



Seat No. _____

HAK-XVII

B. Sc. / M. Sc. (Applied Physics) (Sem. V) (CBCS) Examination

May - 2023

Statistical Physics : XVII

(New Course)

Time : $2\frac{1}{2}$ Hours / Total Marks : 70

Instruction : Write answers of any five questions.

- 1 (a) Write answer of following short questions : 4
- (1) State the fundamental assumptions of statistical mechanics.
 - (2) Define phase space.
 - (3) Write the equation for a phase space of a three-dimension oscillator.
 - (4) What do you mean by ensembles?
- (b) Write about the uses of ensembles. 2
- (c) Discuss microcanonical, canonical and grand canonical ensembles. 3
- (d) Describe phase space in detail with the example of three dimensional harmonic oscillators. 5
- 2 (a) Write answer of following short questions : 4
- (1) Write the name of parameters associated with canonical ensemble.
 - (2) State the postulate of equal a priori probability.
 - (3) Write statistical description or steps of systems of particles.
 - (4) Write the condition for statistical equilibrium.

- (b) Derive the equation for volume in phase space 2

$$d\pi = 2\pi (2m)^{3/2} \varepsilon^{1/2} d\varepsilon \cdot V.$$
- (c) Derive the equations for the number of phase cell for harmonic oscillator and three dimensional free particles. 3
- (d) Describe mechanical equilibrium and particle equilibrium in detail. 5
- 3** (a) Write answer of following short questions : 4
- (1) Define microstate.
 - (2) Discuss the statistical probability.
 - (3) What is partition function?
 - (4) State the postulate of equal a priori probability.
- (b) Write law of general statistical distribution. 2
- (c) Prove: Sterling's Approximation. 3
- (d) Discuss and prove the law of equipartition of energy in brief. 5
- 4** (a) Write answer of following short questions : 4
- (1) Define macrostate.
 - (2) Discuss the number of microstate accessible to a macroscopic system.
 - (3) Define thermodynamic probability.
 - (4) Write the condition for statistical equilibrium.
- (b) Explain law of most probable distribution. 2
- (c) Derive an expression for a number of states accessible to a free particle confined in a one-dimensional box. 3
- (d) Explain connection between partition function and thermodynamic quantities. 5
- 5** (a) Write answer of following short questions : 4
- (1) What are the bosons?
 - (2) Discuss black body radiation in short.
 - (3) What are phonons?
 - (4) Draw the graph ω vs. $\rho(\omega)$ for Plank's radiation law.

- (b) What was the discrepancy in Einstein's specific heat model? 2
- (c) Explain radiation density for photon gas. 3
- (d) Derive an equation for Bose temperature. 5
- 6 (a) Write answer of following short questions : 4
- (1) What are the photons?
- (2) Write the equation for the pressure of radiation.
- (3) What is entropy?
- (4) Define Specific heat.
- (b) What modifications were suggested by Debye in Einstein's model of specific heat? 2
- (c) Discuss three radiative processes between two energy levels. 3
- (d) Derive Einstein equation for specific heat of solids. 5
- 7 (a) Write answer of following short questions : 4
- (1) What are the Fermions?
- (2) What is Chandrasekhar mass limit?
- (3) Probability of energy state E_f occupied by an electron at absolute temperature can be approximated _____.
- (4) What are white dwarfs?
- (b) The molar mass of Lithium is 0.00694 and its density is $0.53 \times 10^3 \text{ kg/m}^3$. Calculate the Fermi of the electrons. 2
- (c) Write a note on Fermi gas in metals. 3
- (d) Derive an equation for pressure exerted by Fermi gas in a white dwarf. 5
- 8 (a) Write answer of following short questions : 4
- (1) What are the photons?
- (2) Draw the Hertzsprung -Russell diagram.
- (3) Define Fermi energy.
- (4) Give relationship between T_f and E_f
- (b) Derive an equation for mean energy of fermions at $T = 0 \text{ K}$. 2
- (c) Derive an equation for Fermi energy of gas using Heisenberg's uncertainty principle. 3
- (d) Explain Electronic specific heat with necessary equations. 5

- 9** (a) Write answer of following short questions : **4**
- (1) Why Bose-Einstein condensation is interesting?
 - (2) Write the equation for average number of bosons in the energy state E_s .
 - (3) What is ideal fermi system?
 - (4) Write the equation for Fermi-Dirac distribution.
- (b) Discuss equilibrium number of photons in the radiation cavity $(N \propto VT^3)$. **2**
- (c) Discuss Emissivity for photon. **3**
- (d) Derive an equation for compressibility of fermi gas. **5**
- 10** (a) Write answer of following short questions : **4**
- (1) What is statistical physics?
 - (2) Write the equation for the energy of simple harmonic oscillation.
 - (3) Maxwell - Boltzmann distribution is useful for _____ type of system.
 - (4) What do you mean by basic postulate in statistical physics.
- (b) Describe the division of phase space into cells. **2**
- (c) Discuss the difference between classical and quantum statistical physics. **3**
- (d) Explain the connection between statistical and thermodynamic quantities. **5**
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