U.G. 6th Semester Examination - 2022

PHYSICS

[HONOURS]

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) Define thermodynamic probability.

b) Write down the fundamental postulates of statistical mechanics.

c) What do you mean by micro-states and macro-states?

d) Draw the phase trajectory of a classical free particle of mass m and energy E which is moving to-and-fro along the x-axis in a force free region between two rigid walls at x=0 and x=a.

e) What do you mean by ensemble average?

f) Define Grand Canonical Ensemble.

g) Write down the basic assumption of BE statistics.

h) Write down differences between MB and FD statistics.

i) What is the number of meaningful ways in which four fermions can be arranged in five compartments?

j) If Fermi energy of copper is 7 eV, find out the value of Fermi velocity.

k) What do you mean by classical limit of quantum statistics?

l) Which of the statistics will you use for the system having (i) electron (ii) photon?

m) Draw Fermi distribution for T=0 K.

n) What are symmetric wave functions?

o) State the Wien's displacement law.

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

a) Find out the possible arrangements of two particles A and B in three cells according to MB-statistics.

b) Briefly explain Gibbs paradox.

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

d) A hot black body emits the energy at the rate of 16 $Jm^{-2}s^{-1}$ and its most intense radiation corresponds to 20,000 Å. When the temperature of this body is further increased and its most intense radiation corresponds to 10,000 Å, then find the value of energy radiated in $Jm^{-2}s^{-1}$.

e) What is the wavelength at which human body radiates maximum energy? Consider human body temperature T=37°C.

f) The spectral energy distribution of the sun (temp = 6050 K) has a maximum at 4750 Å. Find out the temperature of a star for which this maximum appears at 9500 Å?

g) Explain in brief the Bose-Einstein condensation.

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

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

a) Three distinguishable particles each of which can be in one of the ε, 2ε, 3ε, 4ε energy states having total energy 6ε. Find all possible number of distribution of all particles in the energy states. Find the number of micro-states in each case.

b) Using BE statistics derive Planck's law for blackbody radiation. Also derive Wein's formula and Rayleigh-Jean formula from Planck's law. 3+2

c) Find the entropy S(E, V, N) of an ideal gas of N classical monatomic particles with a fixed total energy E, contained in volume V. Hence deduce the equation of state of this gas, assuming N is very large.

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