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

6S-PHYSICS

(Statistical Mechanics and Solid State Physics)

Time : Three Hours] [Maximum Marks : 80

Note :– Attempt **all** questions.

1. (A) Fill in the blanks : 2

(i) The phase space of N particles have _____ dimensions.

(ii) Quantum statistics is applicable to identical and _____ particles.

(iii) Schottky defects are _____ defects.

(iv) Superconductors are perfectly _____.

(B) Choose correct alternative of the following : 2

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

(a) M-B statistics

(b) B-E statistics

(c) F-D statistics

(d) None of these

(ii) Structure of NaCl crystal is :

(a) BCC

(b) FCC

(c) Simple cubic

(d) Hexagonal

(iii) For diamagnetic materials, magnetic susceptibility is :

(a) small and negative

(b) small and positive

(c) large and negative

(d) large and positive

(iv) Nanometer is equal to :

(a) 10^{-3}m

(b) 10^{-6}m

(c) 10^{-7}m

(d) 10^{-9}m

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

(i) What are Bosons ?

(ii) What is point defect ?

(iii) What is Curie temperature ?

(iv) On what factors properties of nanomaterial depend ?

EITHER

2. (A) Write expression for thermodynamic probability in M-B distribution and find expression for M-B distribution law. 6

(B) By using M-B distribution law of molecular speed show that root mean square speed of gas molecule is given by $V_{rms} = \sqrt{\frac{3kT}{m}}$. 4

(C) Find the thermodynamic probability for four distinguishable particles for the microstate (2, 2). 2

OR

3. (P) State and explain principle of priori probability. 4

(Q) Show that most probable velocity of gas molecule is $V_p = \sqrt{\frac{2kT}{m}}$. 4

(R) Explain the terms :

(i) Thermodynamic probability

(ii) Statistical weight. 4

EITHER

4. (A) What are the main postulates of Fermi-Dirac statistics ? 4

(B) Using Bose-Einstein distribution law, deduce an expression for Planck's law of energy distribution in black body radiation. 7

(C) What is Fermi energy ? 1

OR

5. (P) Explain the concept of distinguishable and indistinguishable particles. 3

(Q) Obtain an expression for Fermi-Dirac distribution law by assuming thermodynamic probability. 5

(R) What is Fermi function ? How it behaves at absolute zero ? 4

EITHER

6. (A) Define unit cell of crystal. Explain primitive and non-primitive unit cell. 4

(B) Derive Bragg's law for diffraction of X-rays. 4

(C) What is line defect in crystal ? Explain the screw dislocation in crystal with neat diagram. 4

OR

7. (P) Give the names of seven crystal systems and state the parameters of their unit cells. 6

(Q) What are Miller indices ? Find Miller indices of the plane having intercepts (a, 2b, c/2). 4

(R) What is reciprocal lattice ? 2

EITHER

8. (A) Obtain an expression for electrical conductivity in terms of mean free path of electrons. 4

(B) Discuss formation of insulator, semiconductor and conductor on the basis of band theory of solid. 6

(C) What are conduction electrons ? 2

OR

9. (P) Explain the motion of electron in metals and hence derive an expression for drift velocity of electron. 5

(Q) Explain qualitatively conduction band, valence band and energy gap in solids. 4

(R) Explain nearly free electron model. 3

EITHER

10. (A) State properties of paramagnetic materials. 4

(B) Explain ferromagnetism on the basis of domain theory. 4

(C) What is magnetic dipole moment ? Obtain an expression for orbital magnetic dipole moment. 4

OR

11. (P) Give Langevin's theory of paramagnetism; hence prove that the susceptibility of paramagnetic material is inversely proportional to absolute temperature. 8

(Q) State properties of diamagnetic material. 4

EITHER

12. (A) Give brief idea of BCS theory of superconductivity. 6

(B) Explain type-I and type-II superconductor. 4

(C) Define : 2

(i) Critical temperature

(ii) Critical magnetic field.

OR

13. (P) Explain importance of surface to volume ratio and quantum size effect in nanomaterials. 6

(Q) State any four applications of nanomaterials. 4

(R) What are nanomaterials ? 2