



DCJ-003-2016032

Seat No. _____

B. Sc. (Sem. VI) (CBCS) (W.E.F. 2019) Examination

July - 2022

Physics : P-602

(Statistical Mechanics & Solid State Physics)

(New Course)

Faculty Code : 003

Subject Code : 2016032

Time : $2\frac{1}{2}$ Hours]

[Total Marks : 70

- Instructions :** (1) All questions are compulsory.
(2) Figures on right hand side indicate marks.
(3) Symbols have their usual meanings.

- 1 (a) Write a short answer to the following : 4
- (1) F-D statistics is applicable to particles which are identical and distinguishable
– Is it true or false ?
 - (2) "fermions" are identical and indistinguishable particles with _____ spin.
 - (3) In case of B-E statistics, only one particle can be accommodated in a given quantum state or a cell.
– Do you agree ?
 - (4) An interchange of phase points between two cells gives rise to a new microstate.
– Is it true or false ?
- (b) Answer in brief for the following : (any one) 2
- (1) Using uncertainty principle show that the minimum volume of a cell in a phase space is h^3 .
 - (2) If an energy level having degeneracy $g_i = 4$ is to be occupied by 3 particles. Find the number of ways to arrange them in case of F-D statistics.
- (c) Answer the following : (any one) 3
- (1) Give comparison between M-B, B-E and F-D statistics.
 - (2) State and prove the Sterling's approximation.

- (d) Answer in detail : (any one) 5
- (1) Derive the most probable distribution formula for M-B statistics.
 - (2) Derive the distribution law for Fermi-Dirac statistics.
- 2 (a) Write a short answer to the following : 4
- (1) The alkali metals like Na, Li have a _____ crystal structure.
 - (2) In covalent bond, spins of two electrons are parallel.
– Do you agree ?
 - (3) Covalent bonds are _____ (transparent / opaque) short wavelength radiation.
 - (4) According to Debye, a solid is an isotropic elastic continuum.
– Is it true or false ?
- (b) Answer in brief for the following : (any one) 2
- (1) Sketch the diagram showing cubic crystal having Miller indices (111).
 - (2) In case of solids, if the Plank's constant is increased ten times then what will be the effect on its specific heat C_V ?
- (c) Answer the following : (any one) 3
- (1) Explain Simple Cubic (SC) structure.
 - (2) Write a note on Ionic crystal.
- (d) Write in detail : (any one) 5
- (1) Describe in detail : Hexagonal Closed Packed (hcp) crystal.
 - (2) Discuss : The Einstein model for Specific heat of solids.
- 3 (a) Write a short answer to the following : 4
- (1) For most metals, resistivity is directly proportional to the pressure.
– Is it true or false ?
 - (2) Write Wiedemann-Franz relation.
 - (3) The characteristic property of metals is their _____ lustre. (low / high)
 - (4) The value of Fermi energy changes with size of metal.
– Do you agree ?

- (b) Answer the following : (any one) 2
- (1) The number of free electrons per unit volume of Silver is 5.85×10^{28} . Calculate Fermi energy for it.
 - (2) The Fermi energy for Sodium is 3.1 eV. Calculate Fermi velocity for it.
- (c) Answer the following : (any one) 3
- (1) Write a note on momentum space.
 - (2) Describe criticism of Sommerfelds theory.
- (d) Write in detail : (any one) 5
- (1) Discuss quantum theory of free electron in one-dimensional box.
 - (2) Describe Drude-Lorentz theory.
- 4 (a) Write a short answer to the following : 4
- (1) Semiconductors have _____ temperature coefficient of resistance. (positive/negative)
 - (2) Define mobility of charge carrier.
 - (3) In case of "excess" semiconductors, the Hall coefficient is negative.
– Do you agree ?
 - (4) Measurement of Hall coefficient gives the information about the sign of the charge carrier.
– Is it true or false ?
- (b) Answer the following : (any one) 2
- (1) At room temperature, resistivity of n-type Ge atom is 0.01 ohm-m. If the mobility of electron is $0.39 \text{ M}^2/\text{Volt-sec}$, then find the donor concentration.
 - (2) Find the mobility of electrons in copper if its resistivity is $1.7 \times 10^{-6} \text{ ohm-cm}$ and Number density is $8.49 \times 10^{22} \text{ CM}^{-3}$.
- (c) Answer the following: (any one) 3
- (1) Describe applications of semiconductors.
 - (2) Explain conductivity of semiconductors.
- (d) Write in detail : (any one) 5
- (1) Describe Hall effect in detail.
 - (2) Discuss: Simplified model of an intrinsic semiconductors.

- 5 (a) Write a short answer to the following : 4
- (1) Onnes found that the resistance of mercury drops suddenly to almost zero when the temperature falls below _____ °C.
 - (2) A superconductor exhibits a perfect diamagnetism.
– Is it true or false ?
 - (3) For alloys, the transition temperature is extremely high.
– Do you agree ?
 - (4) In case of superconductors, when atomic mass of isotopes _____ (increases/decreases), its critical temperature decreases.
- (b) Answer the following : (any one) 2
- (1) Transition temperature of Hg having average mass 200 a.m.u. is 4.153 K. If one of its isotope has 204 a.m.u. mass, find its transition temperature.
 - (2) If Initial magnetic field is 20.7×10^5 amp/m at 4.2 K temperature for a superconducting specimen, find critical field at critical temperature 14.5 K.
- (c) Answer the following : (any one) 3
- (1) Explain Meissner effect.
 - (2) Discuss properties which do not change in superconducting transition.
- (d) Write in detail : (any one) 5
- (1) Write a note : Applications of superconductivity.
 - (2) Explain in detail : London's theory.
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