PhysicsByAaryan

CSIR NET . GATE . JEST . BARC - Physics

Microcanonical Ensemble - CSIR NET Physics PYQs

Statistical Mechanics . All PYQs (2015-2025) with answer key

11 questions . Answer key included

www.physicsbyaaryan.com . www.csirnetphysics.com
Contact: 9501976811

Q1. [June 2015] . 3.5 marks

Statistical Mechanics > Microcanonical Ensemble

CSIR NET	2015 June	3.5 M

A system of N distinguishable particles, each of which can be in one of the two energy levels 0 and ϵ, has a total energy $n\epsilon$, where n is an integer. The entropy of the system is proportional to

1. $N \ln n$
2. $n \ln N$
3. $\ln\left(\frac{N!}{n!}\right)$
4. $\ln\left(\frac{N!}{n!(N-n)!}\right)$

Q2. [Dec 2016] . 3.5 marks

Statistical Mechanics > Microcanonical Ensemble

CSIR NET	2016 Dec	3.5M

Consider a gas of N classical particles in a two-dimensional square box of side L. If the total energy of the gas is E, the entropy (apart from an additive constant) is

1. $Nk_B \ln\left(\frac{L^2E}{N}\right)$

2. $Nk_B \ln\left(\frac{LE}{N}\right)$

3. $2Nk_B \ln\left(\frac{L\sqrt{E}}{N}\right)$

4. $L^2k_B \ln\left(\frac{E}{N}\right)$

Q3. [Dec 2017] . 3.5 marks

Statistical Mechanics > Microcanonical Ensemble

CSIR NET	2017 Dec	3.5M

The number of microstates of a gas of N particles in a volume V and of internal energy U, is given by

$$\Omega(U,V,N) = (V - Nb)^N \left(\frac{aU}{N}\right)^{3N/2}$$

(where a and b are positive constants). Its pressure P, volume V and temperature T, are related by

1. $\left(P + \frac{aN}{V}\right)(V - Nb) = Nk_BT$
2. $\left(P - \frac{aN}{V^2}\right)(V - Nb) = Nk_BT$
3. $PV = Nk_BT$
4. $P(V - Nb) = Nk_BT$

Q4. [June 2017] . 3.5 marks

Statistical Mechanics > Microcanonical Ensemble

CSIR NET	2017 June	3.5M

In a thermodynamic system in equilibrium, each molecule can exist in three possible states with probabilities $1/2, 1/3$ and $1/6$ respectively. The entropy per molecule is

1. $k_B l\, n\, 3$
2. $\frac{1}{2} k_B l\, n\, 2 + \frac{2}{3} k_B l\, n\, 3$
3. $\frac{2}{3} k_B l\, n\, 2 + \frac{1}{2} k_B l\, n\, 3$
4. $\frac{1}{2} k_B \ln 2 + \frac{1}{6} k_B \ln 3$

Q5. [Dec 2018] . 3.5 marks

Statistical Mechanics > Microcanonical Ensemble

CSIR NET	2018 Dec	3.5M

The heat capacity C_V at constant volume of a metal, as a function of temperature, is $\alpha T + \beta T^3$, where α and β are constants. The temperature dependence of the entropy at constant volume is

1. $\alpha T + \frac{1}{3}\beta T^3$
2. $\alpha T + \beta T^3$
3. $\frac{1}{2}\alpha T + \frac{1}{3}\beta T^3$
4. $\frac{1}{2}\alpha T + \frac{1}{4}\beta T^3$

Q6. [June 2020] . 5.0 marks

Statistical Mechanics > Microcanonical Ensemble

CSIR NET	2020 June	5M

For an ideal gas consisting of N distinguishable particles in a volume V, the probability of finding exactly 2 particles in a volume $\delta V \ll V$, in the limit $N, V \to \infty$, is

1. $2N\delta V/V$
2. $(N\delta V/V)^2$
3. $\frac{(N\delta V)^2}{2V^2} e^{-N\delta V/V}$
4. $\left(\frac{\delta V}{V}\right)^2 e^{-N\delta V/V}$

Q7. [June 2021] . 5.0 marks

Statistical Mechanics > Microcanonical Ensemble

CSIR NET	2021 June	5M

Balls of ten different colours labeled by $a = 1,2,\ldots,10$ are to be distributed among different coloured boxes. A ball can only go in a box of the same colour, and each box can contain at most one ball. Let n_a and N_a denote respectively, the numbers of balls and boxes of colour a. Assuming that $N_a \gg n_a \gg 1$, the total entropy (in units of the Boltzmann constant) can be best approximated by

1. $\sum_a (N_a \ln N_a + n_a \ln n_a - (N_a - n_a)\ln(N_a - n_a))$
2. $\sum_a \left(N_a \ln N_a - n_a \ln n_a + (N_a - n_a)\ln(N_a - n_a)\right)$
3. $\sum_a \left(N_a \ln N_a - n_a \ln n_a + (N_a - n_a)\ln(N_a - n_a)\right)$
4. $\sum_a \left(N_a \ln N_a + n_a \ln n_a + (N_a - n_a)\ln(N_a - n_a)\right)$

Q8. [June 2023] . 3.5 marks

Statistical Mechanics > Microcanonical Ensemble

CSIR NET	2023 June	3.5M

Two energy levels, 0 (non-degenerate) and ϵ (doubly degenerate), are available to N non-interacting distinguishable particles. If U is the total energy of the system, for large values of N the entropy of the system is $k_B\left[N\ln N-\left(N-\frac{U}{\epsilon}\right)\ln\left(N-\frac{U}{\epsilon}\right)+X\right]$. In this expression, X is

1. $-\frac{U}{\epsilon}\ln\frac{U}{2\epsilon}$
2. $-\frac{U}{\epsilon}\ln\frac{2U}{\epsilon}$
3. $-\frac{2U}{\epsilon}\ln\frac{2U}{\epsilon}$
4. $-\frac{U}{\epsilon}\ln\frac{U}{\epsilon}$

Q9. [Dec 2024] . 3.5 marks

Statistical Mechanics > Microcanonical Ensemble

CSIR NET	2024 Dec	3.5M

An isolated box of volume V contains 5 identical, but distinguishable and noninteracting particles. The particles can either be in the ground state of zero energy or in an excited state of energy ε. The ground state is non-degenerate while the excited state is doubly degenerate. There is no restriction on the number of particles that can be put in a given state. The number of accessible microstates corresponding to the macrostate of the system with energy $E = 2\varepsilon$ are

1. 10
2. 20
3. 40
4. 30

Q10. [June 2024] . 3.5 marks

Statistical Mechanics > Microcanonical Ensemble

CSIR NET	2024 June	3.5M

Two non-interacting classical particles having masses m_1 and m_2 are moving in a one-dimensional box of length L. For total energy not exceeding a given value E, the phase space "volume" is given by

1. $\pi L^2 E\left(\frac{m_1 m_2}{m_1+m_2}\right)$
2. $\pi L^2 E\sqrt{m_1 m_2}$
3. $2\pi L^2 E\left(\frac{m_1 m_2}{m_1+m_2}\right)$
4. $2\pi L^2 E\sqrt{m_1 m_2}$

Q11. [June 2025] . 3.5 marks

Statistical Mechanics > Microcanonical Ensemble

CSIR NET	2025 June	3.5M	Stat. Mech.

The internal energy of a system is given by

$U = g(N)V^{-\frac{2}{3}}\exp\left[\frac{2S}{3NR}\right]$, where V is the volume, S is the entropy, N is the number of molecules and R is a constant. The function $g(N)$ is proportional to

1. $N^{5/3}$
2. $N^{1/3}$
3. $N^{2/3}$
4. N

Answer Key

11 questions . Subject and topic for quick revision

Q. No	Subject	Topic	Answer
Q1	Statistical Mechanics	Microcanonical Ensemble	**4**
Q2	Statistical Mechanics	Microcanonical Ensemble	**3**
Q3	Statistical Mechanics	Microcanonical Ensemble	**4**
Q4	Statistical Mechanics	Microcanonical Ensemble	**3**
Q5	Statistical Mechanics	Microcanonical Ensemble	**1**
Q6	Statistical Mechanics	Microcanonical Ensemble	**3**
Q7	Statistical Mechanics	Microcanonical Ensemble	**2**
Q8	Statistical Mechanics	Microcanonical Ensemble	**1**
Q9	Statistical Mechanics	Microcanonical Ensemble	**3**
Q10	Statistical Mechanics	Microcanonical Ensemble	**4**
Q11	Statistical Mechanics	Microcanonical Ensemble	**1**

Study with PhysicsByAaryan

Full CSIR NET / GATE / JEST / BARC Physics live batch by Aaryan Mehra Sir.
Concept-first teaching, complete PYQ coverage, daily doubt support.

Use coupon CONSISTENCY for Rs. 500 off

Visit
www.physicsbyaaryan.com
www.csirnetphysics.com

Contact
9501976811