B.Sc. (Part—III) Semester—VI Examination

6S-PHYSICS

(Statistical Mechanics and Solid State Physics)

Time : Three Hours]   [Maximum Marks : 80

Note :— (1) All questions are compulsory.

   (2) Draw neat and well labelled diagrams wherever necessary.

1. (A) Fill in the blanks :—   2

    (i) The SI unit of conductivity is _____ .

    (ii) Colour of nanoparticle changes with _____ of the nanoparticles.

    (iii) There are _____ Bravais lattices.

    (iv) A combination of _____ and momentum space is known as phase space.

  (B) Choose the correct alternative :—   2

    (i) The coordination number of Simple Cubic (SC) crystal is :

      (a) six   (b) eight

      (c) ten   (d) twelve

    (ii) Pauli's exclusion principle is applicable to :

      (a) M-B Statistics   (b) B-E Statistics

      (c) F-D Statistics   (d) Both

    (iii) The unit of magnetic susceptibility is :

      (a) Ampere/m   (b) Henry/m

      (c) Weber   (d) No unit

    (iv) Type-I superconductor exists in :

      (a) Two States   (b) Three States

      (c) Four States   (d) Five States

  (C) Answer the following in **one** sentence :—   4

    (i) What are "quantum dots" ?

    (ii) Define magnetisation.

    (iii) Define Fermi energy.

    (iv) What is microstate ?

EITHER

2. (A) State the principle of equal Priori Probability.   2

  (B) Explain unit cell.   2

  (C) Derive an equation for Boltzmann Entropy relation.   8

OR

3. (P) What are Microstate and Macrostate ? 4

   (Q) Using M-B distribution Law, derive an expression for M-B distribution of molecular speeds and hence show that most probable velocity of molecule is $V_p = \sqrt{\dfrac{2KT}{m}}$. 6

   (R) Explain concept of phase space. 2

EITHER

4. (A) Explain distinguishable and indistinguishable particles. 2

   (B) Derive F-D distribution law. 7

   (C) Show that the energy levels above the Fermi level are empty and below the Fermi level are occupied at absolute zero. 3

OR

5. (P) What are Bosons ? State the properties of Bosons. 4

   (Q) Using BE distribution law, derive Planck's law of blackbody radiation. 6

   (R) State conditions of applicability of F-D Statistics. 2

EITHER

6. (A) Distinguish between amorphous solids and crystalline solids. 4

   (B) Derive Bragg's Law for X-ray diffraction. 4

   (C) Explain Schottky defects in the crystal. 4

OR

7. (P) What are plane defects ? Explain grain boundaries and stacking faults. 5

   (Q) Explain X-ray diffraction method to determine lattice parameter of crystal. 4

   (R) Find the Miller Indices of the crystal plane having intercepts at a, 3b and ∞ on x, y and z axes respectively. 3

EITHER

8. (A) Explain the motion of electrons in metal and hence derive an expression for drift velocity of electrons. 4

   (B) State and explain Bloch theorem. 5

   (C) Explain insulator on the basis of band theory of solid. 3

OR

9. (P) Explain formation of conduction band, valence band and energy gap in solids. 4

   (Q) Derive an expression for electrical conductivity in terms of mean free path of electrons in a metal. 5

   (R) Distinguish metal, semiconductor and insulator on the basis of Band theory of solids. 3

EITHER

10. (A) What is magnetic permeability ? State Curie-Weiss law.   2

    (B) State the properties of paramagnetic materials.   4

    (C) State the failures of Langevin's theory of paramagnetism and hence give quantum theory of paramagnetism.   6

OR

11. (P) Define magnetization and magnetic susceptibility.   2

    (Q) Explain the properties of diamagnetic material.   4

    (R) Derive expression for diamagnetic susceptibility on the basis of Langevin's theory of diamagnetism in brief.   6

EITHER

12. (A) Explain Type I and Type II superconductors.   4

    (B) Give brief idea of BCS theory of Superconductivity.   6

    (C) State applications of superconductors.   2

OR

13. (P) What is Meissner Effect ?   1

    (Q) Explain critical temperature and critical magnetic field in superconductor.   3

    (R) Explain the effect of reduction in size on the physical properties of nanomaterials.   4

    (S) State different applications of nanomaterials.   4