



RY-003-106032

Seat No. _____

B. Sc. (Sem. VI) (CBCS) (W.I.F. 2016) Examination

March - 2019

Physics : Paper - 602

(Statistical Mechanics and Solid State Physics)

Faculty Code : 003

Subject Code : 106032

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) "fermions" are identical and indistinguishable particles with _____ spin.
 - (2) In case of B-E statistics, only one particle can be accommodated in a given quantum state or a cell. Is it true or false ?
 - (3) An interchange of phase points between two cells gives rise to a new microstate, but macrostate for that remains same. Do you agree with this ?
 - (4) M-B statistics is applicable to particles which are identical and distinguishable. 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) In case of Sodium, Fermi level (kinetic energy) is 18.2×10^{-19} joule. Calculate velocity of electron at the Fermi level. ($m = 9.1 \times 10^{-31}$ kg)

- (C) Answer the following : (Any One) 3
- (1) State and prove the Sterling's approximation.
 - (2) Give comparison between M-B, B-E and F-D statistics. (any three points)
- (D) Answer in detail : (Any One) 5
- (1) Discuss in detail : Distribution law for Maxwell-Boltzmann statistics.
 - (2) Derive the distribution law for Fermi-Dirac statistics.
- 2 (A) Write a short answer to the following : 4
- (1) Define "basis" in crystal structure.
 - (2) In covalent bond, spins of two electrons are parallel. Do you agree ?
 - (3) What is specific heat ? Define.
 - (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 (010).
 - (2) In case of solids, if the Plank's constant is increased ten times then what effect will be 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 : Miller indices and procedure to determine them.
 - (2) Discuss: The Einstein model for Specific heat of solids.
- 3 (A) Write a short answer to the following : 4
- (1) Free electron gas in a metal can be considered as dense plasma. Is it true or false ?
 - (2) Define : density of states.
 - (3) Write formula for work function (ϕ) of metal.
 - (4) Fermi function $f(E) = 0$ for all values of $E < E_F$
Do you agree ?

- (B) Answer the following : (Any One) 2
- (1) For free electron gas, using Fermi-Dirac distribution law show that $f(E) = 1/2$ for electron having energy $E = E_F$
 - (2) Obtain the formula of wavelength associated with an electron having an energy equal to Fermi energy.
- (C) Answer the following : (Any One) 3
- (1) Derive formula for the density of states in one dimension.
 - (2) Explain in brief : Thermal capacity of free electron system.
- (D) Write in detail : (Any One) 5
- (1) Discuss free electron gas in a one dimensional box and derive the equation for normalized wave function.
 - (2) Discuss in detail : The Hall effect.
- 4 (A) Write a short answer to the following : 4
- (1) What is forbidden band ?
 - (2) In intrinsic semiconductors the Fermi level lies exactly half way between valance band and conduction band at 0 K. Do you agree ?
 - (3) In intrinsic semiconductors the width of forbidden gap is about $0.01 eV$. Is it true or false ?
 - (4) Give a name of any donor impurity.
- (B) Answer the following : (Any One) 2
- (1) Calculate the Fermi level (E_F) for an intrinsic semiconductor having band gap $E_g = 0.7 eV$.
(Given : $K_B T = 0.026 eV$, $m_p^* = 6m_e^*$ and $\ln 6 = 1.8$)
 - (2) Find free electrons concentration (n_e) in N-region of Germanium p-n junction if its conductivity (σ_e) is $2000 (\Omega - m)^{-1}$ and mobility of electron (μ_e) is $0.4 m^2 (V - s)^{-1}$

- (C) Answer the following : (Any One) 3
- (1) Explain effect of impurities in semiconductors.
 - (2) Discuss bonding in semiconductors.
- (D) Write in detail : (Any One) 5
- (1) Describe electron-hole carrier concentration.
 - (2) Discuss in detail : Donor states
- 5** (A) Write a short answer to the following : 4
- (1) Kammerlingh found that the resistance of mercury drops suddenly to almost zero when the temperature falls below _____ K.
 - (2) A superconductor exhibits a perfect ferromagnetism. Is it true or false ?
 - (3) For alloys, the transition temperature is extremely high. Do you agree ?
 - (4) If very high magnetic field is applied to the superconductors, its superconductivity will be destroyed. Is it true or false ?
- (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 14.5K
- (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) Explain : London's theory
 - (2) Write a note : Applications of superconductivity.