


Name:			
Enrolment No:			
<b>UPES</b> <b>End Semester Examination, May 2023</b>			
<b>Course: Statistical Physics</b> <b>Program: BSc. (H) Physics &amp; Int. BSc. MSc. Physics</b> <b>Course Code: PHYS 2028</b>		<b>Semester: IV</b> <b>Time : 03 hrs.</b> <b>Max. Marks: 100</b>	
<b>Instructions:</b> <ol style="list-style-type: none"> <li>All questions are compulsory.</li> <li>Questions 9 and 10 have internal choices.</li> <li>Write your answers clearly and legibly.</li> <li>All numerical problems must be solved using appropriate formulae and units.</li> </ol>			
<b>SECTION A</b> <b>(5Qx4M=20Marks)</b>			
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 $10 \text{ \AA}$ , when its speed does not exceed $10^7 \text{ m/s}$ .	4	CO3
<b>SECTION B</b> <b>(4Qx10M= 40 Marks)</b>			
Q 6	Define the following terms: <ol style="list-style-type: none"> <li>Microstates</li> <li>Macrostates</li> <li>Ensemble</li> <li>Partition Function</li> <li>Entropy</li> </ol>	10	CO1

Q 7	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?	10	CO2										
Q 8	Deduce Wein's law for energy distribution in Black Body radiation.	10	CO2										
Q 9	<p>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.</p> <p>(take <math>V/N = 10^{-20} \text{ cm}^3</math> for He gas and <math>V/N = 5 \times 10^{-23} \text{ cm}^3</math> for liquid He)</p> <p style="text-align: center;">OR</p> <p>The following observations have been noted for a blackbody spectrum taken at 500 K. What will be the corresponding set of values at 1000K?</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th><math>\lambda</math></th> <th><math>E_\lambda</math></th> </tr> </thead> <tbody> <tr> <td>10<math>\mu</math></td> <td>10 units</td> </tr> <tr> <td>8<math>\mu</math></td> <td>14 units</td> </tr> <tr> <td>6<math>\mu</math></td> <td>16 units</td> </tr> <tr> <td>4<math>\mu</math></td> <td>12 units</td> </tr> </tbody> </table>	$\lambda$	$E_\lambda$	10 $\mu$	10 units	8 $\mu$	14 units	6 $\mu$	16 units	4 $\mu$	12 units	10	CO3
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<b>SECTION-C</b> <b>(2Qx20M=40 Marks)</b>													
Q 10	<p>What is the difference 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.</p> <p style="text-align: center;">OR</p> <p>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.</p>	20	CO2										
Q 11	<p>Consider a paramagnetic substance having N magnetic atoms having spin 1/2 and intrinsic magnetic moment <math>\mu</math> 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 (<math>P_+</math>) and antiparallel (<math>P_-</math>) 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.</p>	20	CO4										