6 SEM TDC PHYH (CBCS) C 14

2 0 2 2

(June/July)

PHYSICS

(Core)

Course : C–14

(**Statistical Mechanics**)

Full Marks : 53
Pass Marks : 21

Time : 3 hours

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

1. Choose the correct answer from the following :   1×5=5

   (a) In the equilibrium state, the thermo-dynamic probability of a system is

      (i) zero

      (ii) maximum

      (iii) minimum but not 1

      (iv) one

(Turn Over)

(b) Gibbs' paradox arises due to

   (i) indistinguishability of classical particles

   (ii) distinguishability of classical particles

   (iii) omittance of quantum nature of the particles

   (iv) absence of inter-particle interaction

(c) Rayleigh-Jeans law agrees well with the experimental result at

   (i) low frequency

   (ii) infinity

   (iii) high frequency

   (iv) None of the above

(d) At high temperature, Bose-Einstein distribution approaches Maxwell-Boltzmann distribution.

   (i) False

   (ii) True

   (iii) Cannot say

   (iv) Sometimes true sometimes false

(e) From Fermi-Dirac statistics, $n_i = ?$

   (i) $\dfrac{g_i}{e^{\alpha + \beta \varepsilon_i} + 1}$ *(ii)* $\dfrac{2g_i}{e^{\alpha + \beta \varepsilon_i} + 1}$

   (iii) $\dfrac{g_i}{e^{\alpha + \beta \varepsilon_i} - 1}$ *(iv)* $\dfrac{2g_i}{e^{\alpha + \beta \varepsilon_i} - 1}$

                 (Continued)

(b) Gibbs' paradox arises due to

    (i) indistinguishability of classical particles

    (ii) distinguishability of classical particles

    (iii) omittance of quantum nature of the particles

    (iv) absence of inter-particle interaction

(c) Rayleigh-Jeans law agrees well with the experimental result at

    (i) low frequency

    (ii) infinity

    (iii) high frequency

    (iv) None of the above

(d) At high temperature, Bose-Einstein distribution approaches Maxwell-Boltzmann distribution.

    (i) False

    (ii) True

    (iii) Cannot say

    (iv) Sometimes true sometimes false

(e) From Fermi-Dirac statistics, $n_i = ?$

    (i) $\dfrac{g_i}{e^{\alpha + \beta \varepsilon_i} + 1}$ (ii) $\dfrac{2g_i}{e^{\alpha + \beta \varepsilon_i} + 1}$

    (iii) $\dfrac{g_i}{e^{\alpha + \beta \varepsilon_i} - 1}$ (iv) $\dfrac{2g_i}{e^{\alpha + \beta \varepsilon_i} - 1}$

           (Continued)

4. (a) What is photon gas? What is the difference between photon gas and ideal gas? 1+2=3

   (b) What is Bose-Einstein statistics? Derive an expression

   $$n_i = \frac{g_i}{e^{\alpha+\beta\varepsilon_i} -1}$$ 1+3=4

   Or

   Explain why behavior of liquid helium cannot be explained by classical statistics. How is it overcome by quantum mechanics? 4

   (c) Bosons may condense at very low temperature. Discuss on the basis of statistical mechanics. 4

5. (a) At absolute zero temperature ($T = 0$ K) all the energy levels up to ε_f are completely filled. Calculate the total number of fermions in a Fermi gas at $T = 0$ K and express ε_f in terms of number density (N/V). 6

   Or

   Derive an expression for Fermi-Dirac law of energy distribution for free electrons in a metal.

(Continued)

(b) What is the cause of degeneracy pressure inside a white dwarf star? Explain the limit depending on which some stars become white dwarf and other become neutron star or black hole.   1+5=6

Or

A system has 7 particles arranged in two compartments. The first compartment has 8 cells and the second has 10 cells. All cells are of equal size. Calculate the number of microstate in the microstate (3, 4) when the particles obey F-D statistics.   6

★★★