3 (Sem–6/CBCS) PHY HC 2

2023

PHYSICS

(Honours Core)

Paper : PHY–HC–6026

(Statistical Mechanics)

Full Marks : 60

Time : Three hours

The figures in the margin indicate full marks for the questions.

1. Answer the following questions : 1×7=7

   (a) What is the number of microstates if 8 distinguishable particles are distributed in two compartments ?

   (b) What is ensemble in statistical mechanics ?

   (c) Define phase space.

   (d) What is the importance of Kirchhoff's law of radiation ?

   (e) Give *one* example of bosons.

(f) What is Chandrasekhar mass limit ?

(g) Under what condition quantum statistics approaches the classical statistics ?

2. Answer the following questions : 2×4=8

(a) Write *two* properties of thermal radiation.

(b) Black body radiation is white. Explain.

(c) To what temperature must an ideal black body be raised in order to double the total radiation if original temperature is 127 °C ?

(d) Write *one* similarity and *one* difference between B-E and F-D statistics.

3. Answer ***any three*** questions from the following : 5×3=15

(a) State law of equipartion of energy. Using this law find an expression of the ratio of two specific heat of a gas. 1+4=5

(b) 6 distinguishable particles are to be arranged in 3 compartments of a box. Find the total number of microstates corresponding to the macrostate (0,2,4) and (2,3,1). [There is no restriction of number of particles that can go into any compartment]. 2½+2½=5

(c) In a metal there are 3.14×10^{27} free electrons per cubic metre. Calculate the Fermi energy.

(d) Write a note on Bose-Einstein condensation.

(e) Write the Saha's ionisation formula. Write the assumptions considered to derive the formula. 2+3=5

4. Answer the following : 10×3=30

(a) Write the statistical definition of entropy. What is its unit ? State the physical significance of entropy giving *one* example. Derive the relation between entropy and thermodynamic probability. 2+1+2+5=10

Or

Derive Maxwell-Boltzmann law of energy distribution. 10

(b) What is radiation pressure ? Prove that the diffuse radiation exerts a pressure on the walls of the container, equal to

$\frac{1}{3}$rd of its energy density. 2+8=10

Or

From Planck's law of blackbody radiation, derive : 3+7=10

(i) Rayleigh-Jeans law

(ii) Wien's displacement law

(c) Derive Bose-Einstein's distribution law. 10

Or

Derive the expression of total internal energy of a Fermi-Dirac gas.
