

Total Pages : 3

B.Sc./6th Sem (H)/PHS/23(CBCS)

2023

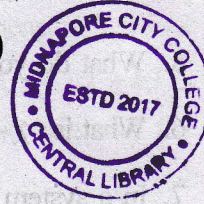
6th Semester Examination

PHYSICS (Honours)

Paper : C 14-T

[Statistical Mechanics]

[CBCS]



Full Marks : 40

Time : Two Hours

*The figures in the margin indicate full marks.  
Candidates are required to give their answers  
in their own words as far as practicable.*

**Group - A**

Answer any *five* questions :  $2 \times 5 = 10$

1. Show that electron gas in a white dwarf star is strongly degenerate and relativistic in nature. 2
2. Write statistical definition of temperature in terms of accessible microstates. Assuming the number of accessible microstates  $\Omega(E, V) \propto \left( V^N E^{\frac{3N}{2}} \right)$ , find the molar specific heat at constant volume. 2
3. Which among the Bose-Einstein and Fermi-Dirac statistics will be followed by (i) Neutrons, (ii) Alpha particles, (iii) Deuterium nuclei, and (iv)  ${}^3_2\text{He}$  atoms? 2

P.T.O.



( 2 )

4. Find the Fermi energy at  $T = 0\text{K}$  for metallic silver containing one free electron per atom. The density of silver is  $10.5\text{gm/cc}$  and atomic weight of silver is 108. 2
5. What do you mean by 'ultraviolet catastrophe'? 2
6. What is ' $\lambda$ -transition' in liquid Helium? 2
7. In a system 8 distinguishable particles are distributed in 2 compartments with equal a priori probability. Calculate the probabilities for the macrostates (i) (4, 4) and (ii) (3, 5). 2
8. What is Chandrasekhar limit? 2

**Group - B**

Answer any *four* questions : 5×4=20

9. What is Gibbs paradox? How is it resolved? 1+4
10. Define Saha's ionization formula and discuss one of its applications. 5
11. Explain B-E condensation in 3 dimension. How does it differ from ordinary condensation? Derive an expression for the critical temperature at which the phenomenon sets in. 5
12. For a completely degenerate Fermi gas of  $N$  molecules the density of states is given by

$$g(\epsilon)d\epsilon = ag_s V \epsilon^n$$

( 3 )

- where  $a$  and  $n$  are constants,  $g_s$  is spin degeneracy and  $V$  is the volume. Calculate the Fermi energy and total energy of the system at zero Kelvin temperature. 5
13. The specific heat of a metal (in three dimensions) at low temperatures can be represented by  $C_V = aT + bT^3$ , where  $a$  and  $b$  are constants. Explain the origin of the first term with necessary deduction. 5
14. Starting from Planck's law deduce (i) Rayleigh-Jeans law and (ii) Wien's law. 2½+2½

**Group - C**

Answer any *one* question : 10×1=10

15. (a) Calculate deviation of an ideal Fermi gas equation from the perfect gas equation for weak degeneracy. How is it related to gas degeneracy? 5+2
- (b) An atom has a non-degenerate ground state with energy  $\epsilon_0 = 0$  and a doubly degenerate excited state with energy  $\epsilon_1 = \epsilon$ . Calculate the specific heat at very low temperature ( $\beta\epsilon \gg 1$ ). 3
16. Write down the single particle partition function for a system having two non-degenerate energy levels with energies :  $\epsilon_1 = -\mu H$  and  $\epsilon_2 = \mu H$ . Evaluate entropy for this system. Hence discuss the concept of negative absolute temperature of such a two-level system. 4+4+2