Second Semester M.Sc. Physics Examination, January 2016

Thermal Physics and Statistical Mechanics

Time: 3 Hours Max. Marks: 80

Instructions: *Answer all questions.*

1. (a) Deduce Maxwell's relations in thermodynamics. 10
   (b) Derive Clausius-Clapeyron equation. 5

OR

2. (a) State and explain Onsager reciprocal equation. 10
   (b) Show that for an ideal gas, $C_p - C_v = R$. 5

3. (a) State and prove Liouville's theorem. 10
   (b) Write a note on Phase space of a molecule. 5

OR

4. (a) Derive the distribution for a canonical ensemble. 10
   (b) State and explain Gibbs paradox. 5

5. (a) Derive the expressions for BE and FD distribution functions starting from a grand canonical ensemble. 10
   (b) Obtain the symmetric and anti symmetric wave functions for a system of two independent quantum particles. 5

OR

6. (a) Obtain an expression for the average value of an observable using density matrix formalism. 10
   (b) Derive an expression for rotational partition function at high temperature. 5

7. (a) Starting from Fermi energy equation derive an expression for zero point pressure of an electron gas in metals. 10
   (b) Write a note on flux quantization. 5

OR

8. (a) Using BE statistics derive Planck's law of black body radiation. 10

(b) Define magnetic susceptibility. 5

9. Answer **any four** of the following: 4X5=20

(a) State and explain second law of thermodynamics.

(b) Given that the critical temperature, critical pressure and molar volume for a gas are 33.2K, 1.295 X 10^6 Pa and 6.5 X 10^{-5} m^3mol^{-1}. Find the Van der waal's constants.

(c) Derive an expression for entropy of a system in terms of Partition function.

(d) Prove that for two systems to be in equilibrium, their chemical potentials must be constant.

(e) Under what condition does one get the classical limit of quantum statistical system?

(f) Deduce the vibrational contributions of the molecules of a gas to the specific heat.

(g) Calculate the Fermi energy in eV for sodium, assuming that it has 1 free electron per atom. Given: density of sodium= 0.97 gcm^{-3}, atomic weight of sodium is 23.

(h) How many photons are there in 1cc of radiation at 727^0C temperature?