

PHY-503**Solid State Physics**

M. Sc. PHYSICS (MSCPHY-12/13/16/17)

First Year, Examination, 2018

Time : 3 Hours**Max. Marks : 80**

Note : This paper is of **eighty (80)** marks containing **three (03)** Sections A, B and C. Learners are required to attempt the questions contained in these Sections according to the detailed instructions given therein.

Section-A**(Long Answer Type Questions)**

Note : Section 'A' contains four (04) long answer type questions of nineteen (19) marks each. Learners are required to answer *two* (02) questions only.

1. Which is the most densely packed structure among the various cubic structures ? Determine the packing fraction of this type of crystal. Give some example of this type of crystal and draw the structure of such a crystal.
2. (a) Describe with suitable diagrams edge dislocations and screw dislocations in crystal lattice.
(b) Discuss a method of investigation of the structure of a single crystal using X-ray.

3. What are Brillouin zones ? How are they related to the energy level of an electron in a metal ? How does zone theory explain the conducting or insulating character of a material.
4. Give an account of the various theories of specific heat of solid. Discuss any *one* of them in detail.

Section–B

(Short Answer Type Questions)

Note : Section ‘B’ contains eight (08) short answer type questions of eight (08) marks each. Learners are required to answer *four* (04) questions only.

1. Find the Miller indices of a set of parallel planes which make intercepts in the ratio $3a : 4b$ on the x and y -axes and are parallel to z -axis. a , b and c are primitive vectors of the lattice.
2. Derive the London equation and explain the term coherence length.
3. What are phonons ? Explain the law of conservation of energy and momentum in the case of inelastic scattering of a photon by phonon.
4. What are paramagnetic and diamagnetic materials ? Give examples. Discuss the temperature variation of magnetic susceptibilities of paramagnetic and diamagnetic materials.
5. Write down the expression for density of electrons and holes in an intrinsic semiconductor. Equating these two equations arrive at an expression for Fermi level. Discuss the significance of this equation.
6. Explain, what is meant by polarization in dielectrics. Arrive at the relation between the dielectric constant and atomic polarizability.

7. Give the energy level diagram of ruby laser. Explain how population inversion and light amplification is obtained in this laser
8. What is Hall Coefficient ? With the help of relevant theory explain how Hall effect experiment is used to distinguish between n -type and p -type semiconductors.

Section–C

(Objective Type Questions)

Note : Section ‘C’ contains ten (10) objective type questions of one (01) mark each. All the questions of this Section are compulsory.

Choose the correct alternative :

1. If r is the radius of the atom in a crystal crystallizing in the simple cubic structure, then the nearest neighbour distance is :
 - (a) $r/2$
 - (b) $4 r$
 - (c) $2 r$
 - (d) None of the above
2. The nearest neighbour distance in the case of bcc structure is :
 - (a) $(a \sqrt{3})/2$
 - (b) $(a \sqrt{2})/2$
 - (c) $2 a / \sqrt{2}$
 - (d) $2 a / \sqrt{3}$

3. At lower temperature the lattice specific heat varies as :

(a) T^3

(b) $1/T^3$

(c) T

(d) $1/T$

4. The classical expression for the electrical conducting of a metal in terms of mass of electron charge of electron, concentration and collision time is given by :

(a) $m n e \tau$

(b) $m e \tau / n$

(c) $n e^2 \tau / m$

(d) $n e^2 \tau^2 / m$

5. Transition temperature T_c and critical field H_c for a superconductor are related as :

(a) $H_c = H_o (T_c - 1)$

(b) $H_c = H_o (T_c + 1)$

(c) $T_c = T_o \left[1 - \left(\frac{H_o}{H_c} \right)^2 \right]$

(d) $H_c = H_o \left[1 - \left(\frac{T}{T_c} \right)^2 \right]$

6. The magnetic dipole moment is the product of current in the loop and :
- (a) flux enclosed by current loop
 - (b) area enclosed by current loop
 - (c) square of area enclosed by current loop
 - (d) None of the above
7. Diamagnetic material process :
- (a) permanent magnetic dipoles
 - (b) no permanent magnetic dipoles
 - (c) induced dipole moment
 - (d) None of the above
8. At Curie temperature the spontaneous magnetization for ferromagnetic material is :
- (a) infinity
 - (b) 1
 - (c) zero
 - (d) None of the above
9. The Fermi level in an n -type semiconductor at 0 K lies :
- (a) below the donor level
 - (b) half way between the conduction band and donor level
 - (c) coincide with intrinsic Fermi level
 - (d) None of the above

10. The density of carriers in a pure semiconductor is proportional to :

(a) $\exp (- E_g / k_B T)$

(b) $\exp (-2 E_g / k_B T)$

(c) $\exp (- E_g / k_B T^2)$

(d) $\exp (- E_g / 2 k_B T)$