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3 (Sem-6/CBCS) PHY HC 2

2022

PHYSICS

(Honours)

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 **any seven** questions from the following : $1 \times 7 = 7$

(a) What is the minimum volume of the phase cell in quantum statistics ?

(b) What is the dimension of partition function ?

(c) Write *one* limitation of Maxwell-Boltzmann statistics.

(d) Name the statistics where Pauli's exclusion principle is used.

(e) State Kirchhoff's law of heat radiation.

Contd.

- (f) What is Fermi energy ?
- (g) What is Chandrasekhar mass limit ?
- (h) What is the absorptive power of a perfectly black body ?
- (i) Write *one* difference between B-E and F-D statistics.
- (j) The temperature of a black body is increased from 27°C to 327°C . By how many times the emission of energy will be increased ?

2. Answer **any four** of the following : $2 \times 4 = 8$

- (a) Define microstate and macrostate.
- (b) Define phase space and phase line.
- (c) What is ultraviolet catastrophe ?
- (d) The wavelength of maximum emissive power of sun's heat radiation is 4750 \AA . Find the surface temperature of the sun. [Wien's displacement constant = 0.2892 cm-K]
- (e) Three particles are to be distributed in four energy levels. Calculate all possible ways of distribution when particles are
 - (i) fermions;
 - (ii) classical particles.

- (f) What is degenerate Bose gas ?
- (g) What is white dwarf star ?
- (h) Define ensemble.

3. Answer **any three** of the following : $5 \times 3 = 15$

- (a) Write a short note on Gibbs paradox.
- (b) Derive the relation $S = k \ln W$, where $S \rightarrow$ entropy, $k \rightarrow$ Boltzmann constant, $W \rightarrow$ probability.
- (c) Derive the distribution law of M-B statistics.
- (d) Derive the distribution law of F-D statistics.
- (e) Show that Fermi energy of electron gas is independent of shape and size of the material.
- (f) Derive Rayleigh-Jeans radiation law from Planck's radiation law.
- (g) Derive Sackur-Tetrode equation.
- (h) What is radiation pressure ? Derive an expression of diffused radiation pressure.

4. Answer **any three** questions of the following : $10 \times 3 = 30$

- (a) State the law of equipartition of energy and prove it. $2 + 8 = 10$

(b) Write Planck's quantum postulate and derive Planck's law of black-body radiation. $2+8=10$

(c) Write the differences between photon and ideal gas. Starting from B-E statistics distribution law derive Planck's law. $3+7=10$

(d) Define Stefan-Boltzmann law and deduce it from thermodynamic consideration. $3+7=10$

(e) What is electron gas ? Derive the expression of energy distribution of free electrons in a metal using F-D statistics. $2+8=10$

(f) Explain Bose-Einstein condensation. Define critical temperature for B-E condensation. $8+2=10$

(g) From Planck's law, derive —

(i) Wien's law;

(ii) Stefan-Boltzmann law. $4+6=10$

(h) Compare among three statistics M-B, B-E and F-D. Under what condition classical statistics approaches the quantum statistics ? $8+2=10$