MANIPAL ACADEMY of HIGHER EDUCATION
(Institution of Eminence Deemed to be University)

Reg.No.									

DEPARTMENT OF SCIENCES, M.Sc (PHYSICS)

FOURTH SEMESTER M.Sc (PHYSICS) END SEMESTER EXAMINATION, APRIL 2023

SUB: STATISTICAL MECHANICS (PHY- 6201)

(REVISED CREDIT SYSTEM)

TIME: 3 HRS. **DATE: 24-04-2023 (9-12 PM)** **MAX. MARKS: 50**

NOTE: ANSWER ALL QUESTIONS

		Marks	CO	BL
1A	Obtain an expression for entropy change between the final state and the initial state of an ideal gas in terms of its (a) temperature and volume, (b) temperature and pressure (c) pressure and volume.	5	1	1, 2
1B	Explain Nernst's heat theorem and its consequence.	5	2	2
2A	For a vander Waals gas prove that $C_P - C_V \cong R\left(1 + \frac{2a}{VRT}\right)$ using $C_P - C_V = T\left(\frac{\partial P}{\partial T}\right)_V \left(\frac{\partial V}{\partial T}\right)_P$ C_p, C_v- specific heats at constant pressure & volume respectively. R- universal gas constant, T- Temperature, a, b- Vander Waal's correction factors	5	3	2
2B	What is Joule's Thomson effect? Derive $dT = \frac{V}{C_p}[T\alpha - 1]\,dp$ Where V- volume, T- temperature, C_p- specific heat at constant pressure, α - coefficient of expansion of gas	1+4= 5	2	1
3A	Derive Boltzmann relation and show that $\beta_1 = \beta_2$ for equilibrium of two systems in thermal contact. Show that the results of statistical approach are essentially equivalent to those of the conventional thermodynamic approach.	4+1=5	3	2

3B	(i) What is Thermodynamic probability? (ii) What is the total number of ways in which 20 bosons can be arranged in 20 elementary phase cells? (ii) List out the differences between Classical statistics and Quantum statistics	2+1+2=5	4	2
4A	Show that the particle distribution of an ideal gas in equilibrium using Maxwell-Boltzmann statistics is: $$f_{MD}(\varepsilon_i) = n_i = \frac{1}{e^{[(\varepsilon_i - \mu)/k_B T]}}$$ k_B- Boltzmann constant, T-temperature, μ- chemical potential of the gas	5	4	1, 3
4B	Show that entropy of a perfect gas in microcanonical ensemble is: $$S = Nk_B \left\{ \ln \left[\left(\frac{V}{N}\right) \left[\frac{2\pi m k_B T}{h^2}\right]^{3/2} \right] + \frac{5}{2} \right.$$ Where V- volume, N- number of particles, m-mass of the particle, k_B - Boltzmann constant, T- temperature	5	5	3
5A	What is the common approach in M-B, B-E, and F-D statistics? explain. Derive Planck's law for black body radiation of photon gas using Bose-Einstein statistics.	2 + 3= 5	5	2
5B	The number density of gold atoms is 5.9 x 10^{28} atoms m^{-3}. Each atom contributes one free electron for conduction. Obtain the Fermi temperature and examine whether the electron gas is strongly degenerate at room temperature.	4+1=5	4	2

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