Paper Code - 5301

M.Sc. Semester-III Physics (Old Course)
July-September-2021
CPH-601 Statistical Mechanics and Nuclear Physics

કુલ સમય :– : ૬૦ મીનીટ **કુલ પ્રશ્નો : ૫૦** **વિદ્યાર્થીએ ટીક કરવાના પ્રશ્નો : ૩૫**

નોંધ : વિદ્યાર્થીએ માત્ર ૩૫ પ્રશ્નો જ ટીક કરવાના રહેશે. જો વધારે ટીક કરેલ હશે તો પ્રથમ ૩૫ પ્રશ્નો જ ગણતરીમાં લેવામાં આવશે.

1. According to ergodic hypothesis if ensemble average is $\langle q^2 \rangle_e$ and time average is $\langle q^2 \rangle_t$, then
   (A) $\langle q^2 \rangle_e = \langle q^2 \rangle_t$ (B) $\langle q^2 \rangle_e < \langle q^2 \rangle_t$ (C) $\langle q^2 \rangle_e > \langle q^2 \rangle_t$ (D) $\langle q^2 \rangle_e = \langle q^2 \rangle_t = 0$
2. The density distribution function $\rho(q, p, t)$ gives
   (A) The probability per unit time (B) The probability per unit volume
   (C) The probability per unit energy (D) The probability per unit momentum
3. According to Hamilton's equation of motion …… is true.
   (A) $\frac{\partial \dot{p}_i}{\partial p_i} = -\frac{\partial^2 H}{\partial q_i \partial p_i}$ (B) $\frac{\partial \dot{p}_i}{\partial p_i} = \frac{\partial^2 H}{\partial q_i \partial \dot{p}_i}$ (C) $\frac{\partial \dot{p}_i}{\partial p_i} = \frac{\partial^2 H}{\partial \dot{q}_i \partial p_i}$ (D) $\frac{\partial \dot{p}_i}{\partial p_i} = \frac{\partial^2 H}{\partial q_i \partial p_i}$
4. If density distribution function $\rho(q, p, t)$ has no explicit dependence on time at all point in phase space, then ensemble is in statistical equilibrium if
   (A) $\frac{\partial \rho}{\partial t} > 0$ (B) $\frac{\partial \rho}{\partial t} < 0$ (C) $\frac{\partial \rho}{\partial t} = 0$ (D) $\frac{\partial^2 \rho}{\partial t^2} > 0$
5. The photon gas obeys…… statistics.
   (A) Bose (B) Fermi (C) Maxwell (D) None of this
6. If the gas is in equilibrium ,its free energy is ……..
   (A) Minimum (B) Maximum (C) Infinite (D) Fluctuating
7. The pressure of the radiation is equal to ……..of the energy density.
   (A) $\frac{5}{3}$ (B) $\frac{2}{3}$ (C) $\frac{4}{3}$ (D) $\frac{1}{3}$
8. Stefan Boltzmann constant is given by
   (A) $\sigma = \frac{k^4\pi^2}{60c^2\hbar^3}$ (B) $\sigma = \frac{k^3\pi^2}{60c^2\hbar^3}$ (C) $\sigma = \frac{k^4\pi^0}{60c^2\hbar^2}$ (D) $\sigma = \frac{k^2\pi^2}{60c^2\hbar^3}$
9. The unit of Stefan Boltzmann constant is
   (A) $Wm^{-3}k^{-3}$ (B) $Wm^{-2}k^{-4}$ (C) $Wm^{2}k^{-4}$ (D) $Wm^{-2}k^{4}$
10. If the number of systems in which the particle is found in the k^{th} cell with co-ordinate q_k is N_k, The probability of particle to be found in the k^{th} cell (P_k) is given by ….
    (A) $P_k = \sqrt{\frac{N_k}{N}}$ (B) $P_k = \frac{N_k^2}{N^2}$ (C) $P_k = \frac{N_k}{N}$ (D) None of these
11. If density distribution function is $\rho(q, p, t)$ and H is Hamiltonian then ……. is correct.
    (A) $\frac{\partial \rho}{\partial t} + \{\rho, H\} \neq 0$ (B) $\frac{\partial \rho}{\partial t} = -\{\rho, H\}$ (C) $\frac{\partial \rho}{\partial t} = -\{H, \rho\}$ (D) $\frac{\partial \rho}{\partial t} > \{\rho, H\}$
12. If the system is in statistical equilibrium, the observed values of the macroscopic physical quantities are ……
    (A) having maximum value (B) equal to their mean values
    (C) far away from their mean values (D) not measurable
13. The role of distribution function $\rho(q, p, t)$ in classical statistics is replaced by the quantity known as …… in quantum mechanics.
    (A) distribution vector (B) distribution matrix (C) density matrix D) quantum mechanical state
14. If the density matrix ρ is constant then …
    (A) $\rho_{mn} > 0 \ldots\ldots\ldots m \neq n$ (B) $\rho_{mn} < 0 \ldots\ldots\ldots m \neq n$
    (C) $\rho_{mn} = 0 \ldots\ldots\ldots m \neq n$ (D) $\rho_{mn} = 0 \ldots\ldots\ldots m = n$
15. If the ensemble is in the pure state, the density matrix satisfies the condition….
    (A) $\rho^2 = \rho$ (B) $\rho^2 = 0$ (C) $\rho^2 = 1$ (D) $\rho^2 = \infty$
16. Chemical potential (μ) for photon is ……..
    (A) 1 (B) -1 (C) 0 (D) ∞
17. Free energy of the gas in equilibrium is.....
    (A) 0 (B) Minimum (C) Maximum (D) None of three
18. Planks radiation law turns into Rayleigh-jeans law when.....
    (A) $\hbar\omega < 1$ (B) $\hbar\omega < kT$ (C) $\hbar\omega \gg kT$ (D) $\hbar\omega \ll kT$
19. Wien's law holds good for radiation of ……..
    (A) higher frequencies (B) low frequencies (C) extremely low frequencies (D) any frequencies
20. MASER stands For ……..
    (A) Microwave Amplitude of Shortwave Emission of Radiation.
    (B) Mega Amplification of Shortwave Emission of Radiation.
    (C) Microwave Amplification of Shortwave Emission of Radiation.
    (D) Microwave Amplification by stimulated Emission of Radiation.
21. BE distribution goes over to MB distribution when…….
    (A) $e^{-\beta\mu} \gg 1$ (B) $e^{-\beta\mu} \ll 1$ (C) $e^{-\beta\mu} = 1$ (D) $e^{-\beta\mu} = 0$
22. Bose-Einstein condensation takes place when temperature (T) …….
    (A) $T = 273\ ^\circ K$ (B) $T = T_c$ (critical temperature) (C) $T = 0\ ^\circ K$ (D) $T = T_b$ (Bose temperature)

23. When temperature(T) is less then Bose temperature (T_b) the total energy of the system is determined by
(A) only the particles in ground states. (B) only the particles in ground states.
(C) the particles in ground states & excited states. (D) the particles either in ground states or excited states.
24. At transition temperature the pressure of an ideal Bose gas is about …… of that of an equivalent Boltzmann gas.
(A) one half (B) two third (C) one third (D) one fourth
25. If the total number of fermions in gas is 10^{24} then the number of states below the Fermi level is ….
(A) 10^{24} (B) 10^{12} (C) 0.5×10^{24} (D) The 10^{24}
26. If the Fermi energy is 6.9×10^{-19} J and the Boltzmann constant is 1.38×10^{-23}JK^{-1}. The Fermi temperature will be ……
(A) $5000\ °K$ (B) $50000\ °K$ (C) $15000\ °K$ (D) $10000\ °K$
27. The brightness of star is proportional to ……..
(A) Predominant wavelength emitted from stars (B) subdominant wavelength emitted from stars
(C) square of predominant wavelength emitted from stars (D) None of the above
28. Exponential Potential $V(r)$ is given by ……
(A) $V(r) = -V_0 e^{-\frac{r}{r_0}}$ (B) $V(r) = V_0 - e^{\frac{r^2}{r_0^2}}$ (C) $V(r) = -V_0 \left(\frac{r}{r_0}\right)^{-1} e^{-\frac{r}{r_0}}$ (D) $V(r) = -V_0 \left(\frac{r}{r_0}\right) e^{-\frac{r}{r_0}}$
29. Yukava Potential $V(r)$ is given by ……
(A) $V(r) = -V_0 e^{-\frac{r}{r_0}}$ (B) $V(r) = V_0 - e^{\frac{r^2}{r_0^2}}$ (C) $V(r) = -V_0 \left(\frac{r}{r_0}\right)^{-1} e^{-\frac{r}{r_0}}$ (D) $V(r) = -V_0 \left(\frac{r}{r_0}\right) e^{-\frac{r}{r_0}}$
30. Which Potential is purely radial potential ?
(A) Majorana (B) Wigner (C) Bartlett (D) Heisenberg
31. Majorana Potential $V(r)$ concerns with ……
(A) the exchange of the space coordinate (B) the exchange of the spin coordinate
(C) the exchange of both space and spin (D) None of these
32. Which of the following two nucleon system is stable ?
(A) nn (B) np (C) pp (D) all three
33. The deuteron is …….. bound system.
(A) loose (B) tight (C) strong (D) None of these
34. Ground state of deuteron is ……
(A) Singlet (B) Doublet (C) Triplet (D) None of three
35. Binding energy per nucleon for deuteron is ……
(A) $2.226\ MeV$ (B) $1.113\ MeV$ (C) $3.339\ MeV$ (D) $3.349\ MeV$
36. In the case of np elastic scattering the phase shift is
(A) real (B) imaginary (C) complex (D) either imaginary or complex
37. …… Is triplet spin state of deuteron.
(A) $^1S_3$ (B) $^3S_3$ (C) $^3S_1$ (D) None of these
38. In the case of np elastic scattering classical total elastic cross section is ……
(A) $4\pi a^2$ (B) πa^2 (C) $0.5\pi a^2$ (D) $2\pi a^2$
39. The spin of neutron and proton are ……to each other in the case of spin state of deuteron.
(A) anti-parallel (B) parallel (C) perpendicular (D) none of these
40. Mass of photon is ……
(A) 0 (B) $1\ amu$ (C) $2\ amu$ (D) $1.5\ amu$
41. CP invariance is not satisfied in case of ……
(A) weak interaction (B) strong interaction (C) fusion reaction (D) none of these
42. Lepton number of electron is ……
(A) -1 (B) 1 (C) 0 (D) ± 0.5
43. Select correct statement ……
(A) Strangeness conservation does not govern the strong interaction.
(B) Strangeness conservation governs the strong and weak interaction.
(C) Strangeness conservation governs the weak interaction but not strong interaction.
(D) Strangeness conservation governs only strong interaction and not the weak interaction.
44. If Strangeness $S = 0$, Baryon number $B = 0$ and $T = 0$, which particle can be produced ?
(A) Pions (B) natural meson (C) nucleons (D) singlet baryon
45. Pion scattering is affected by ……
(A) weak force (B) strong force (C) never affacted (D) none of these
46. The baryon number of all mesons is ……
(A) 1 (B) -1 (C) 0 (D) ± 0.5
47. According to Gell-Mann Nishijima scheme ……
(A) $Q = T_3 + 0.5(B + S)$ (B) $Q = T_3 - 0.5(B + S)$ (C) $Q = T_3 + 0.5(B - S)$ (D) $Q = T_3 - 0.5(B - S)$
48. The electromagnetic interaction is ……
(A) charge independent (B) charge dependent (C) imaginary interaction (D) none of these
49. The strangeness quantum number is defined as ……
(A) $S = \gamma - \beta$ (B) $S = \gamma - \beta$ (C) $S = \sqrt{\gamma^2 + \beta^2}$ (D) $S = \sqrt{\gamma^2 - \beta^2}$
50. Which particle has half integral spin?
(A) Pions (B) Kaons (C) Photons (D) Leptons