18/08/2023

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Reg. No.....

SECOND SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, APRIL 2023

(CBCSS)

Physics

PHY 2C 07—STATISTICAL MECHANICS

(2019 Admission onwards)

Time : Three Hours Maximum : 30 Weightage

Section A

8 Short questions answerable within 7.5 minutes.
Answer **all** *questions, each question carries 1 weightage.*

1. Distinguish between microstate and macrostate.
2. State Liouville's theorem. What are its consequences ?
3. Show that the partition function of a molecule is equal to the product of the partition functions due to its various degrees of freedom.
4. Differentiate between an 'ideal gas' and an 'ideal classical gas'.
5. Draw curves for the distribution of energy in the spectrum of a black body at two different temperatures. List the result obtained from these curves.
6. How Maxwell-Boltzmann distribution can be considered as a limiting case of Bose-Einstein distribution ?
7. What do you mean by fluctuations ? When are these fluctuations negligible ?
8. Define Fermi energy. What is its significance at (i) $T = 0$ K ; and (ii) $T > 0$ K ?

(8 × 1 = 8 weightage)

Turn over

Section B

4 essay questions answerable within 30 minutes.
Answer any **two** *questions, each question carries 5 weightage.*

9. Explain the Gibbs paradox and its resolution by deriving the Sackur -Tetrode formula.
10. State and Prove Equipartition theorem and Virial theorem using canonical ensemble formalism. Illustrate with example.
11. Explain the quantum mechanical ensemble theory. Explain density matrix.
12. Discuss Landau theory of diamagnetism for an ideal Fermi Gas.

(2 × 5 = 10 weightage)

Section C

7 problems answerable within 15 minutes.
Answer any **four** *questions, each question carries 3 weightage.*

13. Ten distinguishable particles are to be placed in four energy levels with energies $0, \in, 2\in$ and $3\in$. If the total energy of the system consisting of these particles is $3\in$, find :
    (i) The number of possible microstates of the system ;
    (ii) The number of microstates corresponding to each macrostate ; and
    (iii) The total thermodynamic probability of the system.
14. The thermodynamic probability of an ideal gas increases from e^{10} to e^{10^3}. Find the change in its terms of the Boltzmann's constant k.
15. Find the average energy of an ideal classical gas in a canonical ensemble in temperature T.
16. For a Bose gas at 2 K, find the condensation fraction n_0/N and the gaseous fraction n_{ex}/N, if $T_c = 3.2$ K.
17. State and explain equipartition theorem.
18. The density of electron in lithium is $4.7 \times 10^{28} m^{-3}$. Calculate the degeneracy pressure of the electron gas in the metal.
19. Find out the wavelength corresponding to maximum emission by a black body at 500° C. Would you be able to see this radiation ?

(4 × 3 = 12 weightage)