T_B$
   c. $T = T_B$
   d. $T \approx 0$

11. In grand canonical ensemble, which one of the following remains constant?
   a. (T, N, V)
   b. (N, E, V)
   c. (T, μ, V)
   d. (T, E, V)

12. Which one of the following option is correct?
   1) π-meson 2) proton 3) neutrino 4) α-partice
   a. (1, 2) are fermions
   b. (2, 4) are bosons
   c. (1, 2) are bosons
   d. (2, 3) are fermions

13. For degeneracy, the value of α depends upon which of the following?
   a. (m, T, n)
   b. (T, n, V)
   c. (k, n, m)
   d. (μ, β, n)

14. The mean energy in terms of partition function is given by
   a. $\frac{\partial}{\partial \beta}(\ln Z)$
   b. $-\frac{\partial}{\partial \beta}(\ln Z)$
   c. $\frac{\partial}{\partial \alpha}(\ln Z)$
   d. $-\frac{\partial}{\partial \alpha}(\ln Z)$

15. The thermodynamic probability of Fermi-Dirac distribution is ---?
   a. $\prod_{i=1}^{k} \frac{g_i!}{(g_i - n_i)!}$
   b. $\prod_{i=1}^{k} \frac{g_i!}{n_i!\,(g_i - n_i)!}$
   c. $\prod_{i=1}^{k} \frac{g_i}{n_i(g_i - n_i)!}$
   d. $\prod_{i=1}^{k} \frac{g_i!}{n_i!\,(g_i + n_i)!}$

16. Which of the following statement is false?
   a. According to Planck's hypothesis, the resonators absorb or emit energy continuously.
   b. A black body radiation chamber is also filled with Planck oscillators.

c. Rayleigh-Jeans law cannot explain the shorter wavelength region.

d. The energy distribution of black body spectrum is not uniform over a wide range of wavelength.

17. In quantum statistics, the particles are---?

a. Identical and Indistinguishable.

b. Non-Identical and Indistinguishable.

c. Identical and Distinguishable.

d. Non-Identical and Distinguishable.

18. Bose-Einstein distribution function is given by n_i =?:

a. $\frac{g_i}{e^{\alpha+\beta E_i}}$

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

c. $\frac{g_i}{e^{\alpha+\beta E_i}-1}$

d. $\frac{g_i}{e^{\alpha+\beta E_i+1}}$

19. The total energy in terms of partition function of an equilibrium system is given by____

a. $E = NkT^3\frac{\partial}{\partial\beta}(\ln Z)$

b. $E = NkT\frac{\partial}{\partial T}(\ln Z)$

c. $E = -NkT^2\frac{\partial}{\partial T}(\ln Z)$

d. $E = NkT^2\frac{\partial}{\partial T}(\ln Z)$

20. The Gibbs potential in terms of partition function of an equilibrium system is given by____

a. $G = RT + NkT(\ln Z)$

b. $G = -NkT(\ln Z)$

c. $G = RT^2 - NkT(\ln Z)$

d. None of these

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Descriptive

Time : 2 hrs. 30 mins. **Marks : 50**

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

1. Derive the Maxwell-Boltzmann law of velocity distribution and show the temperature variation of the distribution. **10**

2. **a.** Derive the Boltzmann entropy relation and explain its significance. **5+5=10**
   b. Find out the no.of possible ways in which 2 particles can be distributed in 3 compartments using Maxwell Boltzmann statistics elaborately and their probability of togetherness and separateness.

3. **a.** Explain black body radiation and its construction. **3+7=10**
   b. State Planck's hypothesis and derive Planck's formula for black body radiation in terms of wavelength and frequency.

4. State and derive Wein's displacement law. **10**

5. What is Bose Einstein condensation? Derive the Bose Einstein condensation equation. **2+8=10**

6. What is Fermi gas and Fermi energy? Derive the Fermi energy of free electron gas and find out its value for electrons in a metal. **2+8=10**

7. What is partition function? Find out the relation between entropy and partition function. Derive any five of the thermodynamic properties using partition function. **1+4+5 =10**

8. Derive the Bose- Einstein law of energy distribution and find out the condition at which it approaches Maxwell Boltzmann distribution. **8+2=10**

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