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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 : $1 \times 7 = 7$
 - (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.

Contd.

- (f) What is Chandrasekhar mass limit ?
- (g) Under what condition quantum statistics approaches the classical statistics ?

2. Answer the following questions : $2 \times 4 = 8$

- (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 : $5 \times 3 = 15$

- (a) State law of equipartition 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]. $2\frac{1}{2} + 2\frac{1}{2} = 5$

- (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 : $10 \times 3 = 30$

- (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.

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Or

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