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

UPES

End Semester Examination, May 2024

Course : THERMAL PHYSICS **Semester : II**

Program : BSc PHYSICS (H) **Time : 03 hrs.**

Course Code: PHYS1033 **Max. Marks: 100**

Instructions:

- **All questions are compulsory (Q9 and Q11 have an internal choice). Use of scientific calculator is allowed.**

SECTION A

(5Qx4M=20Marks)

S. No.		Marks	CO
Q 1	A quantity of dry air at 30 ^{o}C is compressed suddenly to 1/4 of its volume. Find the change in temperature assuming γ to be 1.4 for dry air.	**4**	**CO1**
Q 2	Explain "Thermodynamical Scale of Temperature".	**4**	**CO1**
Q 3	Show that the slope of adiabatic curve through a point in a PV graph is γ times the slope of the isothermal curve through the same point.	**4**	**CO1**
Q 4	What is Clausius inequality and give its physical interpretation.	**4**	**CO2**
Q 5	Explain "enthalpy". Show that for an isobaric process where, the symbols have their usual meanings: $$C_p = \left(\frac{\partial h}{\partial T}\right)_P \quad \text{and} \quad h_f - h_i = H$$	**4**	**CO2**

SECTION B

(4Qx10M= 40 Marks)

Q 6	Efficiency of a Carnot's cycle changes from 1/7 to 1/4 when source temperature is raised by 200 K. Calculate the temperature of the sink.	**10**	**CO1**

Q 7	Explain second order phase transition and hence obtain the Ehrenfest's relations (the symbols have their usual meanings): $$\frac{dP}{dT} = \frac{\alpha_2 - \alpha_1}{K_2 - K_1}$$ $$\frac{dP}{dT} = \frac{CP_2 - CP_1}{VT(\alpha_2 - \alpha_1)}$$	**10**	**CO2**
Q 8	Derive the four Maxwell's thermodynamical relations.	**10**	**CO3**
Q 9	Explain the porous-plug experiment for the production of low temperatures. Show that enthalpy remains constant and find the general expression of the Joule Thomson coefficient. **OR** Illustrate and elucidate the five isotherms observed in Andrew's experiment on a PV diagram corresponding to temperatures of 13.1°C, 21.5°C, 31.1°C, 35.5°C, and 48.1°C. Additionally, mark and explain the "border curve" and the "critical point" on the same plot.	**10**	**CO4**
SECTION-C **(2Qx20M=40 Marks)**			
Q 10	(a) Using Maxwell's thermodynamical relations show that (the symbols have their usual meanings): $$C_p = C_v + T\left(\frac{\partial P}{\partial T}\right)_V \left(\frac{\partial V}{\partial T}\right)_P$$ (b) And hence show that for a Van der Waal gas: $$C_p - C_v = R\left[1 + \frac{2a}{VRT}\right]$$	**20 (10+10)**	**CO3**
Q 11	(a) Describe the setup and operation of the Zartman and Ko experiment used to confirm Maxwell's Boltzmann distribution law for molecular velocities. (b) For a gas molecule at 35 ^{o}C temperature and three atmospheric pressure, determine the mean free path. You are given that the molecular diameter of the gas is 5 x 10^{-8} cm, 1 atmospheric pressure		**CO4**

	= 101325 N/m^2 and Boltzmann constant = 1.38 x 10^{-23} Joules per Kelvin. **OR** (a) Derive an expression for the coefficient of viscosity utilizing the mean free path expression $\left(\lambda = \frac{1}{\sqrt{2}\pi\sigma^2 n}\right)$. (b) You are given that for a gas the critical temperature and pressure of are 40 ^{o}C and 80 atmospheres, respectively. Assuming that the gas obeys Van der Waal's equation determine the critical volume and radius of the gas molecules (given: R = 82.07 cm^3 Atm K^{-1}, Avogadro's number = 6.022 x 10^{23} $mole^{-1}$ and gram molecular volume = 22400 cm^3).	**20** **(10+10)**	