

6. (a) What are transport phenomena? Deduce expression for coefficient of thermal conductivity  $K$  and coefficient of viscosity  $\eta$  of gas on basis of kinetic theory.
- (b) Establish relation between  $K$  and  $\eta$ . (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)

(3000)

[This question paper contains 4 printed pages.]

23 DEC 2022

Your Roll No. ....

Sr. No. of Question Paper : 1708

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.
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1. Attempt any five of the following : (5×3)
    - (a) Define the concept of temperature and the law that defines it.

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- (b) Calculate average energy of Planck's oscillator vibrating with frequency  $1.5 \times 10^{14}$  Hz at temperature 1800K.
- (c) Find expression for work done 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  $k_B = 1.38 \times 10^{-23} \text{ JK}^{-1}$ .
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  $-173^\circ\text{C}$  and the pressure difference across the

plug is 20 atm. Given  $R = 8.3 \text{ JK}^{-1} \text{ mol}^{-1}$ ,  $a = 3.41 \times 10^{-3} \text{ Nm}^4 \text{ mol}^{-2}$ ,  $b = 23.7 \times 10^{-6} \text{ m}^3 \text{ mol}^{-1}$  and  $C_p = 2.5R$ . Take  $1 \text{ atm} = 10^5 \text{ Nm}^{-2}$ . (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 Clausius 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
- $$C_p - C_v = T \left( \frac{dp}{dT} \right)^2 \left( \frac{dV}{dT} \right)_p \quad (9,6)$$