

04
[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 7336

J

Unique Paper Code : 42224303

Name of the Paper : Thermal Physics & Statistical Mechanics

Name of the Course : B.Sc. Prog.

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. Q. 1 is compulsory.
3. Attempt **five** questions in all.
4. All questions carry equal marks.

1. Attempt any **five**.

(a) Using third law of thermodynamics explain why it is not possible to attain absolute zero.

(b) Distinguish between reversible and irreversible processes.

P.T.O.

- (c) Calculate mean free path of a gas molecule whose diameter is 3 \AA and number of molecules/cc 3×10^{19} .
- (d) What is the wavelength at maximum intensity of radiation emitted by a body maintained at temperature 3000°C . Given Wien's constant $2.898 \times 10^{-3} \text{ m K}$.
- (e) Describe all the possible microstates for a system obeying B-E statistics and having two particles and two quantum states.
- (f) Establish the T-dS equation

$$T dS = C_v dT + T \left(\frac{\partial P}{\partial T} \right)_V dV$$

- (g) Using Clausius-Clapeyron equation discuss the effect of pressure on boiling point of a liquid. (5×3)

2. (a) Show that the work done in a Carnot cycle is the area enclosed by the two isotherms and two adiabatics in P-V diagram and hence derive the expression for efficiency.
- (b) A Carnot engine has an efficiency of 50% when the temperature of the sink is 27°C . Calculate the temperature of the source so that the efficiency becomes 60%. (10,5)

3. (a) State first law of thermodynamics. What is its physical significance and discuss its limitations?
- (b) One mole of an ideal gas ($\gamma = 1.4$) initially kept at 17°C is adiabatically compressed so that its pressure becomes 10 times its original value. Calculate
- (i) its temperature after compression
 - (ii) work done on the gas.
- (c) Calculate the change in entropy of a perfect gas in terms of temperature and pressure. (5,5,5)
4. (a) Using thermodynamic potentials derive Maxwell's four thermodynamical relations.
- (b) Using appropriate Maxwell's relations prove

$$C_p - C_v = T \left(\frac{\partial P}{\partial T} \right)_V \left(\frac{\partial V}{\partial T} \right)_P$$

and hence show that for an ideal gas $C_p - C_v = R$.
(10,5)

5. (a) What is transport phenomenon? Derive the expression for coefficient of viscosity of a gas using Kinetic Theory.

P.T.O.

- (b) Explain the porous plug experiment and discuss its results. Prove that enthalpy remains constant in Joule-Thomson expansion. (9,6)
6. (a) Starting from the Maxwell's law of velocity distribution obtain expressions for root mean square velocity, average velocity and most probable velocity.
- (b) Calculate the root mean square velocity of hydrogen molecule at 27°C . Given mass of hydrogen molecule = $3.34 \times 10^{-27}\text{Kg}$ and $k = 1.38 \times 10^{-23}\text{J}/^{\circ}\text{K}$.
- (c) State the law of equipartition of energy and hence determine the ratio of specific heat capacities (γ) for a monoatomic and diatomic gas. (6,3,6)
7. (a) Explain the spectral distribution of radiation emitted by a black body and its variation with temperature.
- (b) Derive Planck's law of black body radiation and hence derive Rayleigh-Jean's law and Wien's law. (3,12)
8. (a) Differentiate between MB, BE and FD statistics.
- (b) Derive Maxwell-Boltzmann distribution law for an ideal gas having N particles and energy E . (5,10)
- (3300)