

(Pages : 3)

G – 4474

Reg. No. :

Name :

Second Semester M.Sc. Degree Examination, July 2019

Branch: Physics

PH 222 : THERMODYNAMICS, STATISTICAL PHYSICS AND BASIC
QUANTUM MECHANICS

(2018 admission)

Time : 3 Hours

Max. Marks : 75

PART – A

- I. Answer **any five** questions. Each question carries 3 mark:
- (a) What is Gibbs free energy? Show that it is a constant for an isothermal process?
 - (b) Why do liquid boils at a higher temperature inside a pressure cooker?
 - (c) What is an ensemble? Write down the probability density function of a microcanonical ensemble?
 - (d) If we have two indistinguishable particles, elucidate the different ways in which the particles can be arranged using Maxwell Boltzmann, Bose Einstein and Fermi Dirac statistics?
 - (e) What are Fermions? Write down the postulates of Fermi Dirac statistics?
 - (f) What is a Hilbert's space? What are its properties?
 - (g) Give the basic postulates of quantum mechanics?
 - (h) What are unitary transformations? What is its significance?

(5 × 3 = 15 Marks)

P.T.O.

PART – B

II. Answer A or B part of questions II, III and IV. Each questions carries **15** marks:

(a) (i) What are thermodynamic potentials? Derive Maxwell's thermodynamic relations?

(ii) Derive Clapeyron's latent heat equation using Maxwell's thermodynamic relations?

Or

(b) (i) What do you mean by entropy of a system? Obtain Boltzmann entropy relation?

(ii) Explain is Gibbs Paradox? How can it be resolved?

III. (a) What is Bose-Einstein statistics? What are the basic postulates used? Derive the expression for the most probable distribution of particles of a system obeying B.E statistics and hence deduce Planck's Black body radiation formula?

Or

(b) Derive the expression for the probability distribution of particles governed by Fermi-Dirac statistics? Derive the expression for the energy distribution of electrons in a metal and hence obtain the relation for the average kinetic energy of the electrons at absolute zero.

IV. (a) What are creation and annihilation operators? Explain its properties? Solve the harmonic oscillator problem using operator method. Sketch the form of the wave functions and probability densities for the first four lower energy states.

Or

(b) (i) Find the solution for the Schrodinger equation of a particle in a finite potential well.

(ii) Applying appropriate boundary conditions find the probability for a particle to penetrate the barrier.

(3 × 15 = 45 Marks)



PART – C

V. Answer **any three** questions. Each question carries 5 mark:

- (a) Calculate the change in boiling point of water when the pressure is increased by 1 atmosphere. Given, boiling point of water is 373 K, specific volume of steam is $1.671 \text{ m}^3 \text{ kg}^{-1}$ and latent heat of steam is $2.268 \times 10^6 \text{ Jkg}^{-1}$.
- (b) Show that for a perfect gas $\partial U / \partial V)_T = 0$.
- (c) How many photons are present in 1 cm^3 of radiation at 727°C ? What is their average energy? Given that $\int_0^\infty \frac{x^2 dx}{e^x - 1} = 2.405$.
- (d) The number of conduction electrons per cm^3 is 24.2×10^{22} in Beryllium and 0.91×10^{22} in Cesium. If the Fermi energy of conduction electrons in Be is 14.44 eV, calculate that in Cesium.
- (e) State and prove uncertainty principle.
- (f) Find the probability that a particle trapped in a box of width L can be found between 0.45L and 0.55L for the ground and first excited states.

(3 × 5 = 15 Marks)

