# Classical Statistics JEST

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## JEST Questions

### Q.No:1 JEST-2012

Consider a system of particles in three dimensions with momentum $\vec{p}$ and energy $E = c|\vec{p}|$, $c$ being a constant. The system is maintained at inverse temperature $\beta$, volume $V$ and chemical potential $\mu$. What is the grand partition function of the system?

(A) $\exp\left[e^{\beta\mu} 8\pi V/(\beta ch)^3\right]$

(B) $\exp\left[e^{\beta\mu} 6\pi V/(\beta ch)^3\right]$

(C) $\frac{1}{3}, \frac{2}{3}\mu$

(D) $e^{\beta\mu} 8\pi V/(\beta ch)^2$

### Q.No:2 JEST-2012

Consider a system maintained at temperature $T$, with two available energy states $E_1$ and $E_2$ each with degeneracies $g_1$ and $g_2$. If $p_1$ and $p_2$ are probabilities of occupancy of the two energy states, what is the entropy of the system?

(A) $S = -k_B[p_1 \ln(p_1/g_1) + p_2 \ln(p_2/g_2)]$

(B) $S = -k_B[p_1 \ln(p_1 g_1) + p_2 \ln(p_2 g_2)]$

(C) $S = -k_B[p_1 \ln(p_1^{g_1}) + p_2 \ln(p_2^{g_2})]$

(D) $S = -k_B[(1/p_1) \ln(p_1/g_1) + (1/p_2) \ln(p_2/g_2)]$

### Q.No:3 JEST-2012

A collection of $N$ two-level systems with energies 0 and $E > 0$ is in thermal equilibrium at temperature $T$. For $T \to \infty$, the specific heat approaches

(A) 0

(B) $Nk_B$

(C) $3Nk_B/2$

(D) $\infty$

### Q.No:4 JEST-2013

Consider a particle with three possible spin states: $s = 0$ and $\pm 1$. There is a magnetic field $h$ present and the energy for a spin state $s$ is $-hs$. The system is at a temperature $T$. Which of the following statements is true about the entropy $S(T)$?

(A) $S(T) = \ln 3$ at $T = 0$, and 3 at high $T$

(B) $S(T) = \ln 3$ at $T = 0$, and zero at high $T$

(C) $S(T) = 0$ at $T = 0$, and 3 at high $T$

(D) $S(T) = 0$ for $T = 0$, and $\ln 3$ at high $T$

### Q.No:5 JEST-2014

A monoatomic gas consists of atoms with two internal energy levels, ground state $E_0 = 0$ and an excited state $E_1 = E$. The specific heat of the gas is given by

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

(B) $\frac{E^2 e^{E/kT}}{kT^2(1+e^{E/kT})^2}$

(C) $\frac{3}{2}k + \frac{E^2 e^{E/kT}}{kT^2(1+e^{E/kT})^2}$

(D) $\frac{3}{2}k - \frac{E^2 e^{E/kT}}{kT^2(1+e^{E/kT})^2}$

### Q.No:6 JEST-2014

Consider a system of $2N$ non-interacting spin 1/2 particles each fixed in position and carrying a magnetic moment $\mu$. The system is immersed in a uniform magnetic field $B$. The number of spin up particle for which the entropy of the system will be maximum is

(A) 0

(B) $N$

(C) $2N$

(D) $N/2$

### Q.No:7 JEST-2015

For a system in thermal equilibrium with a heat bath at temperature $T$, which one of the following equalities is correct? ($\beta = \frac{1}{k_B T}$)

(A) $\frac{\partial}{\partial\beta}\langle E\rangle = \langle E\rangle^2 - \langle E^2\rangle$

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(B) $\frac{\partial}{\partial\beta}\langle E\rangle = \langle E^2\rangle - \langle E\rangle^2$

(C) $\frac{\partial}{\partial\beta}\langle E\rangle = \langle E^2\rangle + \langle E\rangle^2$

(D) $\frac{\partial}{\partial\beta}\langle E\rangle = -(\langle E^2\rangle + \langle E\rangle^2)$

## Q.No:8 JEST-2015

A particle in thermal equilibrium has only 3 possible states with energies $-\in, 0, \in$. If the system is maintained at a temperature $T \gg \frac{\in}{k_B}$, then the average energy of the particle can be approximated to,

(A) $\frac{2\in^2}{3k_BT}$

(B) $\frac{-2\in^2}{3k_BT}$

(C) $\frac{-\in^2}{k_BT}$

(D) 0

## Q.No:9 JEST-2015

Electrons of mass $m$ in a thin, long wire at a temperature $T$ follow a one-dimensional Maxwellian velocity distribution. The most probable speed of these electrons is,

(A) $\sqrt{\left(\frac{kT}{2\pi m}\right)}$

(B) $\sqrt{\left(\frac{2kT}{m}\right)}$

(C) 0

(D) $\sqrt{\left(\frac{8kT}{\pi m}\right)}$

## Q.No:10 JEST-2016

The energy of a particle is given by $E = |p|+|q|$, where $p$ and $q$ are the generalized momentum and coordinate, respectively. All the states with $E \leq E_0$ are equally probable and states with $E > E_0$ are inaccessible. The probability density of finding the particle at coordinate $q$, with $q > 0$ is:

(A) $(E_0 + q)/E_0^2$

(B) $q/E_0^2$

(C) $(E_0 - q)/E_0^2$

(D) $1/E_0^2$

## Q.No:11 JEST-2016

A gas of $N$ molecules of mass $m$ is confined in a cube of volume $V = L^3$ at temperature $T$. The box is in a uniform gravitational field $-g\hat{z}$. Assume that the potential energy of a molecule is $U = mgz$, where $z \in [0, L]$ is the vertical coordinate inside the box. The pressure $P(z)$ at height $z$ is:

(A) $(P(z) = \frac{N}{V}\frac{mgL}{2}\frac{\exp\left(-\frac{mg(z-L/2)}{k_BT}\right)}{\sinh\left(\frac{mgL}{2k_BT}\right)}$

(B) $P(z) = \frac{N}{V}\frac{mgL}{2}\frac{\exp\left(-\frac{mg(z-L/2)}{k_BT}\right)}{\cosh\left(\frac{mgL}{2k_BT}\right)}$

(C) $P(z) = \frac{k_BTN}{V}$

(D) $P(z) = \frac{N}{V}mgz$

## Q.No:12 JEST-2016

A two dimensional box in a uniform magnetic field $B$ contains $N/2$ localised spin-1/2 particles with magnetic moment $\mu$, and $N/2$ free spinless particles which do not interact with each other. The average energy of the system at a temperature $T$ is:

(A) $3NkT - \frac{1}{2}N\mu B\sinh(\mu B/k_BT)$

(B) $NkT - \frac{1}{2}N\mu B\tanh(\mu B/k_BT)$

(C) $\frac{1}{2}NkT - \frac{1}{2}N\mu B\tanh(\mu B/k_BT)$

(D) $\frac{3}{2}NkT + \frac{1}{2}N\mu B\cosh(\mu B/k_BT)$

## Q.No:13 JEST-2016

For a quantum mechanical harmonic oscillator with energies, $E_n = (n+1/2)\hbar\omega$, where $n = 0, 1, 2...$, the partition function is:

(A) $\frac{e^{\hbar\omega/k_BT}}{e^{\hbar\omega/2k_BT}-1}$

(B) $e^{\hbar\omega/2k_BT} - 1$

(C) $e^{\hbar\omega/2k_BT} + 1$

(D) $\frac{e^{\hbar\omega/2k_BT}}{e^{\hbar\omega/k_BT}-1}$

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## Q.No:14 JEST-2017

If the mean square fluctuations in energy of a system in equilibrium at temperature $T$ is proportional to $T^{\alpha}$, then the energy of the system is proportional to

(A) $T^{\alpha-2}$.

(B) $T^{\frac{\alpha}{2}}$.

(C) $T^{\alpha-1}$.

(D) $T^{\alpha}$.

## Q.No:15 JEST-2017

Let particle of mass $1 \times 10^{-9} Kg$, constrained to have one dimensional motion, be initially at the origin ($x = 0m$). The particle is in equilibrium with a thermal bath ($k_B T = 10^{-8} J$). What is $\langle x^2 \rangle$ of the particle after a time $t = 5s$?

## Q.No:16 JEST-2017

Two classical particles are distributed among $N$ ($> 2$) sites on a ring. Each site can accommodate only one particle. If two particles occupy two nearest neighbour sites, then the energy of the system is increased by $\epsilon$. The average energy of the system at temperature $T$ is

(A) $\frac{2\epsilon e^{-\beta\epsilon}}{(N-3)+2e^{-\beta\epsilon}}$.

(B) $\frac{2N\epsilon e^{-\beta\epsilon}}{(N-3)+2e^{-\beta\epsilon}}$.

(C) $\frac{\epsilon}{N}$.

(D) $\frac{2\epsilon e^{-\beta\epsilon}}{(N-2)+2e^{-\beta\epsilon}}$.

## Q.No:17 JEST-2018

When a collection of two-level systems is in equilibrium at temperature $T_0$, the ratio of the population in the lower and upper levels is $2:1$. When the temperature is changed to $T$, the ratio is $8:1$. Then

(A) $T = 2T_0$

(B) $T_0 = 2T$

(C) $T_0 = 3T$

(D) $T_0 = 4T$

## Q.No:18 JEST-2018

A collection of $N$ interacting magnetic moments, each of magnitude $\mu$, is subjected to a magnetic field $H$ along the $z$ direction. Each magnetic moment has a doubly degenerate level of energy zero, and two non-degenerate levels of energies $-\mu H$ and $\mu H$ respectively. The collection is in thermal equilibrium at temperature $T$. The total energy $E(T, H)$ of the collection is

(A) $-\frac{\mu H N \sinh(\mu H/k_B T)}{1+\cosh(\mu H/k_b T)}$

(B) $-\frac{\mu H N}{2(1+\cosh(\mu H/k_B T))}$

(C) $-\frac{\mu H N \cosh(\mu H/k_B T)}{1+\cosh(\mu H/k_b T)}$

(D) $-\mu H N \frac{\sinh(\mu H/k_B T)}{\cosh(\mu H/k_B T)}$

## Q.No:19 JEST-2018

A large cylinder of radius $R$ filled with particles of mass $m$. The cylinder spins about its axis at an angular speed $\omega$ radians per second, providing an acceleration $g$ for the particles at the rim. If the temperature $T$ is constant inside the cylinder, what is the ratio of air pressure $P_0$ at the axis to the pressure $P_c$ at the rim?

(A) $\exp\left[\frac{mgR}{2k_b T}\right]$

(B) $\exp\left[-\frac{mgR}{2k_b T}\right]$

(C) $\frac{mgR}{2k_b T}$

(D) $\frac{2k_b T}{mgR}$

## Q.No:20 JEST-2019

Consider a diatomic molecule with an infinite number of equally spaced non-degenerate energy levels. The spacing between any two adjacent levels is $\varepsilon$ and the ground state energy is zero. What is the single particle partition function $Z$?

(A) $Z = \frac{1}{1-\frac{\varepsilon}{k_B T}}$

(B) $Z = \frac{1}{1-e^{\frac{\varepsilon}{k_B T}}}$

(C) $Z = \frac{1}{1-e^{\frac{2\varepsilon}{k_B T}}}$

(D) $Z = \frac{1-\frac{\varepsilon}{k_B T}}{1+\frac{\varepsilon}{k_B T}}$

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## Q.No:21 JEST-2019

Consider a system of $N$ distinguishable particles with two energy levels for each particle; a ground state with energy zero and an excited state with energy $\varepsilon > 0$. What is the average energy per particle as the system temperature $T \to \infty$?

(A) 0

(B) $\frac{\varepsilon}{2}$

(C) $\varepsilon$

(D) $\infty$

## Q.No:22 JEST-2019

Consider a grand canonical ensemble of a system of one dimensional non-interacting classical harmonic oscillators (each of frequency $\omega$). Which one of the following equations is correct? Here the angular bracket $\langle\cdot\rangle$ indicate the ensemble average. $N, E$ and $T$ represent the number of particles, energy and temperature, respectively. $k_B$ is the Boltzmann constant.

(A) $\langle E\rangle = N\frac{k_BT}{2}$

(B) $\langle E\rangle = \langle N\rangle\frac{k_BT}{2}$

(C) $\langle E\rangle = Nk_BT$

(D) $\langle E\rangle = \langle N\rangle k_BT$

## Q.No:23 JEST-2020

Consider a system of two particles at temperature $T \to \infty$. Each of them can occupy three different quantum energy levels having energies $0, \epsilon$ and $2\epsilon$, and both of them cannot occupy the same energy level. What is the average energy of the system?

(A) $\epsilon$

(B) $3\epsilon/2$

(C) $2\epsilon$

(D) $4\epsilon$

## Q.No:24 JEST-2020

Consider an ideal gas whose entropy is given by

$$S = \frac{n}{2}\left[\sigma + 5R\ln\frac{U}{n} + 2R\ln\frac{V}{n}\right]$$

where $n$ is the number of moles, $\sigma$ is a constant, $R$ is the universal gas constant, $U$ is the internal energy and $V$ is the volume of the gas. The specific heat at constant pressure is then given by

(A) $\frac{5}{2}nR$

(B) $\frac{7}{2}nR$

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

(D) $nR$

## Q.No:25 JEST-2020

Consider a cube (see figure) of volume $V$ containing $N$ molecules each of mass $m$ with uniform density $n = N/V$. Suppose this system is equivalent to a system of $M$ non-interacting gases such that molecules of the $i$th gas are $N_i = n_iV$ in number, each with an identical $y$-component of velocity $v_i$. What is the pressure $P$ on the surface $\square ABCD$ of area $\mathbb{A}$

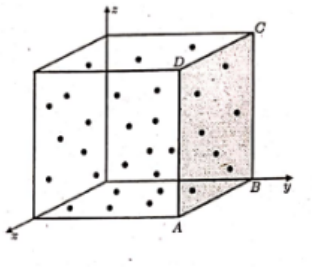


Figure 1: Cube with surface ABCD.

(A) $P = m\sum_{i=1}^{M} n_iv_i^2$

(B) $P = \frac{m\sum_{i=1}^{M} n_iv_i^2}{\sum_{i=1}^{M} n_i}$

(C) $P = \frac{m\sum_{i=1}^{M} n_iv_i^2}{2}$

(D) $P = 2m\sum_{i=1}^{M} n_iv_i^2$

## Q.No:26 JEST-2020

A classical gas of $N$ particles is kept at a temperature $T$ and is confined to move on a two-dimensional surface ($xy$-plane). If an external linear force field is applied along the $x$-axis, then the partition function of the system will be proportional to

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(A) $T^N$

(B) $T^{2N}$

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

(D) $T^{3N/2}$

## Q.No:27 JEST-2021

Consider a system consisting of three non-degenerate energy levels, with energies $0, \epsilon$, and $2\epsilon$. In the limit of infinite temperature $T \to \infty$, the probability of finding a particle in the ground state is

(A) 0

(B) 1/2

(C) 1/3

(D) 1

## Q.No:28 JEST-2021

An ideal gas at temperature $T$ is composed of particles of mass $m$, with the $x$-component of velocity $v_x$. The average value of $|v_x|$ is

(A) 0

(B) $\sqrt{3k_BT/m}$

(C) $\sqrt{k_BT/2\pi m}$

(D) $\sqrt{2k_BT/\pi m}$

## Q.No:29 JEST-2021

Five distinguishable particles are distributed in energy levels $E_1$ and $E_2$ with degeneracy of 2 and 3 respectively. Find the number of microstates with three particles in energy level $E_1$ and two particles in $E_2$.

(A) $k_BT$.

(B) $\frac{1}{2}k_BT$.

(C) $2k_BT$.

(D) $\frac{3}{2}k_BT$.

## Q.No:31 JEST-2022

A system with two energy levels is in thermal equilibrium with a heat reservoir at temperature $600K$. The energy gap between the levels is $0.1eV$. Let $p$ be the probability that the system is in the higher energy level. Which of the following statement is correct? [Note: $1eV = 11600K$]

(A) $0.1 < p \leq 0.2$

(B) $0 < p \leq 0.1$

(C) $0.2 < p \leq 0.3$

(D) $p \geq 0.3$

## Q.No:32 JEST-2022

If mean and standard deviation of the energy distribution of an equilibrium system vary with temperature $T$ as $T^\nu$ and $T^\alpha$ respectively, then $\nu$ and $\alpha$ must satisfy

(A) $\nu + 1 = 2\alpha$

(B) $2\nu + 1 = \alpha$

(C) $\nu = 1 + 2\alpha$

(D) $2\nu = 1 + \alpha$

## Q.No:33 JEST-2022

Adding $1eV$ of energy to a large system did not change its temperature ($27°C$) whereas it changed the number of micro-states by a factor $r$. $r$ is of the order [Note: $1eV = 11600K$]

(A) $10^{17}$

(B) $10^{23}$

(C) $10^4$

(D) $10^{-19}$

## Q.No:34 JEST-2022

The energy of two Ising spins ($s_1 = \pm 1, s_2 = \pm 1$) is given by $E = -s_1s_2 - \frac{1}{2}(s_1 + s_2)$. At certain temperature $T$ probability that both spins take $+1$ values is 4 times than they both take $-1$ values. What is the probability that they have opposite spins? [$\beta = 1/k_BT$]

(A) $\frac{1}{6}$

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(B) $e^{\beta}\tanh\beta$

(C) $\frac{e^{\beta}}{1+e^{2\beta}}$

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

## Q.No:35 JEST-2022

A container has two compartments. One compartment contains Oxygen gas at pressure $P_1$, volume $V_1$ and temperature $T_1$. The second compartment contains Nitrogen gas at pressure $P_2$, volume $V_2$, and temperature $T_2$. The partition separating two compartments is removed and the gases are allowed to mix. What is the temperature of the mixture when it comes to equilibrium?

(A) $\frac{(P_1V_1+P_2V_2)T_1T_2}{P_1V_1T_2+P_2V_2T_1}$

(B) $\frac{(V_1T_1+V_2T_2)}{V_1+V_2}$

(C) $\frac{(P_1V_1T_2+P_2V_2T_1)}{P_1V_1+P_2V_2}$

(D) $\frac{(P_1V_1T_1+P_2V_2T_1)}{P_1V_1+P_2V_2}$

## Q.No:36 JEST-2022

A particle can access only three energy levels $E_1 = 1eV, E_2 = 2eV$, and $E_3 = 6eV$. The average energy $\langle E\rangle$ of the particle changes as temperature $T$ changes. What is the ratio of the minimum to the maximum average energy of the particle?

## Q.No:37 JEST-2022

A system of $N$ classical non-identical particles moving in one dimensional space is governed by the Hamiltonian

$$H=\sum_{i=1}^{N}(A_ip_i^2+B_i|q_i|^{\alpha}),$$

where $p_i$ and $q_i$ are momentum and position of the $i$-th particle, respectively, and the constant parameters $A_i$ and $B_i$ characterize the individual particles. When the system is in equilibrium at temperature $T$, then the internal energy is found to be

$$E=\langle H\rangle=\frac{2}{3}Nk_BT,$$

where $k_B$ is the Boltzmann constant. What is the value of $\alpha$?

## Q.No:38 JEST-2023

A gas is in equilibrium at temperature $T$. Using the kinetic theory of gasses, compute the following quantity:

$$\frac{\langle|\vec{v}|\rangle^2}{\langle|v_x|\rangle^2+\langle|v_y|\rangle^2+\langle|v_z|\rangle^2}$$

where $\vec{v}$ represents the velocity vector with the components $v_x, v_y, v_z$ and $\langle ...\rangle$ represents the thermal average of the quantity.

(A) 0

(B) $\frac{4}{3}$

(C) 1

(D) $\frac{1}{3}$

## Q.No:39 JEST-2023

Consider a system of classical non-interacting particles constrained to be in the XY plane subject to the potential:

$$V(x,y)=\frac{1}{2}\alpha(x-y)^2$$

If they are in equilibrium with a thermal bath at temperature $T$, what is the average energy per particle? The Boltzmann constant is $k_B$.

(A) $\frac{5}{2}k_BT$

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

(C) $2k_BT$

(D) $\frac{3}{2}k_BT$

## Q.No:40 JEST-2023

A cylinder of height $L$ and cross-section A placed vertically along the central axis is filled with noninteracting particles each of mass $m$ which are acted upon by a gravitational force of magnitude $mg$ in the downward direction. The system is maintained at a temperature $T$. What is the ratio

$$\frac{C_v(T\to 0)}{C_v(T\to\infty)},$$

where $C_v$ is the specific heat at constant volume.

(A) $\frac{3}{5}$

(B) $\frac{3}{2}$

(C) $\frac{1}{3}$

(D) $\frac{5}{3}$

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## Q.No:41 JEST-2024

A quantum oscillator with energy levels

$$E_n = \left(n + \frac{1}{2}\right)\hbar\omega, \quad n = 0, 1, 2\ldots$$

is in equilibrium at a low enough temperature $T$ so that the occupation of all states with $n \geq 2$ is negligible. What is the mean energy of the oscillator as a function of the inverse temperature $\beta = \left(\frac{1}{k_B T}\right)$?

(A) $\hbar\omega\left[\frac{1}{2} + \frac{1}{1+\exp(\beta\hbar\omega)}\right]$

(B) $\hbar\omega\left[\frac{1}{2} + \frac{1}{1-\exp(\beta\hbar\omega)}\right]$

(C) $\hbar\omega\left[1 + \exp(-\beta\hbar\omega)\right]$

(D) $\hbar\omega\left[1 - \exp(-\beta\hbar\omega)\right]$

## Q.No:42 JEST-2024

Consider a system of $N$ noninteracting spin-$\frac{1}{2}$ atoms subjected to a magnetic field with the Hamiltonian given by

$$H = -g\mu_B B\sum_{i=1}^{N} S_i^z,$$

where $g$ is the dimensionless Landé factor, $\mu_B$ is the Bohr magneton, $B$ is the strength of the magnetic field, and $S_i^z$ is the z-component of the spin of the $i$th atom. The system is in equilibrium at temperature $T$. What is the probability that the z-component of the spins corresponding to two given atoms have the same value? Take $\beta = \frac{1}{k_B T}$, where $k_B$ is the Boltzmann constant.

(A) $\frac{\exp(-\beta g\mu_B B)+\exp(\beta g\mu_B B)}{2+\exp(-\beta g\mu_B B)+\exp(\beta g\mu_B B)}$

(B) $\frac{\exp(-\beta g\mu_B B)}{2+\exp(-\beta g\mu_B B)+\exp(\beta g\mu_B B)}$

(C) $\frac{\exp(\beta g\mu_B B)}{2+\exp(-\beta g\mu_B B)+\exp(\beta g\mu_B B)}$

(D) $\frac{1}{4}$

## Q.No:43 JEST-2024

The speed distribution of the molecules of an ideal gas in equilibrium at inverse temperature $\beta(= \frac{1}{k_B T})$ is found to obey the Maxwell distribution:

$$P(v) = Cv^2 \exp\left(-\frac{1}{2}\beta m v^2\right)$$

where $m$ is the mass of a molecule and $C$ is a normalization constant. Compute $\langle v^4\rangle^{1/4}$.

(A) $\sqrt{\frac{\sqrt{15}k_B T}{m}}$

(B) $\sqrt{\frac{4k_B T}{m}}$

(C) $\sqrt{\frac{3k_B T}{m}}$

(D) $\sqrt{\frac{11k_B T}{\pi m}}$

## Q.No:44 JEST-2026

Consider a system of a large even number of hard identical particles confined within a length $L$ in one dimension which is bounded by two reflecting hard boundaries. At time $t = 0$, half of these particles have velocity $+v$ and the other half have velocity $-v$ distributed randomly among them. Assuming that all collisions are elastic, which of the following statements is correct?

(A) The velocity distribution of the system remains unchanged in all future times.

(B) The velocity distribution of the system becomes the Maxwell-distribution within the time $t < L/v$.

(C) The velocity distribution of the system becomes the Maxwell-distribution at the time $t > L/v$.

(D) The velocity distribution changes later from the initial distribution but it never becomes the Maxwell-distribution.

## Q.No:45 JEST-2026

There are $N$ non-interacting magnetic moments of unit strength, fixed at certain positions in free space. The moments are subjected to a constant magnetic field

$$\vec{B} = B\hat{k}$$

and the temperature of the system is $T$. If $k_B$ is the Boltzmann constant, the Helmholtz free energy $F$ of the system is

(A) $Nk_B T\left[\ln\left(2\sinh\frac{B}{k_B T}\right) - \ln\left(\frac{B}{k_B T}\right)\right]$

(B) $-Nk_B T\left[\ln\left(2\sinh\frac{B}{k_B T}\right) + \ln\left(\frac{B}{k_B T}\right)\right]$

(C) $-Nk_B T\left[\ln\left(2\sinh\frac{B}{k_B T}\right) - \ln\left(\frac{B}{k_B T}\right)\right]$

(D) $Nk_B T\left[\ln\left(2\sinh\frac{B}{k_B T}\right) + \ln\left(\frac{B}{k_B T}\right)\right]$

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| **Question No.** | **Entrance with year** | answer |
|---|---|---|
| 1 | JEST 2012 | A |
| 2 | JEST 2012 | A |
| 3 | JEST 2012 | A |
| 4 | JEST 2013 | D |
| 5 | JEST 2014 | C |
| 6 | JEST 2014 | B |
| 7 | JEST 2015 | A |
| 8 | JEST 2015 | B |
| 9 | JEST 2015 | C |
| 10 | JEST 2016 | C |
| 11 | JEST 2016 | A |
| 12 | JEST 2016 | C |
| 13 | JEST 2016 | D |
| 14 | JEST 2017 | C |
| 15 | JEST 2017 | 250 |
| 16 | JEST 2017 | A |
| 17 | JEST 2018 | C |
| 18 | JEST 2018 | A |
| 19 | JEST 2018 | B |
| 20 | JEST 2019 | B |
| 21 | JEST 2019 | B |
| 22 | JEST 2019 | D |
| 23 | JEST 2020 | C |
| 24 | JEST 2020 | B |
| 25 | JEST 2020 | A |
| 26 | JEST 2020 | D |
| 27 | JEST 2021 | C |
| 28 | JEST 2021 | D |
| 29 | JEST 2021 | 720 |
| 30 | JEST 2017 | A |
| 31 | JEST 2022 | A |
| 32 | JEST 2022 | A |
| 33 | JEST 2022 | A |
| 34 | JEST 2022 | A |
| 35 | JEST 2022 | A |
| 36 | JEST 2022 | 0.33 |
| 37 | JEST 2022 | 6 |
| 38 | JEST 2023 | B |
| 39 | JEST 2023 | D |
| 40 | JEST 2023 | D |
| 41 | JEST 2024 | A |
| 42 | JEST 2024 | A |
| 43 | JEST 2024 | A |
| 44 | JEST 2026 | A |
| 45 | JEST 2026 | C |

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