

Roll No.

E-512

**M. Sc. (Second Semester) (Main/ATKT)
EXAMINATION, May-June, 2021**

PHYSICS

Paper Second

(Statistical Mechanics)

Time : Three Hours]

[Maximum Marks : 80

Note : Attempt all Sections as directed.**Section—A**

1 each

(Objective/Multiple Choice Questions)**Note :** Attempt all questions.

Choose the correct answer :

1. According to Liouville theorem the rate of change of density ρ of phase points in phase space is given by :

- (a) $\frac{\partial \rho}{\partial t} = \infty$
 (b) $\frac{\partial \rho}{\partial t} = 0$
 (c) $\frac{\partial \rho}{\partial t} = \text{negative}$
 (d) $\frac{\partial \rho}{\partial t} = 1$

2. In a canonical ensemble, the quantities same for each system are :
 (a) Temperature, volume and the number of particles
 (b) Energy, volume and the number of particles
 (c) Only energy
 (d) Only volume and the number of particles
3. The entropy of a system in an irreversible adiabatic process :
 (a) Decreases
 (b) Increases
 (c) Unchanged
 (d) Nothing can be said.
4. Four distinguishable coins are tossed many times. The most probable macrostate will be :
 (a) 0, 4
 (b) 1, 3
 (c) 2, 2
 (d) 3, 1
5. In a microcanonical ensemble, each system has the same :
 (a) Energy and chemical potential
 (b) Temperature and number of particles
 (c) Temperature and chemical potential
 (d) Energy and number of particles

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6. Boltzmann's partition function z is :

(a) $e^{-\beta/\epsilon_r}$

(b) $\sum_r g_r e^{-\beta/\epsilon_r}$

(c) $\frac{\sum_r g_r e^{-\beta/\epsilon_r}}{\sum_r \epsilon_r}$

(d) $\frac{\sum_r \epsilon_r g_r e^{-\beta/\epsilon_r}}{\sum_r g_r e^{-\beta/\epsilon_r}}$

7. Electrons obey :

(a) M. B. Statistics

(b) B. E. Statistics

(c) F. D. Statistics

(d) All of the above

8. Particles can be considered distinguishable if :

(a) $\frac{n_i}{g_i} \ll 1$

(b) $\frac{n_i}{g_i} \gg 1$

(c) $\frac{n_i}{g_i} \lesssim 1$

(d) None of the above

9. Fermions are not :

(a) Molecules

(b) Electrons

(c) Protons

(d) Neutrons

10. Two particles obeying the Fermi-Dirac statistics are divided in 6 energy levels. The number of possible arrangements will be :

(a) 36

(b) 15

(c) 12

(d) 8

11. The Brownian motion becomes more vigorous :

(a) When temperature is increased and viscosity of supporting fluid is decreased.

(b) When temperature is decreased and viscosity of supporting fluid is increased.

(c) When temperature and viscosity of supporting fluid is increased.

(d) None of the above

12. For Bose gas, the chemical potential μ is always :

(a) Positive

(b) Zero

(c) Negative

(d) None of the above

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13. He^4 obeys the :
- (a) B. E. Statistics
 - (b) F. D. Statistics
 - (c) M. B. Statistics
 - (d) None of the above
14. Liquid He II has :
- (a) Low entropy and high viscosity
 - (b) Zero entropy and zero viscosity
 - (c) Zero entropy and low viscosity
 - (d) High entropy and high viscosity
15. It is possible from the study of Brownian motion to determine the value of :
- (a) Avogadro number
 - (b) Boltzmann constant
 - (c) Both (a) and (b)
 - (d) None of the above
16. For a system with a large value of degree of freedom, the fluctuation is :
- (a) Large
 - (b) Negligible
 - (c) Zero
 - (d) None of the above

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17. Transition from non-ferromagnetic state to ferromagnetic state is a phase transition of :
- (a) First order
 - (b) Second order
 - (c) Zero order
 - (d) Not a phase transition
18. If D is coefficient of diffusion and B is mobility, then the correct form of Einstein relation in fluctuation is :
- (a) $D = \frac{B}{kT}$
 - (b) $D = B.kT$
 - (c) $D = \frac{T}{kB}$
 - (d) None of the above
19. If ρ is the function of some property of the ensemble which is independent of time the ensemble is in :
- (a) Thermal equilibrium
 - (b) Statistical equilibrium
 - (c) Mechanical equilibrium
 - (d) Particle equilibrium
20. The mean distance between molecular of a gas :
- (a) Increases as density increases
 - (b) Decreases as density increases
 - (c) Increases with increasing temperature
 - (d) None of the above

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Section—B

2 each

(Very Short Answer Type Questions)

Note : Attempt all questions.

1. Explain phase space.
2. Define micro-canonical ensemble.
3. Explain macroscopic states.
4. Define energy fluctuations in the canonical ensemble.
5. Discuss the density of states.
6. Describe the property of ideal Fermi gas.
7. Define white dwarf stars.
8. Explain thermo-dynamic fluctuations.

Section—C

3 each

(Short Answer Type Questions)

Note : Attempt all questions.

1. Explain volume in phase space.
2. State the conditions of F. D. Statistics.
3. Explain contact between statistics and thermodynamics.
4. State and prove Liouville's theorem.
5. Explain electron gas in metals.
6. State the properties of liquid Helium II.
7. What do you understand by viral equation of state ?
8. Discuss the density of states.

Section—D

5 each

(Long Answer Type Questions)

Note : Attempt any *four* questions.

1. Explain phase space and quantum state. Obtain an expression for the volume element of the phase space and number of quantum states corresponding to this volume state.
2. Write in brief about partition function of canonical ensemble.

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3. Explain in brief Boltzmann's transport equation.
4. Write the difference between M. B., F. D. and B. E. Statistics.
5. What is degenerate electron gas ? Calculate Fermi energy of degenerate electron gas.
6. State and prove fluctuation dissipation theorem.
7. What is Brownian motion ? Discuss Einstein-Smoluchowski theory of Brownian motion.
8. Derive expression for the most probable distribution of particles according to Bose-Einstein's Statistics.

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