OMR Answer Sheet No.

Question Booklet Number

8117

M.Sc. (Sem.-VIII) Examination, 2022-23

Booklet Series

A

PHYSICS

Statistical Physics

[Time : 1 : 30 Hours

[समय : 1 : 30 घण्टे

[Maximum Marks : 75

[अधिकतम अंक : 75

(To be filled in by the Candidate / निम्न पूर्तियाँ परीक्षार्थी स्वयं भरें)

Roll No. (in figures) ____________
अनुक्रमांक (अंकों में)

Roll No. (in words) ____________
अनुक्रमांक (शब्दों में)

Enrolment No. (in figures) ____________

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कॉलेज का नाम

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कक्ष निरीक्षक के हस्ताक्षर

Instructions to the Examinee :

1. Do not open the booklet unless you are asked to do so.
2. The booklet contains 75 questions. Examinee is required to answer any 50 questions in the OMR Answer Sheet provided and not in the question booklet. In case Examinee attempts more than 50 Questions, ***first*** 50 attempted questions will be evaluated. All Questions carry equal marks.
3. Examine the Booklet and the OMR Answer-Sheet very carefully before you proceed. Faulty question booklet due to missing or duplicate pages/questions or having any other discrepancy should be immediately replaced.

(Remaining Instructions on last page)

परीक्षार्थियों के लिए निर्देश :

1. प्रश्न-पुस्तिका को तब तक न खोलें जब तक आपसे कहा न जाए।
2. प्रश्न-पुस्तिका में 75 प्रश्न हैं। परीक्षार्थी को किन्हीं 50 प्रश्नों को दी गई OMR उत्तर-पत्रक पर ही हल करना है। परीक्षार्थी द्वारा 50 से अधिक प्रश्नों को हल करने की स्थिति में, *प्रथम* 50 उत्तरों को ही मूल्यांकित किया जाएगा। सभी प्रश्नों के अंक समान हैं।
3. प्रश्नों के उत्तर अंकित करने से पूर्व प्रश्न-पुस्तिका तथा OMR उत्तर-पत्रक को सावधानीपूर्वक देख लें। दोषपूर्ण प्रश्न-पुस्तिका, जिसमें कुछ भाग छपने से छूट गये हो या प्रश्न एक से अधिक बार छप गये हों या किसी भी प्रकार की कमी हो, उसे तुरन्त बदल लें।

(शेष निर्देश अन्तिम पृष्ठ पर)

70. The partition function of two independent (non-interacting) system i and j is given by:

(A) $z_{ij}=z_i+z_j$

(B) $z_{ij}=z_i-z_j$

(C) $z_{ij}=z_i z_j$

(D) $z_{ij}=z/z_j$

71. The internal energy of an ideal gas depends only:

(A) P

(B) V

(C) T

(D) Both on P and T

72. For removing the Gibbs paradox one should multiply the expression of number of microstates by a factor of:

(A) $\frac{1}{N!}$

(B) 2 N!

(C) $\frac{1}{2N!}$

(D) N!

73. A gas can approach ideal behaviour only:

(A) at low temperature & low pressure

(B) at high temperature & high pressure

(C) at high pressure and low temperature

(D) at low pressure and high temperature

74. At the most probable state of a system the entropy of the system is:

(A) minimum

(B) maximum

(C) constant

(D) None of the above

75. Planck's radiation law can be drived by using

(A) M. B. Statistics

(B) B. E. Statistics

(C) F. D. Statistics

(D) All above

65. Which of the following is an example of the second order phase transition?

(A) Transformation of feromagnetic substance into paramagnetic substance at curie temperature.

(B) Transformation of water into vapour at constant temperature and volume

(C) Transformation of ice into water at 0^0C and 1-atmospheric pressure

(D) None of these

66. Fokker-Planck equation is:

(A) $\frac{\partial P}{\partial q} = -\frac{\partial}{\partial v}[M_1 P] + \frac{1}{2}\frac{\partial^2}{\partial v^2}[M_2 P]$

(B) $\frac{\partial P}{\partial q} = +\frac{\partial}{\partial v}[M_1 P] + \frac{1}{2}\frac{\partial^2}{\partial v^2}[M_2 P]$

(C) $\frac{\partial P}{\partial q} = -\frac{\partial}{\partial v}[M_1 P] - \frac{1}{2}\frac{\partial^2}{\partial v^2}[M_2 P]$

(D) $\frac{\partial P}{\partial q} = \frac{\partial}{\partial v}[M_1 P] - \frac{1}{2}\frac{\partial^2}{\partial v^2}[M_2 P]$

(where P - Probability function

v- velocity

q- time difference

$M_n = \frac{< 1 \Delta v(z) 1^2 >}{\tau}$

τ - time interval

67. The entropy of a system in equilibrium is:

(A) maximum

(B) zero

(C) one

(D) minimum but not one

68. Consider the Fermi-Dirac distribution f(E) at room temperature where E refers to energy. It E_F is the Fermi energy, which of the following is true?

(A) f(E) is a step function

(B) $f(E_F)$ has value 1/2

(C) states with $E<E_F$ are filled completely

(D) None of these

69. In a Maxwell-Boltzmann system with two state of energies ϵ and 2ϵ, respectively and a degeneracy of 2 for each state, the partition function is:

(A) $2e^{-2\epsilon/kT}$

(B) $2e^{-3\epsilon/kT}$

(C) $e^{-\epsilon/kT} + e^{-2\epsilon/kT}$

(D) $2(e^{-\epsilon/kT} + e^{-2\epsilon/kT})$

58. Viscosity is:
   (A) Transport of mass
   (B) Transport of momentum •
   (C) Transport of energy
   (D) None of the above

59. Ist term in Fokkor Plank equation is called:
   (A) Fluctuating Force Term
   (B) Friction term
   (C) Drift term
   (D) Diffusion term

60. Landau theory of phase transition describes:
   (A) Zero order phase transition
   (B) second order phase transition,
   (C) first order phase transition
   (D) all of the above

61. Which of the following is not the essential feature of Brownian motion:
   (A) The motion of each particle is completely irregular & random
   (B) The laws of kinetic theory of gases are not applicable to Brownian motion •
   (C) The smaller particles appears to be more agitated than the bigar particles
   (D) The motion becomes more violent on increasing the temperature

62. According to Langavin's theory of Brownian motion, the force experience by a suspended particles are:
   (A) Frictional force & Fluctuating force •
   (B) Gravitational force & Nuclear force
   (C) Electromagnetic force & Nuclear force
   (D) Nuclear force & Fluctuating force

63. Landau's theory of phase transitions is related to:
   (A) Enthalpy of a thermodynamic system
   (B) Entropy of a thermodynamic system •
   (C) Free energy of a thermodynamic system
   (D) None of these

64. The Gibb's function 'G' in thermodynamics is:
   (A) G=H+TS •
   (B) G=H−TS
   (C) G=T+HS
   (D) G=T−HS

   (where H - Enthalpy,
   T - Temperature
   S - Entropy)

50. Which one is virial theorem:

(A) $\left\langle \Sigma q_i \frac{\partial H}{\partial q_i} \right\rangle = -\Sigma q_i p_i$

(B) $\left\langle \Sigma q_i \frac{\partial H}{\partial q_i} \right\rangle = -(\Sigma q_i p_i)$

(C) $\left\langle \Sigma q_i \frac{\partial H}{\partial q_i} \right\rangle = -\Sigma q_i p_i$

(D) $\left\langle \Sigma q_i \frac{\partial H}{\partial q_i} \right\rangle = -\Sigma q_i p_i$

51. The energy per unit dimension is:

(A) $\frac{3}{2}kT$

(B) $\frac{1}{3}kT$

(C) $\frac{1}{2}kT$

(D) kT

52. Which thermodynamical relations is correct among the following:

(A) $T = -\left(\frac{\partial E}{\partial V}\right)_{N,S}$

(B) $T = \left(\frac{\partial S}{\partial E}\right)_{N,V}$

(C) $T = \left(\frac{\partial S}{\partial E}\right)_{V,E}$

(D) $T = \left(\frac{\partial E}{\partial S}\right)_{N,V}$

53. The value of ln n! will be:

(A) $n \ln n + n$

(B) $n \ln n - n$

(C) $n \ln n + \frac{1}{n}$

(D) $n \ln n - \frac{1}{n}$

54. The correct expression for cluster expansion of classical gas will be

(A) $\frac{N}{V} = \lim_{V\to\infty}\left(\frac{Z}{V}\frac{\partial \ln Q}{\partial Z}\right) = \frac{1}{\lambda^3}\sum_{l=1}^{\infty} l b_l z^l$

(B) $\frac{V}{N} = \lim_{V\to\infty}\left(\frac{Z}{V}\frac{\partial \ln R}{\partial Z}\right) = \frac{1}{\lambda^3}\sum_{l=1}^{\infty} l b_l z^l$

(C) $\frac{N}{V} = \lim_{V\to\infty}\left(\frac{Z}{V}\frac{\partial \ln Q}{\partial Z}\right) = \frac{1}{\lambda^3}\sum_{l=1}^{\infty} l b_l z^l$

(D) None of these

55. Size of collidal particle is:

(A) $(10^{-9}-10^{-6})$m

(B) $(10^{-3}-10^{-2})$m

(C) $(10^{-11}-10^{1})$m

(D) $(10^{-10}-10^{-9})$m

56. Choose correct relation between $<(\Delta x)^2>$ and time for 2D system:

(A) $<(\Delta x)^2> \sim 2Dt$

(B) $<(\Delta x)^2> \sim 3Dt$

(C) $<(\Delta x)^2> \sim 6Dt$

(D) $<(\Delta x)^2> \sim 4Dt$

57. In Brownian motion, fluctuating force comes due to:

(A) Drag force

(B) Collision milk watts of versel

(C) Activity of Brownian particle

(D) random collisian of molecules on Brownian particle

43. For an energy state E of a photon gas, the density of states is proportional to:

(A) $E^{1/2}$

(B) E

(C) $E^{3/2}$ •

(D) E^2

44. In canonical ensemble the fractional fluctuation is proportional to:

(A) N

(B) N^2

(C) $N^{1/2}$

(D) $N^{-1/2}$ •

(N is the number of particles in the ensemble)

45. The relation between entropy and statistical probability is given by:

(A) $s=\log\Omega$

(B) $s=k\ln\Omega$ •

(C) $s=k\log\Omega^2$

(D) None of the above

46. Fluctuations are thermodynamically negligible in:

(A) single phase system

(B) Double phase system

(C) Triple phase system

(D) All the above

47. Langevin theory of Brownian motion is applied on a particle:

(A) free and only force is molecular bombardment

(B) bound and attractive force due to ions

(C) free and bound repulsive force due to ions

(D) None of the above

48. The study of fluctuations as a function of time is important because it gives information about:

(A) thermal properties of system

(B) mechanical properties of system

(C) Statistical properties of system

(D) dissipative properties of system

49. Helmholtz free energy of harmonic oscillator is:

(A) $A=-T\ln Q_N$

(B) $A = kTl_n\left(\frac{hw}{kT}\right)$

(C) $A = NkTl_n\left(\frac{hw}{kT}\right)$

(D) $A = l_n\left(\frac{hw}{kT}\right)$

36. Partition function is:

(A) $Z = $ [illegible]

(B) $Z = $ [illegible]

(C) $Z = 2$ [illegible]

(D) $Z = 2$ [illegible]

(where $\beta = \frac{1}{kT}$)

37. Consider the microcanonical ensemble, canonical ensemble and grand canonical ensemble. Which one physical property is same/constant in all the ensembles:

(A) Temperature-T

(B) Pressure-P

(C) Volume-V

(D) Total No. of particles N

38. From Fermi-Dirac statistics n_i is equal to:

(A) $\frac{g_i}{e^{\alpha+\beta\epsilon_i}+1}$

(B) $\frac{g_i}{e^{\alpha+\beta\epsilon_i}-1}$

(C) $\frac{g_i}{e^{\alpha-\beta\epsilon_i}+1}$

(D) $\frac{g_i}{e^{\alpha-\beta\epsilon_i}-1}$

39. In how many ways 2 Fermions can be distributed in 10 cell?

(A) 10

(B) 90

(C) 1/2

(D) 45

40. Pauli's exclusion principle applies to:

(A) Maxwell-Boltzmann statistics

(B) Bose-Einstein statistics

(C) Fermi-Dirac statistics

(D) None of these

41. The value of probability of an event can not be:

(A) zero

(B) 1

(C) 1/2

(D) negative

42. Which one of the following particles does not have a spin $\frac{1}{2}$?

(A) Proton

(B) Neutron

(C) Nutrino

(D) Photon

30. The statistical condition of equilibrium of two systems in thermal contact is:

(A) $T_A = T_B$

(B) $S_A = S_B$

(C) $\frac{\partial}{\partial E_A} \log W(A) = \frac{\partial}{\partial E_B} \log W(B)$

(D) $W_A = W_B$

(T - Temperature, S-Entropy, W-Thermodynamical probability)

31. The probability that in tossing a coin 10 times we get 5 heads and 5 tail, is:

(A) 252×2^{-10}

(B) 252×2^{10}

(C) 120×2^{-10}

(D) 120×2^{10}

32. The volume of a cell in six dimensional phase space is:

(A) h^{-3}

(B) h^{3}

(C) h^{6}

(D) h^{-6}

(where h is the Plank Constant)

33. The probability of drawing two kings in succession from a well shuffled pack is:

(A) $\frac{1}{144}$

(B) $\frac{1}{52}$

(C) $\frac{1}{221}$

(D) None of these

34. Which of the following particles obeys Maxwell-Boltzmann statistics?

(A) electrons

(B) photons

(C) protons

(D) gas-molecules

35. In a random distribution of 10 particles between two boxes with equal probability the number of microstates (3, 7) is:

(A) 120

(B) 5

(C) $\frac{10}{21}$

(D) 120×10^{-10}

26. The entropy of assembly of N-molecules of an ideal gas is:

(A) $S = Nk \log Z$

(B) $S = Nk \log Z + \frac{3}{2} Nk$

(C) $S = Nk \log Z + \frac{5}{2} Nk$

(D) $S = Nk \log Z + \frac{1}{2} Nk$

(where Z is partition function and k is the Boltzmann constant)

27. Sackur-Tetrode equation for entropy of a perfect gas is:

(A) $S = kN \log \frac{V}{N} \left(\frac{2\pi mkT}{h^2}\right)^{3/2} + \frac{5}{2} kN$

(B) $S = kN \log \frac{V}{N} \left(\frac{2\pi mkT}{h^2}\right)^{3/2} + \frac{3}{2} kN$

(C) $S = kN \log \frac{V}{N} \left(\frac{2\pi mkT}{h^2}\right)^{3/2} + \frac{5}{2} kN$

(D) $S = kN \log \frac{V}{N} \left(\frac{2\pi mkT}{h^2}\right)^{3/2} + \frac{3}{2} kN$

(where N- No. of molecules

V- Volume

m-mass of molecule

T-absolute temperature

k-Boltzmann constant

h-Planks constant)

28. For the mixing of two identical gases (indistinguishable) the increase in the total entropy is given by:

(A) $2kN \log 2$

(B) $\frac{1}{2} kN \log 2$

(C) $kN \log 2$

(D) $\frac{3}{2} kN \log 2$

(N-number of molecules

k-Boltzmann constant)

29. According to statistical mechanics parameter β is:

(A) $\frac{3}{E} \log W$

(B) $\frac{3}{2W} \log (E)$

(C) $\frac{3}{2E} (W)$

(D) $\frac{3}{2E} \log (W)$

(where E - The Total energy

W - The thermodynamical probability)

13. Fermions have spin value:

(A) $\frac{1}{2}$

(B) 1

(C) 0

(D) Anyone

14. It z be the partition function and $\beta = \frac{1}{K_B T}$ then average energy of the system is given by:

(A) $-\frac{\partial}{\partial\beta} \ln z$

(B) $\frac{\partial}{\partial\beta} \ln z$

(C) $-\beta \frac{\partial}{\partial\beta}\left(\frac{\ln z}{\beta}\right)$

(D) $\beta \frac{\partial}{\partial\beta}\left(\frac{\ln z}{\beta}\right)$

15. Which statistics follow classical mechanics?

(A) Maxwell Boltzmann Statistics

(B) Fermi Dirac Statistics

(C) Bose Einstein Statistics

(D) None

16. Total energy of fermi gas at $T \to 0K$ will be:

(A) $E_0 = \frac{2n}{5} E_f(0)$

(B) $E_0 = \frac{3n}{5} E_f(0)$

(C) $E_0 = \frac{2n}{5} \sqrt{E_f(0)}$

(D) $E_0 = \frac{3n}{5} \sqrt{E_f(0)}$

17. What will be the correct expression for Fermi gas at $T \to 0K$

(A) $E_f(0) = \left|\frac{n}{v} \times \frac{3}{8\pi} \frac{h^3}{g\pi m^{3/2}\sqrt{2}}\right|^{2/3}$

(B) $E_f(0) = \left|\frac{n}{v} \times \frac{3}{8\pi} \frac{h^3}{g\pi m^{3/2}\sqrt{2}}\right|^{3/2}$

(C) $E_f(0) = \left|\frac{n}{v} \times \frac{3}{4\pi} \frac{h^3}{g\pi m^{3/2}\sqrt{2}}\right|^{3/2}$

(D) $E_f(0) = \left|\frac{n}{v} \times \frac{3}{4\pi} \frac{h^3}{g\pi m^{3/2}\sqrt{2}}\right|^{2/3}$

18. The correct expression for Bose temperature (T_B) of an ideal base gas will be:

(A) $T_B = \left(\frac{n}{v}\right)^{2/3}\left(\frac{1}{2.612}\right)^{2/3} \frac{h^2}{2\pi mk}$

(B) $T_B = \left(\frac{n}{v}\right)^{5/2}\left(\frac{1}{2.612}\right)^{2/3} \frac{h^2}{2\pi mk}$

(C) $T_B = \left(\frac{n}{v}\right)^{5/2}\left(\frac{1}{2.612}\right)^{3/2} \frac{h^2}{2\pi mk}$

(D) $T_B = \left(\frac{n}{v}\right)^{5/2}\left(\frac{1}{2.612}\right)^{2/3} \frac{h^2}{2\pi mk}$

7. The particles obeying Maxwell-Boltzmann statistics are:

(A) Electrons

(B) Protons

(C) Identical & Indistinguishable

(D) Indentical & distinguishable

8. Two particles are distributed in three energy states. According to Maxwell-Boltzmann statistics how many distributions are possible?

(A) 1

(B) 3

(C) 6

(D) 9

9. The Bose-Einstein distribution function is:

(A) $\frac{n_i}{g_i} = \frac{1}{e^{\alpha+\beta\varepsilon_i}+1}$

(B) $\frac{n_i}{g_i} = \frac{1}{e^{\alpha+\beta\varepsilon_i}-1}$

(C) $\frac{n_i}{g_i} = \frac{1}{e^{\alpha-\beta\varepsilon_i}+1}$

(D) $\frac{n_i}{g_i} = \frac{1}{e^{\alpha-\beta\varepsilon_i}-1}$

10. Gibb's paradox arises due to:

(A) indistinguishability of classical particles

(B) distinguishability of classical particles

(C) ommittance of quantum nature of the particles

(D) absence of inter-particle interaction

11. Fermi Dirac (FD) statistics governs:

(A) Fermions

(B) Free electrons

(C) both (A) and (B)

(D) None of the above

12. Bosons have symmetrical wave function they do not obey:

(A) Aufbau principle

(B) Pauli's exclusion principle

(C) Hund's rule of maximum multiplicity

(D) Heisenberg's uncertainty principle

1. According to the Fermi-Dirac statistics the number of particles in a phase call can be:

(A) any number

(B) only two

(C) only three

(D) only one.

2. Which statistics will apply to deutrons and α-particles?

(A) B.E.

(B) F.D.

(C) M.B.

(D) None of these

3. For a single particle of mass m enclosed in a volume V, the number of acessible microstates in energy range E to E+δE is given by (the phase is given by):

(A) $\Omega(E) = \frac{2\pi V(2m)^{3/2} E^{1/2}}{h^3} \delta E$

(B) $\Omega(E) = \frac{2\pi V(2mE)^{3/2}}{h^3} \delta E$

(C) $\Omega(E) = \frac{2\pi V(2m)^{3/2}}{h} \delta E$

(D) $\Omega(E) = \frac{2\pi V(2mE)^{3/2}}{h} \delta E$

4. In a canonical ensemble a system A of fixed volume is in contact with a large reservoir B. Then:

(A) A can change only in energy with B.

(B) A can change only particles with B

(C) A can change both energy & particles with B

(D) A can change neither energy nor particles with B

5. Quantum statistics (i.e. B.E & F.D. statistics) approaches to classical statistics (i.e. Maxwell Boltzmann statistics) if the occupation index $\left(\frac{n_i}{g_i}\right)$ is:

(A) $\frac{n_i}{g_i} = 1$

(B) $\frac{n_i}{g_i} << 1$

(C) $\frac{n_i}{g_i} >> 1$

(D) None of these

6. The Maxwell-Boltzmann energy distribution law in the general form is:

(A) $n_i = \frac{g_i}{e^{\alpha+\beta E_i}}$

(B) $n_i = g_i e^{\alpha+\beta E_i}$

(C) $n_i = g_i e^{-\alpha} e^{\beta E_i}$

(D) $n_i = g_i e^{\alpha-\beta E_i}$

19. During BE condensation all the atoms fall back to:

(A) Ground state •

(B) First excited state

(C) Highest excited state

(D) None of these

20. He shows BE condensation below what temperature?

(A) 100.5 K

(B) 12.3 K

(C) 5.12 K

(D) 2.13 K •

21. Five bosons are distributed in two boxes. There are three cells in the first box and four cells in the second box. The thermodynamic probability of the macrostes (3, 2) is:

(A) 100

(B) 10

(C) 50

(D) 20

22. Spin of Boson is:

(A) $\frac{1}{2}$

(B) $-\frac{1}{2}$

(C) $-\frac{3}{2}$

(D) 0 •

23. Which of the following is suitable statistics for photons?

(A) Maxwell-Boltzmann Statistics

(B) Fermi-Dirac Statistics

(C) Bose-Einstein Statistics •

(D) None of these

24. Phase space is a:

(A) 3-dimensional space

(B) 4-dimensional space

(C) 5-dimensional space

(D) 6-dimensional space •

25. In statistical mechanics Gibb's paradox is related to the:

(A) additive property of the temperature

(B) additive property of the energy

(C) additive property of the momentum

(D) additive property of the entropy •