

220350

M.Sc. (Semester-II) Examination, Oct. 2022

PHYSICS

PAPER - II

STATISTICAL MECHANICS

Time Allowed : 3 hours

Maximum Marks : 40

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*Note : Attempt all the questions. Options are internal.*

**Section-A**

**(Objective Type Questions)  $5 \times 1 = 5$**

1. (i) If an ensemble is a collection of independent isolated assemblies having same energy  $E$ , volume  $V$  and number  $N$  of systems; then it is called :

- (a) Micro Canonical Ensemble
- (b) Canonical Ensemble
- (c) Macro Canonical Ensemble
- (d) Grand Canonical Ensemble

- (ii) In statistical mechanics  $\beta$  is given by :

- (a)  $(kT)$
- (b)  $(1 + kT)$
- (c)  $(1 - kT)$
- (d)  $(1/kT)$

(ii) The susceptibility of ferromagnetic material at normal temperature is :

- (a) Very large positive
- (b) Small negative
- (c) Small positive
- (d) None

(iii) In edge dislocation Burgers vector is \_\_\_\_\_ to the dislocation line and lies in the slip plane :

- (a) Parallel
- (b) Perpendicular
- (c) Oblique
- (d) None

(iv) Negative value of hall coefficient refer to change carriers to be :

- (a) Electron
- (b) Hole
- (c) Proton
- (d) None

(v) Structure of carbon nano tube is :

- (a) 0-D
- (b) 1-D
- (c) 2-D
- (d) 3-D

### Section-B

(Short Answer Type Questions)

5×2=10

2. What is persistent current?

OR

What do you know by a Cooper pair? Explain.

What do you understand by electron gas in metal?  
Give a brief idea.

4. Define virial expansion of gas.

OR

What is scaling hypothesis in thermodynamics?

5. What is meant by fluctuations in thermodynamic quantities?

OR

Define fluctuation in energy.

6. Define phase transitions.

OR

Give a comparison between first order and second order phase transition.

### Section-C

(Long Answer Type questions)

5×5=25

7. Explain Gibb's paradox.

OR

State and prove Liouville theorem.

8. Write down the concept of Maxwell-Boltzmann statistics and obtain its distribution law.

OR

Explain Boltzmann transport equation.



9. Give detailed notes on:  
 (1) Cluster expansion of a classical gas.

OR

- (2) Ising model in 1-dimension.

10. Explain Brownian motion.

OR

Obtain Fokker-Planck equation.

11. How low temperature can be obtained using Yong and Lee method? Explain.

OR

What is adiabatic demagnetization? Explain how absolute zero can be approached?



OR

OR

**PC-044**

**M.Sc. II Semester, 2017-18**

**Physics (Paper-II)**

**(Statistical Mechanics)**

**[M.M. : 42]**

**Time : 3 hrs.]**

**Note: Attempt all questions.**

**[Section-A]**

**7×1=7**

**(Objective Type Questions)**

1. Choose the correct option :

(1) Gibb's Paradox is resolved by the concept of :

- (a) Classical Mechanics
- (b) Electrodynamics
- (c) Thermodynamics
- (d) Quantum Mechanics

(2) Fermi-Dirac statistics is applicable to :

- (a) Electrons                      (b) Protons
- (c) Neutrons                      (d) All the above

(3) In canonical ensemble the system can exchange :

- (a) Particles

- (b) Energy
- (c) Both Energy & Particles
- (d) Neither Energy nor Particles

(4) For a classical cluster expansion thermal wavelength is given by :

$$(a) \lambda = \sqrt{\frac{2\pi\hbar^2}{mkT}} \quad (b) \lambda = \sqrt{\frac{4\pi\hbar^2}{mkT}}$$

$$(c) \lambda = \sqrt{\frac{8\pi\hbar^2}{mk^2T^2}} \quad (d) \text{None of these}$$

(5) Brownian motion increases when :

- (a) Viscosity of medium increases
- (b) Temperature of medium increases
- (c) Density of medium increases
- (d) None of these

(6) Super fluid has the property :

- (a) Zero entropy
- (b) Zero viscosity
- (c) Flows without resistance
- (d) All of the above

(7) The Boltzmann transport equation is associated with the calculation of distribution function of a system is :

- (a) Equilibrium State
- (b) Non-equilibrium State
- (c) Vertex State
- (d) None of these

#### [Section-B]

5×2=10

#### (Short Answer Type Questions)

2. What do you understand by classical ideal gas ?

OR

Write short note on entropy of mixing.

3. Explain electron gas in metals.

OR

Differentiate between classical and quantum statistics.

4. What are virial coefficients ?

OR

Write short note on mean field theory of Ising Model is 2-dimension.

5. What is thermodynamic fluctuation ?



OR

Discuss Brownian motion in brief.

6. What do you understand by partition function ?

OR

Write properties of ideal Bose gas.

[Section-C]

5×5=25

(Long Answer Type Questions)

7. What is meant by an ensemble ? Discuss microcanonical, canonical and grand canonical ensembles. Compare these three types of ensembles.

OR

State and prove Liouville's theorem.

8. State and prove Boltzmann transport equation.

OR

Compare the basic postulates of Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics. Deduce the law of distribution of energy of particles according to Fermi-Dirac statistics.

9. Explain virial equation of state. What is its significance ?

OR

State and explain mean field theory of Ising model in 3-dimension.

10. State the derive Fokker-Planck equation.

OR

Explain the Langevin theory for the Brownian motion of particles.

11. Write short notes on any two of the following :

- (a) Gibbs paradox
- (b) Density matrix
- (c) Ising model in 1-dimension
- (d) Spatial Correlation