

Reg. No

Name

M. Sc DEGREE END SEMESTER EXAMINATION - MARCH 2020**SEMESTER 2 : PHYSICS****COURSE : 16P2PHYT08 : THERMODYNAMICS AND STATISTICAL MECHANICS***(For Regular - 2019 Admission & Supplementary 2018/2017/2016 Admissions)*

Time : Three Hours

Max. Marks: 75

Section A**Answer All the Following (1 mark each)**

- If system expands at constant pressure then its called:
(a) Isothermal (b) Isobaric (c) adiabatic (d) none of these
- At low temperatures for a diatomic molecule having only vibrational motion will have heat capacity
(a) k_B (b) exponentially decreasing (c) linearly decreasing (d) Constant
- Why do we observe only mean values of thermodynamic quantities?
(a) Because the systems in the statistical ensemble are spread over the microstates, and our experimental apparatus averages over all of them.
(b) Because the probability of occurrence of it is a Gaussian distribution centred around the mean value, and for a Gaussian distribution the mean value coincides with the position of the maximum.
(c) Because the magnitude of fluctuations is negligible with respect to the mean value of thermodynamic quantities.
(d) All the above
- Why the definition of the entropy of a system with f degrees of freedom is independent of the energy scale dE ?
(a) Because the definition of the entropy does not depend explicitly on the energy scale dE .
(b) Because the number of states in the energy interval $[E, E+dE]$ is of the order of E^f .
(c) Because the ratio of the different energy scales is at most of the order of $\ln(f)$, whereas the entropy is of the order to f .
(d) All the above
- Chemical potential of phonon is
(a) 0 (b) 1 (c) Temperature (d) Fermi Energy

(1 x 5 = 5)

Section B**Answer any 7 (2 marks each)**

- How do one calculate equation of state?
- Two independent systems A and B undergo an approach to thermal equilibrium. Obtain the expression for the rate of change of entropy with time.
- What is meant by micro-canonical ensemble? Explain with example.
- Write down the expression for Enthalpy.
- Obtain C_v for a monoatomic gas.
- Obtain C_p for a diatomic gas.
- Obtain average Energy in terms of free energy.
- What is a Fermi wave vector?
- Obtain the grand partition function of a Fermi and bose system for a particular 'k'.
- Discuss the Fermi Dirac distribution function $n(k)$ for low temperatures graphically? (2 x 7 = 14)

Section C**Answer any 4 (5 marks each)**

16. In how many ways can you choose from 12 objects, three subgroups containing 3,4 and 5 objects respectively.
17. A manufacturer knows that their resistors have values which are distributed as a Gaussian probability distribution with a mean resistance of 100Ω and standard deviation of 5Ω . What percentage of resistors have resistances between 95 and 105?.
18. A system has 2 energy levels with an energy gap of 3.2×10^{-21} J; the upper level is twofold degenerate, the lower level is occupied if the system is in thermal contact with a heat bath at a temperature of 150 K?
19. Calculate the partition function in 3 dimensions for a particle whose energies varies as $e(k) = ak^3$
20. Consider the reaction $3O_2 \rightleftharpoons 2O_3$. Identify the stoichiometric coefficients. What is the condition for chemical equilibrium between oxygen and ozone?
21. Obtain the expression for chemical potential for a free particle.

(5 x 4 = 20)

Section D**Answer any 3 (12 marks each)**

- 22.1. Discuss the calculation of the increase in entropy in any 2 irreversible process.
OR
2. Show that among engines operating between the same 2 temperatures, the Carnot engine is the most efficient.
- 23.1. Show that the Translation motion of a single particle in 3 dimension gives a heat capacity of $3k_B/2$.
OR
2. State and prove equipartition theorem.
- 24.1. Discuss the conditions for chemical equilibrium in terms of chemical potentials by taking an example.
OR
2. Show that the pressure due to a black body radiation is given as $1/3$ of the internal energy density.

(12 x 3 = 36)