Name: **Enrolment No:**	UPES UNIVERSITY WITH A PURPOSE

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, December 2019

Course: Thermal Physics **Semester: III**
Program: B.Sc. Physics (H) **Time 03 hrs.**
Course Code: PHYS 2002 **Max. Marks: 100**

Instructions: 1. All sections are compulsory.
2. Your answer should be concise and to the point.
3. Values of constants are given at the end of the paper.

SECTION A (All questions are compulsory)

S. No.		**Marks**	**CO**
Q 1	Illustrate an expression for the work done in a quasi-static Adiabatic Process for an ideal gas.	**4**	**CO1**
Q 2	Derive the Energy Equation: $$\left(\frac{\partial U}{\partial V}\right)_T = T\left(\frac{\partial P}{\partial T}\right)_V - P$$	**4**	**CO3**
Q 3	Using Law of Equipartion of Energy, show that the values of $\gamma = \frac{C_P}{C_V}$ for monoatomic and diatomic gases are 1.66 and 1.44 respectively.	**4**	**CO4**
Q 4	Evaluate the value of temperature at which the root mean square velocity of a gas becomes half of its velocity at 0°C by keeping its pressure constant.	**4**	**CO4**
Q 5	Show graphically the variation of Temperature with Entropy for Carnot Cycle.	**4**	**CO2**

SECTION B (All questions are compulsory. Q6 has internal choice.)

Q 6	Explain transport phenomena. Derive an expression for coefficient of thermal conductivity of gases based on kinetic theory of gases.	**10**	**CO4**
	OR		
	a. Explain the term "critical temperature" of a gas. Discuss the results obtained by Andrew's in his experiment on Carbon Dioxide.	**6**	**CO4**
	b. The coefficient of viscosity of gas is 16.6 X 10^{-6} Ns/m^2, the density of gas is 1.24 kg/m^3 and the average speed of molecules of gas is 4.5 X 10^2 m/s. Calculate mean free path of the gas molecule.	**4**	**CO4**

Q 7	Using Maxwell's thermodynamic potentials, derive the four Maxwell's thermodynamic relations.	**10**	**CO3**
Q 8	The equation of state of a gas is $(P + b)V = RT$, and the internal energy is given by $U = aT + bT + U_0$, where a, b and U_0 are constants. Calculate a. C_V and $C_P - C_V$ b. Show that for the above gas the adiabatic relation is $TV^{R/C_V} = constant.$	**10**	**CO1**
Q 9	a. Show that entropy always increases for an irreversible process. b. Using Clausis-Clapeyron Heat equation, explain the effect of change of pressure on boiling point of liquid and melting point of solid. Hence, explain why cooking (boiling eggs, boiling potatoes etc.) takes longer time at higher altitudes.	**4** **6**	**CO2** **CO2**
SECTION-C (All questions are compulsory. Q11 has internal choice.)			
Q 10	a. Explain Joule Thompson Effect. Evaluate an expression for Joule-Thompson coefficient for real gas. Illustrate the value of Temperature of Inversion for real gas in terms of Vander Waal constants 'a' and 'b'. Discuss the Joule – Thompson effect in terms of deviation from Boyle's Law and Joule's Law. b. Using Maxwell Relations, show that: $$C_P - C_V = \frac{TV\alpha^2}{\beta_T}$$ where, α is volume expansivity and β_T is Isothermal compressibility.	**15** **5**	**CO3** **CO3**
Q 11	a. Using Maxwell's law of distribution of speed, derive the expression for: i) Average speed ii) Most probable speed iii) Root mean square speed b. Derive an expression for coefficient of thermal conductivity of gases based on the kinetic theory. c. Define mean free path. Obtain the relation, $$\lambda = \frac{1}{\pi d^2 n}$$ where symbols have their usual meaning. **OR** a. Using Vander's Waal equation of state, estimate the expression for critical temperature (T_C), critical pressure (P_C) and critical volume (V_C) in terms of	**10** **5** **5** **10**	**CO4** **CO4** **CO4** **CO4**

	Vander Waal's constants 'a' and 'b'. Hence, prove that for real gases, $\frac{RT_C}{P_C V_C} = \frac{8}{3}$, where R is universal gas constant.	5	CO4
	b. Illustrate the Viral equation from the Vander Waal's equation of a gas.	5	CO4
	c. Express the Vander Waal's equation in terms of reduced parameters P_R, T_R and V_R.		

Value of constants:

1. Boltzmann Constant: K_B =1.38 X 10^{-23} J K^{-1}.
2. Universal gas constant: R = 8.31 J mol^{-1} K^{-1}.