Seat No. _____

HA-003-2016032

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

April - 2023

Physics : P-602

(Statistical Mechanics and Solid State Physics)

(New Course)

Faculty Code : 003

Subject Code : 2016032

Time : $2\frac{1}{2}$ / 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) Which statistics is applicable to particles which are identical and distinguishable ?
   (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) State and prove the Sterling's theorem.
   (2) Derive an equation of volume in Phase space in terms of momentum.

(d) Answer in detail : (any one)   **5**
    (1) Derive the most probable distribution formula for M-B statistics.
    (2) Derive the distribution law for Bose-Einstein 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. – Is it true ?
    (3) Covalent crystals are _____ (transparant/opaque) to short wavelength radiation.
    (4) According to Debye, a solid is an isotropic elastic continuum. – Do you agree ?

(b) Answer in brief for the following : (any one)   **2**
    (1) Draw a figure for a cubic crystal having Miller indices (100).
    (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. (True/False)
    (2) Write Widemann - Franz relation.
    (3) The characteristic property of metals is their _____ luster. (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 Fermi energy for Sodium is 3.1 eV. Calculate Fermi velocity for it.
    (2) The number of free electrons per unit volume of Silver is 5.85×10^{28}. Calculate Fermi energy for it.

(c) Answer the following : (any one)   3
    (1) Write a note on momentum space.
    (2) Describe criticism of Sommerfeld's theory.

(d) Write in detail : (any one)   5
    (1) Describe Drude-Lorentz theory.
    (2) Discuss quantum theory of free electron in one-dimensional box.

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) Find the mobility of electrons in copper if its resistivity is 1.7×10^{-6} ohm-cm and number density is 8.49×10^{22} cm^{-3}.
    (2) At room temperature, resistivity of N-type Ge atom is 0.01 ohm-m. If the mobility of electron is 0.39 m^2/volt-sec, then find the number of electrons per unit volume for this semiconductor.

(c) Answer the following : (any one)   3
    (1) Describe importance of the Hall effect.
    (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 _____ °K.
    (2) A superconductor exhibits a perfect _____. (ferromagnetism/diamagnetism)
    (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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