M 14393

Reg. No.: .....

Name: .....

# IV Semester M.Sc. Degree Examination, April 2008
## PHYSICS
## PH-401 : Statistical Mechanics (2006 Admn.)

Time: 3 Hours Max. Marks: 50

*Instructions : 1) Contains **three** Sections, **A, B** and **C**.*
*2) Section – A contains **4** essay type questions, candidate has to answer **any two** questions.*
*3) Section-**B** contains **8** questions, can answer **5** questions.*
*4) Section – **C** contains **5** questions, can answer **3** questions.*

### SECTION – A

Essay questions. Answer **any two** questions : **(2×10=20)**

1. What is Gibb's distribution ? Using this distribution obtain an expression for generalized equipartition of energies and virial theorem. **10**

2. What is Bose-Einstein condensation ? Estimate the critical temperature for Bose-Einstein condensation and discuss the behaviour of specific heat of a Bose-Einstein gas around the critical temperature. **10**

3. What is Fermi gas ? Deduce an expression for the energy of a Fermi gas at absolute zero. Comment on its physical significance. **10**

4. Define grand canonical partition function. How can you obtain various thermodynamic quantities from it ? Discuss the density fluctuations in grand canonical ensemble. **10**

### SECTION – B

Answer **any five** questions : **(5×3=15)**

5. Discuss the concept of thermodynamic probability and thermal equilibrium. **3**

6. Give brief descriptions of different types of phase space and ensembles. **3**

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7. Deduce the Sackur-Tetrode equation for the translational entropy of an ideal gas in equilibrium at a temperature T. 3

8. Calculate the mean square fluctuation in the number of photons in an enclosure of volume V at a temperature T. 3

9. Define density matrix for various thermodynamic parameters from the density operator. 3

10. Explain the Planck's theory of black body radiation. 3

11. Obtain an expression for specific heat of metals at low temperatures and comment on its significance. 3

12. Explain how ising model can simulate the lattice gas. 3

## SECTION – C

Answer **any three** questions : (3×5=15)

13. Calculate the translational partition function and different thermodynamical quantities for molecular oxygen gas at a temperature of 1500K and a pressure of one atmosphere. The molecular weight of oxygen is 32. 5

14. Show that the fluctuations in energy and in temperature are given by

$$\overline{(\delta E)^2} = KT^2Cv \text{ and } \overline{(\delta T)^2} = \frac{KT^2}{Cv}$$ 5

15. Treating liquid $_2He^4$-I as an ideal Bose-Einstein gas find the critical temperature $T_C$ at which there is a transition of liquid He-I to liquid He-II, the molar volume of liquid He at $T_c$ is $27.4\times10^{-6}m^3$ and mass of $_2He^4$ is $6.65\times10^{-27}kg$. 5

16. Calculate the Fermi energy at 0K of sodium assuming that it has one free-electron per atom and also determine the internal energy of the electron gas per unit volume. The density and atomic weight of sodium are 0.97 $gm/cm^3$ and 23 respectively. 5

17. Calculate the entent of energy range between F(E) = 0.9 and F(E) = 0.1 of the Fermi-Dirac distributions at a temperature of 200 k and express it as a function of $E_F$ which is 3eV. 5