B.Sc. Semester III (Honours) Examination, 2021 (CBCS)

Subject: Physics

Paper: CC-VI

Time: 2 Hours **Full Marks: 40**

The questions are of equal value. Candidates are required to give their answers in their own words as far as practicable.

Answer any **eight** of the following questions: 5 x 8 = 40

1. a) State the Zeroth law of thermodynamics and discuss its importance?

b) What is Coefficient of Performance (COP) of a refrigerator? Why COP of an ideal refrigerator will be higher in winter than in summer?

2. a) What is free expansion? Show that for an ideal gas, internal energy depends only on temperature and is independent of pressure and volume.

b) One mole of an ideal gas expands from volume V_o to $2V_o$ under Joule expansion. What is the change of entropy in the gas, the surroundings, and the Universe during this Joule expansion?

3. a) What is the change in internal energy due to adiabatic expansion of an ideal gas from (P_1, V_1) to (P_2, V_2) ?

(b) What is adiabatic lapse rate? Graphically represent how the temperature of the atmosphere vary with height above sea level, considering atmosphere as an ideal gas system?

4. a) Explain why an adiabatic process need not be isentropic always.

b) A system has heat capacity $C = \alpha T^2$ J/K with temperature 200 K, where α is a constant. Find out the change in entropy of the system when it is cooled down to the temperature of the thermal reservoir which is at 100 K.

5. a) Establish the condition of equilibrium of a closed composite system consisting with two simple systems separated by a movable diathermic wall that is impervious to the flow of matter.

b) Write down any two important differences between the first and the second order phase transition.

6. a) What do you mean by inversion line and inversion point in case of Joule-Thomson effect?

b) State Nernst's heat theorem and establish the equivalence of this theorem with the unattainability of absolute zero.

7. a) Show that, $C_P = T\left(\frac{\partial V}{\partial T}\right)_P \left(\frac{\partial P}{\partial T}\right)_S$ and $C_V = -T\left(\frac{\partial P}{\partial T}\right)_V \left(\frac{\partial V}{\partial T}\right)_S$.

b) Prove that heat is generated under compression for a substance which expands on heating and cooling takes place for a substance which contracts on heating.

8. a) What do you mean by Doppler broadening of spectral lines?

b) Show that the root mean square value of a Cartesian component of molecular velocity v_x is equal to $\sqrt{\frac{P}{\rho}}$, where P is the pressure and ρ the density of the gas.

9. a) Show that mean free path of an ideal gas is directly proportional to the absolute temperature of the gas and inversely proportional to its pressure.

b) What are the different degrees of freedom of a linear tri-atomic molecule? Are all these degrees of freedom excited simultaneously? Justify your answer.

10. a) Derive reduced equation of state from Vander Waal's equation and state its significance.

b) Transportation of which quantity in a gas gives rise to the phenomenon of thermal conductivity? Why hydrogen gas has larger thermal conductivity compared to any other gas at any given temperature?