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C 23369 (Pages : 2) Name.....

Reg. No.....

SECOND SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, APRIL 2022

(CBCSS)

Physics

PHY 2C 07—STATISTICAL MECHANICS

(2019 Admission onwards)

Time : Three Hours Maximum : 30 Weightage

General Instructions

1. *In cases where choices are provided, students can attend* **all** *questions in each section.*
2. *The minimum number of questions to be attended from the Section / Part shall remain the same.*
3. *The instruction if any, to attend a minimum number of questions from each sub section / sub part / sub division may be ignored.*
4. *There will be an overall ceiling for each Section / Part that is equivalent to the maximum weightage of the Section / Part.*

Section A

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

1. Differentiate between μ-space and Γ-space.
2. Explain Gibb's paradox.
3. A system has three energy levels ϵ, 2ϵ and 3ϵ. Determine the partition function
4. What do you mean by a grand canonical ensemble and write an expression for the density function?
5. State the postulates of equal a priori probability.
6. Why is the electronic contribution to the specific heat of a metal vary with temperature at low temperatures ?
7. How is Bose-Einstein condensation different from the ordinary condensation of a gas in physical space ?
8. What do you mean by an ideal Fermi Gas ?

(8 × 1 = 8 weightage)

Turn over

Section B

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

9. Derive Liouville's theorem and explain its consequences.
10. Explain microcanonical ensemble. Find the quantum states and the phase space of linear harm oscillator.
11. Derive Plank's formula for black body radiation using Bose-Einstein statistics. Using the re deduce Stefan's-Boltzmann law.
12. Explain Pauli Para magnetism and obtain the expression for susceptibility.

(2 × 5 = 10 weigh

Section C

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

13. The energy of a mole of an ideal gas at constant volume is doubled. How would the total nu of available microstates change ?
14. A composite system has two interacting systems 1 and 2 having thermodynamic probabi $\Omega_1 = 8 \times 10^{20}$ and $\Omega_2 = 3 \times 10^{19}$,
    (i) Calculate the individual entropies S_1 and S_2 of the two systems.
    (ii) Also calculate the total entropy and the thermodynamic probability of the composite s
15. A system in a canonical ensemble is at a temperature of 400 K. If the probability of the s being in a microstate 1 is 3 times the probability of it being in microstate 2, which of the two has higher energy and by how much ?
16. Find the condensation temperature for the vapour of Rb^{87} atom at a number den $n = 2.5 \times 10^{12}\ cm^{-3}$ treating it as a B.E gas.
17. Derive the density matrix for a system in a canonical ensemble.
18. TheFermi energy in silver is 5.49 eV. What is the average energy of a free electron in s 0K ? At what temperature would the molecules of an ideal classical gas have this much a energy ?
19. The cosmic microwave background radiation (CMBR) has a temperature of ≈ 2.7 K. Find wavelength λ_m corresponding to maximum spectral density of the cosmic background ra What photon energy corresponds to the maximum U_λ ?

(4 × 3 = 12 wei