ACTIVITY ID : 1903167021

B.Sc 6th Semester (Honours) Examination, 2020

PHYSICS

(STATISTICAL MECHANICS)

Paper-602/C-14/T-14

COURSE ID-62412

TIME: 1 HOUR **FULL MARKS - 12**

The figures in the right hand side margin indicate full marks

Candidates are required to give their answer in their own words and to the point

SECTION - I

1. *Answer any two questions of the followings:* ***1 x 2 = 2***

- **a)** What is the significance of the critical temperature for an ideal Bose gas?
- **b)** Does the energy of a Fermi gas become zero at absolute zero? Explain your answer.
- **c)** What is the importance of the Chandrasekhar Mass Limit?
- **d)** What do you mean by statistical temperature?
- **e)** Define chemical potential (μ) and what is its physical significance?
- **f)** Give two examples (with critical temperature) which shows the Bose-Einstein condensation phenomenon.

SECTION - II

2. *Answer any one question of the followings:* ***4 x 1 = 4***

a) Draw the phase-space diagram, with proper labelling of the axes (as necessary), for the following systems:

I. A free particle of mass "m" is moving in one dimension with momentum P_x.

II. A particle of mass "m" is moving in one dimension under a potential V(x) = a|x| ; where a > 0.

2 + 2 = 4

Please turn over

b) In a system of two particles, each particle can be in any of three possible states. Find the ratio of the probability that the two particles occupy the same state to the probability that the two particles occupy different states for BE (Bose-Einstein) statistics and FD (Fermi-Dirac) statistics. 4

c) What are the basic differences between photon gas and ideal gas? Show graphically how does the specific heat (C_V) of a solid vary with the absolute temperature (T) at low as well as at high temperature.
Five identifiable particles are distributed in three non-degenerate levels with energies 0, E and 2E. Determine the most probable distribution for total energy 3E.

(1 + 1) + 2 = 4

SECTION - III

3. Answer any one question of the followings: ***6 x 1 = 6***

a) Consider a 2-level system with energy states $\boldsymbol{\varepsilon}$ and **ε+∇** (**∇**>0).

I. Calculate the partition function and free energy of the system.
II. How does the heat capacity of the system vary with temperature?
III. Will there be any change in the entropy of the system if the number of particles are increased? Explain.

2 + 2 + 2 = 6

b) Write down the Bose-Einstein (BE) distribution function and show it graphically. What is Bose-Einstein condensation? Obtain Planck's radiation formula using the BE statistics. 2 + 1 + 3 = 6

c) A system, containing *N* distinguishable *spin ½* particles, is kept in a magnetic field *B*. Each particle, in the system, has an energy $+\mu B$ $(+{}^{1}/_{2})$ or $-\mu B$ $(-{}^{1}/_{2})$. If *N* is the total number of particles in the *spin-up* state, then

I. Compute the partition function and calculate the total energy of the system.
II. How does the entropy vary with the magnetic field *B*?
III. Compute the mean magnetization of the system.

(1½ + 1½)+1 + 2 = 6