

SEAT No. _____

[73]

SARDAR PATEL UNIVERSITY
Fifth Semester B. Sc. Examination

7th October - 2025

Time: From 10:00 am to 1:00 pm

Subject: PHYSICS [US05CPHY 123]

Title: Thermodynamics and Statistical Mechanics



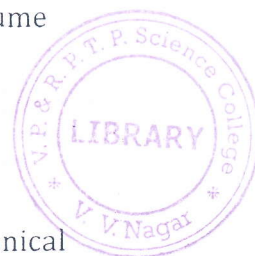
Total Marks [70]

Instruction: (1) Attempt all questions (2) The symbols have their usual meaning (3) Figure to the right indicates full marks.

Q-1 Write correct answer for each of the following MCQs

[10]

- 1 If system changes from one state to another state at constant pressure (P) then it's called an ____ process.
 (a) adiabatic (b) isobaric (c) isothermal (d) isochoric
- 2 An isentropic process on a T-S diagram is obviously a ____.
 (a) circle (b) ellipse (c) vertical line (d) rectangle
- 3 In second order phase transition process, there is _____.
 (a) no change in entropy and volume (b) change in entropy and volume
 (c) change in entropy but not volume (d) change in heat and volume
- 4 A Carnot reversible cycle has following processes ____.
 (a) 4 isobaric (b) 4 isothermal
 (c) 4 adiabatic (d) 2 isothermal and 2 adiabatic
- 5 The Helmholtz function is defined as $A =$ ____.
 (a) $U-TS$ (b) $U+TS$ (c) $U+PV$ (d) $U-PV$
- 6 Which of the following parameters remain constant in micro-canonical ensemble?
 (a) $[V, E, T]$ (b) $[N, V, E]$ (c) $[\mu, V, T]$ (d) $[\mu, N, E]$
- 7 The Stirling formula is $\ln N! =$ ____.
 (a) $N \ln N$ (b) $N \ln n$ (c) $N \ln N - N$ (d) $\ln(N/e)$
- 8 The spin quantum number s of the ____ is $\frac{1}{2}$.
 (a) μ -meson (b) π -meson (c) photon (d) alpha particle
- 9 When mean distance between the particles is larger than the de-Broglie wavelength, the ____ distribution can apply.
 (a) classical (b) quantum (c) Gibb's (d) Planck's
- 10 The mean kinetic energy of a particle having three degree of freedom is ____.
 (a) $\frac{1}{2} KT$ (b) KT (c) $\frac{KT}{4}$ (d) $\frac{3}{2} KT$



Q-2 Write answers of any ten questions in brief.

[20]

- 1 Define absolute zero temperature.
- 2 Draw the block diagram for a heat engine and refrigerator.
- 3 Obtain second T.dS equation.
- 4 Define throttling process and prove that $H_i = H_f$.
- 5 Show that for isotropic solid, compressibility $k = 3\delta$.



- 6 Define phase point and phase path.
- 7 Write Nernst's heat theorem in brief.
- 8 Define: Macroscopic and Microscopic states.
- 9 Write the expression for canonical average in classical statics and quantum statics.
- 10 Define F-D system in brief.
- 11 Using M-B velocity distribution law, obtain average velocity of the particles. $V_{av} = 1.596\sqrt{\frac{KT}{m}}$.
- 12 Define Degeneracy and Chemical potential.
- Q-3 (a) Define first order phase transition and obtain Clausius Clapeyron latent heat equation. [06]
(b) Write a short note on Kelvin temperature scale. [04]
- OR
- Q-3 (a) Using work diagram obtaining Clausius's theorem derive the equation of second law of thermodynamics. [06]
(b) Explain in brief application of the entropy principle. [04]
- Q-4 (a) Using alternative method, obtain Maxwell's four thermodynamical equations. [06]
(b) Write a short note on enthalpy (H). [04]
- OR
- Q-4 (a) With the help of the porous plug experiment explain Joule- Kelvin - effect and also obtain (μ) for an ideal gas. [06]
(b) Write note on Expansivity with proper diagram. [04]
- Q-5 (a) State Liouville's theorem and prove that $\frac{dg}{dt}=0$ using proper diagram. [06]
(b) Explain in brief about Canonical partition function. [04]
- OR
- Q-5 (a) Explain entropy of a perfect gas in a micro-canonical ensemble. [06]
(b) Deduce postulates of equal a priori probability. Why is it acceptable? [04]
- Q-6 (a) Define Maxwell- Boltzmann system. Obtain expression for the M-B distribution of the particles among various states. [06]
(b) Obtain Grand Canonical partition function [04]
- OR
- Q-6 (a) What is Bose -Einstein system? Discuss the Bose -Einstein distribution of the particles among various states. [06]
(b) With help of M-B velocity distribution law, obtain $V_p n(V_p) = \frac{4N}{2\sqrt{\pi}}$. [04]
