Name: **Enrolment No:**	UPES UNIVERSITY OF TOMORROW

UPES

End Semester Examination, May 2023

Course: Statistical Physics **Semester: IV**

Program: BSc. (H) Physics & Int. BSc. MSc. Physics **Time : 03 hrs.**

Course Code: PHYS 2028 **Max. Marks: 100**

Instructions:

1. **All questions are compulsory.**
2. **Questions 9 and 10 have internal choices.**
3. **Write your answers clearly and legibly.**
4. **All numerical problems must be solved using appropriate formulae and units.**

SECTION A

(5Qx4M=20Marks)

S. No.		Marks	CO
Q 1	Define phase space. What will be the phase trajectory of a stone under free fall?	**4**	**CO1**
Q 2	What is the difference between the Fermi-Dirac and Bose-Einstein distribution functions?	**4**	**CO1**
Q 3	Show that the radiation enclosed in a thermally insulated enclosure is independent of the nature and shape of the walls of enclosure.	**4**	**CO2**
Q 4	Assume that each face of a six-faced dice is equally likely to land uppermost. Consider a game that involves tossing 5 such dice. Determine the probability that number 2 appears uppermost (i) in one dice, (ii) in exactly two dice.	**4**	**CO2**
Q 5	Deduce the number of quantum states available to an electron moving in one dimension confined within 10 Å, when its speed does not exceed 10^7 m/s.	**4**	**CO3**

SECTION B

(4Qx10M= 40 Marks)

Q 6	Define the following terms: (a) Microstates (b) Macrostates (c) Ensemble (d) Partition Function (e) Entropy	**10**	**CO1**

<table>
<tr><td>Q 7</td><td>Find the expression for the entropy of mixing of two ideal monoatomic gases separated by a diathermic wall. What is Gibbs' paradox and how was it removed?</td><td>10</td><td>CO2</td></tr>
<tr><td>Q 8</td><td>Deduce Wein's law for energy distribution in Black Body radiation.</td><td>10</td><td>CO2</td></tr>
<tr><td>Q 9</td><td>Discuss whether the classical treatment would be valid for He gas at
(i) NTP (T=273 K and P= 1 atm),
(ii) at 3 K and atmospheric pressure.

(take V/N = 10^{-20} cm^3 for He gas and V/N= $5x10^{-23}$ cm^3 for liquid He)

OR

The following observations have been noted for a blackbody spectrum taken at 500 K. What will be the corresponding set of values at 1000K?

<table><tr><th>λ</th><th>E_λ</th></tr><tr><td>10μ</td><td>10 units</td></tr><tr><td>8μ</td><td>14 units</td></tr><tr><td>6μ</td><td>16 units</td></tr><tr><td>4μ</td><td>12 units</td></tr></table></td><td>10</td><td>CO3</td></tr>
<tr><td colspan="4" align="center">SECTION-C
(2Qx20M=40 Marks)</td></tr>
<tr><td>Q 10</td><td>What is the deference between a strongly degenerate FD gas and a strongly degenerate BE gas? Derive the conditions for Bose-Einstein condensation and discuss the properties of liquid helium.
OR
Show the difference between a completely degenerate and a strongly degenerate Fermi gas using the plot of occupation number versus energy curve at 0K and at any other temperature T. Deduce the expression for specific heat for a strongly degenerate FD gas and show that it varies linearly with temperature.</td><td>20</td><td>CO2</td></tr>
<tr><td>Q 11</td><td>Consider a paramagnetic substance having N magnetic atoms having spin 1/2 and intrinsic magnetic moment μ per unit volume placed in an external magnetic field B. Calculate the probabilities that in thermal equilibrium at a temperature T an atom points parallel (P_+) and antiparallel (P_-) to the direction of the magnetic field. What happens if (a) B is very high and T is very small and (b) if B is small and T is high? Also evaluate the average magnetic moment of such an atom and hence obtain an expression for the average value of intensity of magnetization as a function of T.</td><td>20</td><td>CO4</td></tr>
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