RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College affiliated to University of Calcutta)

B.A./B.Sc. SIXTH SEMESTER EXAMINATION, MAY 2019

THIRD YEAR [BATCH 2016-19]

Date : 04/05/2019 **PHYSICS (Honours)**

Time : 11 am – 1 pm **Paper :** VII [Gr-B] Full Marks : 30

Answer <u>any three</u> questions of the following : [3×10]

1. a) Distinguish between microcanonical ensemble and canonical ensemble. [2]

   b) What is phase trajectory? Determine the phase trajectory of a free particle and a simple harmonic oscillator. [1+3]

   c) For a microcanonical ensemble find out the expresion of temperature (*T*), pressure (*P*) and chemical potential (μ) in terms of number of accessible states (Ω). What do you mean by chemical potential of a system? [3+1]

2. a) Find the partition function of a system of *N* ideal (monatomic) gas molecules. What is Gibbs' correction? Why is it necessary? [3+1+1]

   b) From above partition function find the Helmholtz free energy (*F*) and the expression of pressure (*P*). Hence find the equation of state of the ideal gas. [3]

   c) Find the chemical potential of the ideal gas molecule. [2]

3. a) Show that $-\left(\frac{\partial f_{FD}}{\partial E}\right)$ is a maximum and symmetric about the fermi level. (f_{FD} is the *F–D* distribution function) [4]

   b) Show that for a two-dimensional (non-relativistic) free electron gas, the number of free electrons per unit area is given by $n = \frac{4\pi m k_B T}{h^2} \ln\left[\exp\left(\frac{E_7}{k_B T}\right)+1\right]$ [6]

   [Symbols are of usual significance]

4. a) What is *B–E* condensation? Why a Fermi gas never undergoes such a condensation? [1+1]

   b) Derive the relation between Fermi level energy at absolute zero and the particle density of the system. Explain briefly how Fermi energy depends on temperature. [3+1]

   c) Starting from *BE* distribution formula, establish Planck's formula for black body radiation. [4]

5. a) Find the average energy $\langle E \rangle$ of a canonical system in terms of partition function. Hence find the mean square fluctuation of energy. [3]

   b) Show that one-dimensional random walk problem can be treated as a diffusion phenomena. [4]

   c) The limit to the sensitivity of a spring balance is obtained when the r.m.s. fluctuation becomes equal to the deflection produced by the weight. If α be the spring constant, estimate the smallest mass which can be measured by the balance at a temperature *T*. [3]

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