MSc - 2
SM

Set-1

STATISTICAL MECHANICS

Full Marks : 70

Time : 3 hours

Answer any **six** questions including **Q. No. 1**
which is compulsory

The figures in the right-hand margin indicate marks

1. Which statistics is followed by the followings : 2 × 10

    (*i*) Electron, ideal gas molecule, phonon, ^{3}He gas.

    (*ii*) Show the validity of equipartition theory for one dimensional harmonic oscillator with energy given by

    $$E = p^2/2m + 1/2k_0 x^2$$

    (*iii*) Write down density matrix for a system having probabilities P_1, P_2 and P_3 with corresponding state Ψ_1, Ψ_2 and Ψ_3.

(*Turn Over*)

(*iv*) Distinguish between Bose-Einstein and Fermi system.

(*v*) What is Bose-Einstein condensation ? Why it is called disorder-order transition ?

(*vi*) Show the jump in specific heat in the light of G-L theory.

(*vii*) Write down the total energy for an ideal and non-ideal gas.

(*viii*) Show that partition function

   $Z = 2\Pi KT/h\omega$, for an oscillator

   defined by energy $E = p^2/2m + 1/2\, mw^2 q^2$

(*ix*) State the difference between Pauli Paramagnetism and Langevin Paramagnetism.

(*x*) State the difference between Red giant star and White Dwarf star.

2. What do you mean by ensembles ? Distinguish between different ensembles. Obtain the thermodynamics for ideal gases. 10

(*Continued*)

3. (a) What is degenerate gas ? Find out the Fermi energy of electron in single particle states. 5

   (b) The molar mass of Lithium is 0·00694 and density is $0·53 \times 10^3$ Kg/m³. Calculate the Fermi energy and Fermi Temperature of the electrons. http://www.odishastudy.com 5

4. How can a White Dwarf star be understood in terms of degenerate gas ? Calculate the pressure for White Dwarf star. What is the Chandrasekhar limit for White Dwarf star ? 10

5. How do you understand partition function ? With low density approximation find the average energy of the interacting system. 10

6. A particle can exit in one of the two states ($| 0 >$ and ($| 1 >$). Obtain distribution function for Bose-Einstein system. 10

7. Write short notes on any *two* : 10

   (i) Virial expansion

   (ii) Gibb's paradox

   (iii) Plank's black body radiation

   (iv) Liouville's theorem.

8. Find out Maxwell thermodynamic relations. Express Grand canonical ensemble in term of density matrix. 10

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