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JB-003-1016032 Seat No. _____

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

August – 2019

Physics : Paper - 602

(Statistical Mechanics And Solid State Physics)

(New Course)

Faculty Code : 003
Subject Code : 1016032

Time : $2\frac{1}{2}$ Hours] [Total Marks : **70**

Instructions : (1) Symbols and notations have their usual meaning.
(2) Total marks of the question are indicated on the right side of the question.
(3) Attempt as many questions as instructed in the main question.

UNIT - 1

1 (A) Objective type questions : (1 mark each) **4**
(1) How many coordinates does the phase space have? Which?
(2) The electrons are regarded as Fermions. The statement is true or false?
(3) Which type of statistical laws are applicable to Photons ?
(4) What is the least volume occupied by the phase cell?

(B) Answer in brief : (any **one** out of two) **2**
(1) Suppose at N.T.P. a gas has a molecular density of $10^{19} molecules/cm^3$, if the average radius of the molecule of gas is $10^{-8} cm$, show that the gas molecules are distinguishable particles.
(2) Find the value of 50! using Striling's approximation.

(C) Answer in detail : (any **one** out of two) **3**
(1) Discuss Stirling's approximation.
(2) Compare and discuss the BS statistics and FD statistics.

(D) Write notes on following : (any **one** out of two) **5**
(1) Discuss in detail the Maxwell-Boltzmann distribution laws.
(2) Discuss in detail the Fermi-Dirac distribution laws.

UNIT - 2

2 (A) Objective type questions : (1 mark each) **4**

(1) Give the names of seven crystal systems.

(2) How many Bravais lattices are possible for Tetragonal system?

(3) Give one example of Ionic crystal and Covalent crystal.

(4) Define Heat capacity.

(B) Answer in brief : (any **one** out of two) **2**

(1) In a cubic system with lattice constant 'a' calculate the spacing between planes of $(1\,0\,0), (1\,1\,0), (1\,1\,1)$ and $(1\,0\,1)$

(2) $NaCl$ crystallizes as cubic structure. The molecular weight of $NaCl$ is $58.46\ gm$ and the density at room temperature is $2.167\ gm/cm^3$, calculate the lattice constant of the cubic unit cell. (Avogadro number is $6.02 \times 10^{23} mole^{-1}$)

(C) Answer in detail : (any **one** out of two) **3**

(1) Write a note on the covalent crystals.

(2) Write a note on Miller indices in crystalline solids.

(D) Write a note on following : (any **one** out of two) **5**

(1) Write detailed note on classical theory of heat capacity of solids.

(2) Write detailed note on the Einstein's model for heat capacity of solids.

UNIT - 3

3 (A) Objective type questions : (1 mark each) **4**

(1) What is the Wiedemann-Frantz ratio in metal? What does it signify?

(2) Define density of available electronic states $D(E)$ in Free electron model?

(3) Define Fermi energy level in the Free electron model of metals.

(4) Which type of statistical distribution law was applied by Sommerfield in his modification to the Free electron model for metals.

(B) Answer in brief : (any **one** out of two) **2**

(1) Calculate the number of the energy states available for electrons in one cubic cm of box lying below the energy of $1\,eV$.

(2) Evaluate the temperature at which there is 25% probability that a state with energy $0.5\,eV$ above the Fermi energy level would be occupied by electron.

(C) Answer in detail : (any **one** out of two) **3**

(1) Derive the equation for calculating the Fermi energy levels in the metal having volume V and N free electrons.

(2) Explain the classification of Conductors and Insulators based on band diagram.

(D) Write note on following : (any **one** out of two) **5**

(1) Write a detailed note on Boltzmann transport equation.

(2) Using the Sommerfield modification to the electronic part of the heat capacity of metal write the detailed note on the thermal conductivity of metals.

UNIT - 4

4 (A) Objective type questions : (1 mark each) **4**

(1) The Fermi level lies half way between the valance and the conduction band in insulators. The statement is true or false?

(2) P and N type semiconductors are called intrinsic semi-conductors. True or False?

(3) The energy band gap in Germanium semiconductor is higher than that in Silicon semiconductor. True or False?

(4) The resistivity of semiconductors decreases with temperature. True or False?

(B) Answer in brief : (any **one** out of two) **2**

(1) If the Fermi level in n-type semi-conductor lies $0.4\,eV$ below the conduction band. What is the proportion of the donor impurity compared to the total charge carried at $300K$ temperature.

(2) For an intrinsic semiconductor with $E_g = 0.7\,eV$ determine the position of the Fermi level at $300K$ if $m_p^* = 6m_e^*$.

(C) Answer in detail : (any **one** out of two) **3**

(1) Explain in brief the bonding in semiconductor.

(2) Explain effect of impurities on intrinsic semi-conductor.

(D) Write a note on following : (any **one** out of two) **5**

(1) Discuss carrier concentration in intrinsic semi-conductor

(2) Discuss Fermi level in extrinsic semiconductor.

UNIT - 5

5 (A) Objective type questions : (1 mark each) **4**

(1) The superconducting state was first observed in which material?

(2) Which type of magnetism is seen in the superconducting state?

(3) What do the terms T_c and H_c denote in superconductivity?

(4) Cupper pairing is mediated by phonons.
The statement is true or false?

(B) Answer in brief : (any **one** out of two) **2**

(1) If the density of Lead is $11.3 \times 10^3 kg/m^3$ and atomic weight is 207.19, then calculate the London penetration depth at $0\,K$.

(2) For Aluminium the $H_0 = 99\,Gauss$ and $T_c = 1.18K$, then calculate the value of critical field H_c at the temperature $T = 0.5K$

(C) Answer in detail : (any **one** out of two) **3**

(1) Explain in brief the influence of external agents on superconducting state.

(2) Explain in brief the London theory of superconductivity.

(D) Write notes on following : (any **one** out of two) **5**

(1) Write detailed note on the thermodynamics of superconductivity.

(2) Write detailed note on the Josephson effect in superconductivity.
