[221/A17]

SEAT No._____ **No. of Printed Papers: 02**

SARDAR PATEL UNIVERSITY

M.Sc. (Physics) 1st Semester Examination

Wednesday, 24th October, 2018

Subject: PS01CPHY02 (Classical and Statistical Mechanics)

Time: 10:00 am to 01:00 pm **Total Marks: 70**

Q-1 Eight multiple choice questions. (MCQ) [01 marks each]

1. In the given equation, $L(r, \dot{r}, \theta, \dot{\theta}) = \frac{1}{2}(\dot{r}^2 + r^2\dot{r}^2) - V(r)$ find the cyclic coordinate.
   (a) r (b) $\dot{r}$ (c) θ (d) $\dot{\theta}$

2. The constraints that does not depend on time.
   (a) Scleronomous (b) Rheonomous (c) Cleronomous (d) ideal

3. The value of **[u, c]** = _____. Where **u** is a variable and **c** is a constant.
   (a) u (b) c (c) 0 (d) 1

4. The equilibrium is said to be unstable if the extremum value of potential energy V is _____.
   (a) maximum (b) minimum (c) zero (d) none of them

5. Trace of density matrix should be
   (a) zero (b) one (c) complex number (d) None of these

6. Specific heat of boson gas at low temperature varies as
   (a) T^3 (b) T (c) T^2 (d) $T^{1.5}$

7. Value of Fermi distribution function is one at
   (a) $E = E_F$ (b) $E \leq E_F$ (c) $E \geq E_F$ (d) $E > E_F$

8. White dwarf stars in equilibrium must have mass less than
   (a) $1.44M_0$ (b) $1.34M_0$ (c) $0.44M_0$ (d) $2.44M_0$

Q -2 Attempt any 7 of the following 9 question briefly. [02 marks each]

1. Explain virtual displacement with necessary example?

2. In small oscillations discuss the secular equation.

3. Prove the Poisson bracket obeys the distributive laws of algebra.

4. Explain infinitesimal transformation.

5. Write the density operators of various ensembles in the energy representation.

6. Write Clausius - Clapeyron equation and its physical significance.

7. Define first order and second order phase transitions with example.

8. Define fugacity of gas. Explain properties of the fugacity for Boson gas.

9. Define critical exponent and write any two scaling relations.

Q-3

(a) In the gauge transformation derive the relation between new and old Lagrange's. Explain the importance of generating function. [06]

(b) Derive the Lagrange's equations of motion for a conservative holonomic system. [06]

OR

(b) Derive the Hamilton's canonical equations of motion. Prove how they form a set of 2n first order differential equations of motion and replaces the n-Lagrange equations of second order. [06]

Q-4

(a) Derive the Hamilton-Jacobi equation and prove that they are first order partial differential equations in (n+1) variables. [06]

(b) For a two coupled simple pendulums derive the fundamental frequencies using secular equations. [06]

OR

(b) Show that the eigenvectors corresponding to the two distinct eigen frequencies are orthogonal. Discuss the meaning of orthogonality. [06]

Q-5

(a) Obtain partition function and density matrix for a free particle in coordinate space. [06]

(b) Derive thermodynamic properties of ideal Bose gas at finite temperature. [06]

OR

(b) Derive thermodynamic properties for degenerate Fermi gas. [06]

Q-6

(a) Explain in details Landau's theory of second order phase transition. [06]

(b) Prove that the 1-D Ising model does not explain the spontaneous magnetization. [06]

OR

(b) Derive Boltzmann transport equation of a thermodynamic system in non-equilibrium state. [06]

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