U.G. 6th Semester Examination - 2020

PHYSICS

Course Code : BPHSCCHC602

Course Title : Statistical Mechanics

Full Marks : 30 Time : 2 Hours

The figures in the right-hand margin indicate marks.

Candidates are required to give their answers in their own words as far as practicable.

1. Answer any **ten** questions: 1×10=10

a) Which of the statistics will you use for the systems having (i) electrons (ii) photons (iii) oxygen molecules?

b) What is meant by Chandrasekhar limit?

c) Write down the difference between classical and quantum statistics.

d) Using the de Broglie's wavelength write the condition reduction of quantum statistics to classical statistics.

e) At the same temperature

i) a fermion gas exerts the greatest pressure

ii) a boson gas exerts the greatest pressure

iii) a fermion gas exerts the least pressure

iv) a classical gas exerts the greatest pressure

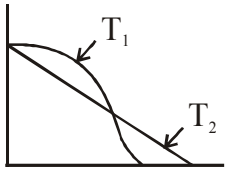
f) Write down the Liouville equation.

g) Write down the relation between Fermi energy and density of electrons.

h) If the energy of a quantum harmonic oscillator is $E_n = nh\gamma$, $n = 0, 1, 2, ..., \infty$. Write down the partition function of the system.

i) If z be the partition function of a system of particles, show that the average energy can be written as $\bar{E} = -\frac{\partial \ln z}{\partial \beta}$.

j) The following FD distributions correspond to two different temperature T_1 and T_2. Which one of these is correct?



i) $T_1 > T_2$

ii) $T_1 < T_2$

iii) $T_1 = T_2$

iv) can not be said definitely

k) State the basic difference between canonical and grand canonical ensembles.

l) What do you mean by microstate and macro-state?

m) What do you mean by ensemble average?

n) What is meant by a priori probability?

o) What is the S.I. unit of Stefan's constant?

2. Answer any **five** questions: 2×5=10

a) Find the density of states g(E) for a two dimensional electron gas.

b) Briefly explain Gibbs paradox.

c) Obtain the relation between entropy and thermodynamic probability.

d) Two particles are to be distributed in three cells. Find out the total number of micro-states if the particles follow

i) MB statistics

ii) BE statistics

iii) FD statistics

e) Calculate the occupation probability (occupancy) at 2KT units of energy above the Fermi energy, E_F.

f) Differentiate between BE and FD statistics.

g) Draw a phase trajectory of a simple harmonic oscillator in phase space and explain the diagram.

h) Calculate the density of states for an electron with energy 5eV constructed to more in a cubical box of length 0.5 mm.

3. Answer any **two** questions: 5×2=10

a) Find the entropy $S(E, V, N)$ of an ideal gas of N classical mono-atomic particles with a fixed total energy E, contained in volume V. Deduce the equation of state of this gas, assuming that N is very large. 3+2

b) Which particles do obey Bose-Einstein statistics? Derive the BE distribution formula. 1+4

c) Obtain Planck's formula for blackbody radiation using Bose-Einstein statistics. Show that Wein's formula and Rayleigh-Jeans formula can be deduced as particular cases of Planck's law. 3+2

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