

[86 & A-54]

SARDAR PATEL UNIVERSITY

M. Sc. (Physics) (Ist Semester) Examination

Day: Thursday, Date: 12/04/2018, Time: 02:00 p.m. to 05:00 p.m.

Course No. PS01CPHY02 (Classical and Statistical Mechanics)

Important Note: Q.1: Eight multiple choice questions (MCQ) carry one mark each.

Q.2: Short answer questions carry two marks each (attempt any seven out of nine).

Q.3 to Q.6: Long answer questions carry 12 marks each.

Total Marks: 70

- Q1 (i) The mathematical representation of D'Alembert's principle is _____.
- (a) $\sum_i (F_i - \dot{p}_i) \cdot \delta r_i = 0$ (b) $\sum_i (F_i - \dot{r}_i) \cdot \delta p_i = 0$
 (c) $\sum_i (\dot{p}_i - F_i) \cdot \delta r_i = 0$ (d) $\sum_i (\dot{r}_i - F_i) \cdot \delta p_i = 0$
- (ii) The solution of $\frac{\partial H}{\partial p_j}$ is _____.
- (a) \dot{q}_i (b) $-\dot{q}_i$ (c) \dot{p}_i (d) $-\dot{p}_i$
- (iii) The equilibrium is said to be stable if extremum value of potential energy V is a _____.
- (a) minimum (b) maximum
 (c) zero (d) any value between minimum and maximum
- (iv) The Poisson bracket $[p_i, H]$ is equal to _____.
- (a) $-\partial H / \partial q_i$ (b) $-\dot{p}_i$ (c) p_i (d) \dot{q}_i
- (v) Bose occupation function can be expressed as,
- (a) $[\exp[(E - E_f)/kT] - 1]^{-1}$ (b) $[\exp[(E - E_f)/kT] - 1]$
 (c) $[\exp[(E - E_f)/kT] + 1]$ (d) $\exp[(E - E_f)/kT]^{-1}$
- (vi) In a microcanonical ensemble if a system "A" of fixed volume is in contact with a large reservoir, then
- (a) A can exchange neither energy nor particles (b) A can exchange only energy
 (c) A can exchange only particle (d) A can exchange both energy and particles
- (vii) The transition between phases of different symmetry is always,
- (a) 1st order (b) 2nd order (c) 3rd order (d) None of these
- (viii) Boltzmann's H-Theorem states that,
- (a) $dH/dt \leq 0$ (b) $dH/dt > 0$ (c) $dH/dt = 0$ (d) None
- Q2 (i) Discuss Poisson brackets of representing the equation of motion in a symmetric form. Prove anti-commutative property.
- (ii) Explain constraints in mechanics? Discuss four types of constraints.
- (iii) What is virtual displacement of a system, explain with suitable example.
- (iv) What are the characteristics of a chaotic motion?
- (v) Discuss secular or characteristic equation in small oscillation system.
- (vi) What is partition function? Write partition functions for different ensembles.
- (vii) Write Boltzmann transport equation and its physical significance.

C.P.T.O.)

(viii) Define critical exponent and write any two scaling relations.

(ix) Explain briefly white dwarf stars and Chandrasekhar limit.

Q3 (a) Using canonical transformation solve the harmonic oscillator problem. The given generating function for the harmonic oscillator is $F_1 = \frac{1}{2} m \omega q^2 \cot Q$. 6

(b) What is gauge transformation? What arbitrariness does it introduces? Derive the relation between new Lagrangian L' and old Lagrangian L using generating function. 6

OR

(b) Write a note on Poisson bracket? Prove that the Poisson brackets are invariant under canonical transformations. 6

Q4 (a) Derive equations of fundamental frequencies using secular equation for a two coupled simple pendulums. 6

(b) Discuss the theory for obtaining the resonant frequencies and normal modes of oscillations by considering a system of linear triatomic molecule. 6

OR

(b) Explain by deriving necessary equations the small oscillations of particles on a string. 6

Q5 (a) Derive partition function and density matrix of free particle in coordinate space. 6

(b) Discuss the thermodynamic properties of an ideal Bose gas at finite temperature. 6

OR

(b) Discuss ideal Fermi gas and derive ground state pressure of it. 6

Q6 (a) Derive the virial equation of state and second virial coefficient for real gas system. 6

(b) Explain Boltzmann H-theorem and prove it. 6

OR

(b) Discuss Landau's theory of second order phase transition in detail. 6

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