This question paper contains 4 printed pages.]

Your Roll No. .....

1220

B.Sc. (Hons.) / II **A**

PHYSICS – PAPER X

(Thermal Physics)

Time : 3 Hours **Maximum Marks : 38**

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt **five** questions in all.

Question No. 1 is compulsory.

Attempt **one** question from each Section.

1. Attempt any **two** of the following : $3 \times 2 = 6$

   (a) Define four thermodynamic potentials. Why are they called as potentials ?

   (b) Distinguish between first and second order phase transition, giving one example of each.

(c) A reversible engine converts one-third of heat input to work. When the temperature of the sink is reduced by 100 °C, it is able to convert one-half of heat input to work. Find the temperatures of source and sink.

(d) Show that the enthalpy remains constant during Joule-Thomson expansion.

SECTION – A

2. (a) Derive Maxwell-Boltzmann distribution law for velocities of particles of a gas. 6

(b) Describe briefly any one method to verify the above law experimentally. 2

3. (a) What are transport phenomena ? 2

(b) Derive an expression for coefficient of thermal conductivity of a gas on the basis of kinetic theory. 6

SECTION – B

4. (a) What do you mean by critical temperature of a gas ? Obtain an expression for the critical constants of a van der Waal's gas and show that $\frac{RT_c}{P_cV_c}$ is the same for all gases. 5

(b) Obtain the three adiabatic equations for an ideal gas. 3

5. (a) Derive an expression for Joule-Thomson coefficients for an ideal gas and a real gas. 4

(b) Explain which of the following processes can be thermodynamically reversible : 2

(i) Isothermal evaporation of water at constant pressure.

(ii) Heating of water from 0 °C to 100 °C from a constant temperature source.

(c) 1 gm molecule of a perfect gas expands isothermally to four times its initial volume. Assuming total conversion of heat into work, calculate the change in its entropy. Given R = 8.314 J/mole K. 2

SECTION – C

6. (a) Prove the equivalence of Kelvin-Planck and Clausius statements of second law of thermodynamics. 4

(b) What do you mean by entropy ? Show that for any thermodynamic process, the entropy either remains constant or increases. 4

7. (a) State and prove Carnot theorem. 4

(b) It is claimed that an engine working on new heat engine cycle between temperatures 1400 °C and 30 °C receives 4.2 kJ/s of heat and develops a power of 3.675 kW. 4

(i) Show that it is not possible.

(ii) What change in condition(s) would validate the claim ?

SECTION – D

8. (a) Using first and second laws of thermodynamics, derive Maxwell's four thermodynamic relations. 5

   (b) Using Maxwell's relation, show that the ratio of isentropic to isochoric pressure coefficient of expansion is $\frac{\gamma}{\gamma - 1}$. 3

9. (a) Derive an expression for work done by a magnetic system. 3

   (b) Describe the principle and experiment related to production of low temperature by adiabatic demagnetization. 5
