BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

CLASS: IMSc **SEMESTER :IV**
BRANCH: PHYSICS **SESSION : SP/2025**

SUBJECT: PH201R1 THERMAL PHYSICS

TIME:3 Hours **FULL MARKS: 50**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
***4*. Before attempting the question paper, be sure that you have got the correct question paper.**
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

			CO	BL
Q.1(a)	The heat absorbed or conducted, ΔQ is either expressed in terms of change in Enthalpy ΔH, or in terms of product of temperature and change in Entropy, that is, $T\Delta S$. Evaluate the differences in just a few lines.	[5]	1	V
Q.1(b)	An ideal gas undergoes the following reversible cycle: (i) an isobaric expansion from the state (*P*1,*V*1) to the state (*P*1,*V*2) (ii) an isochoric reduction in pressure to the state (*P*2,*V*2) (iii) an isobaric reduction in volume to the state (*P*2,*V*1) (iv) an isochoric increase in pressure back to the original state (*P*1,*V*1) What work is done on the gas in this cycle? If P_1 = 3.0 atm, P_2 = 1.0 atm, V_1 = 1.0 L and V_2 = 2.0 L, how much work is done on the gas in traversing the cycle 100 times?	[5]	1	III
Q.2(a)	Consider a substance held under a pressure *P* and at a temperature T. Show that $$\left(\frac{\partial(\text{heat emitted})}{\partial P}\right)_T = T\left(\frac{\partial V}{\partial T}\right)_P$$ Hint: Utilize one of the Maxwell's thermodynamic relations.	[5]	2	II
Q.2(b)	The Helmholtz function of one mole of a certain gas is defined as $$f = f(V,T) = -\frac{a}{V} - RTln(V-b) + j(T)$$ Where a and b are constants j is a function of T only. Deduce the expression for the number of microstates.	[5]	2	III
Q.3(a)	Write the names of the two important thermodynamic variables that play a key role in describing the first- and second-order phase changes. Why we needed to investigate the Ehrenfest equation despite Clausius-Clapeyron Equation? Investigate the changes in Entropy s and Volume v in the Ehrenfest equation.	[5]	3	V
Q.3(b)	A paramagnetic salt is magnetized isothermally and reversibly from zero applied magnetic field to a final value of B_0. It obeys the Curie law $\chi_m = C/T$. Show that the heat of magnetization is $$Q = -\frac{CV}{2\mu_0}\frac{B_0^2}{2}$$ where V is the volume of the salt. Hint: Express$S = S(T, B_0)$.	[5]	3	III
Q.4(a)	Considering nitrogen gas in atmosphere as an ideal gas, find the most probable speed and average kinetic energy of nitrogen molecules at $300\,\text{K}$. Take mass of single nitrogen molecule as $4.65 \times 10^{-26}\,\text{kg}$.	[5]	4	III
Q.4(b)	Using kinetic theory of gases, obtain the relation between pressure and *rms* speed of an ideal gas.	[5]	4	III
Q.5(a)	Write the equation of state for a van der Waals gas. Sketch its isotherms at different temperatures and identify the critical isotherm. Explain the significance of the critical isotherm.	[5]	5	IV
Q.5(b)	Find the temperature T_C, pressure p_C and volume V_C at the critical point of a van der Waals gas.	[5]	5	III

::::::25/04/2025::::::M