[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 1708 **C**

Unique Paper Code : 42224303

Name of the Paper : Thermal Physics and Statistical Mechanics

Name of the Course : **B.Sc. Prog. – CBCS_Core**

Semester : III

Duration : 3 Hours Maximum Marks : 75

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Question no. **1** is compulsory.
3. Attempt any **five** questions in all.
4. Use of non-programmable scientific calculator is allowed.

1. Attempt any **five** of the following : (5×3)

   (a) Define the concept of temperature and the law that defines it.

P.T.O.

(b) Calculate average energy of Planck's oscillator vibrating with frequency 1.5×10^{14} Hz at temperature 1800K.

(c) Find expression for work gone during adiabatic process.

(d) Find the atomicity of a monoatomic gas using law of equipartition of energy.

(e) Draw T-S diagram of Carnot cycle. What is its advantage?

(f) Define thermodynamic probability of a thermal system.

(g) The radius of argon atoms is 0.128nm. Calculate their mean free path at 25°C and one atmospheric pressure. Given $k_B = 1.38 \times 10^{-23} JK^{-1}$.

2. (a) Describe the porous plug experiment and obtain the expression for Joule Thompson change in temperature. Why do hydrogen and Helium exhibit rise in temperature during the throttling process?

(b) Calculate the change in temperature when helium is made to undergo Joule-Thomson expansion at −173°C and the pressure difference across the

plug is 20 atm. Given R = $8.3 JK^{-1}mol^{-1}$, a = $3.41 \times 10^{-3} Nm^4mol^{-2}$, b = $23.7 \times 10^{-6} m^3mol^{-1}$ and $C_p = 2.5R$. Take 1 atm = $10^5 Nm^{-2}$. (10,5)

3. (a) State the second law of thermodynamics and explain its physical significance. Prove that the Kelvin Planck and Clausius statements are equivalent.

(b) State and prove Carnot theorem.

(c) Explain the concept of Thermodynamic scale of temperature (6,6,3)

4. (a) Derive the Claussius Clayperon equation for change of state. Discuss effect of pressure on boiling point and melting point.

(b) What are TdS equations? Derive the two TdS equations. (6,9)

5. (a) Define thermodynamic potentials and explain their physical significance.

(b) Using appropriate Maxwell's thermodynamic relations, prove

Cp--Cv = T(dp/dT)v(dV/dT)p (9,6)

P.T.O.

6. (a) What are transport phenomena? Deduce expression for coefficient of thermal conductivity K and coefficient of viscosity η of gas on basis of kinetic theory.

(b) Establish relation between K and η. (10,5)

7. (a) Give the salient features of Blackbody radiation. What was Planck hypothesis to explain the blackbody radiation?

(b) Derive an expression for mean energy of a resonator using the Planck's hypothesis. (6,9)

8. (a) Distinguish between classical and quantum statistics.

(b) Derive Fermi-Dirac distribution law for a system of ideal gas containing n molecules.

(c) Show that Fermions have tendency to occupy higher energy states than bosons. (3,9,3)