AU–161

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 :

(i) A cell in a phase space have a minimum volume of the order of _____ .

(ii) In case of nano-particles, the ratio of surface area to the volume _____ as compared with bulk particles.

(iii) The conductivity of a semiconductor _____ with increase in temperature.

(iv) Miller indices are denoted by _____ .   2

(B) Choose the correct alternative :

(i) In M-B statistics particles are :

(a) Distinguishable   (b) Indistinguishable

(c) Not defined   (d) None of these

(ii) Superconductors are perfectly :

(a) Ferromagnetic   (b) Dimagnetic

(c) Paramagnetic   (d) Ferrimagnetic

(iii) S.I. Unit of conductivity is :

(a) Siemens per meter   (b) $(ohm.m)^{-1}$

(c) ohm.m   (d) Both (a) and (b)

(iv) The co-ordination number of simple cubic structure is :

(a) 6   (b) 8

(c) 12   (d) 16   2

(C) Answer in **one sentence** each :

    (i)   What is a primitive cell ?

    (ii)   State Bragg's Law.

    (iii) What is Fermi energy ?

    (iv) What is superconductivity ?   4

EITHER

2. (A) Explain the concept of Macrostate and Microstate with example.   6

    (B) Using Maxwell-Boltzmann's distribution, derive an expression for Maxwell-Boltzmann's energy distribution law.   4

    (C) Give the limitations of Maxwell-Boltzmann statistics.   2

OR

3. (P) What is unit cell in a phase space ? Show that smallest volume of unit cell in phase space is h^3.   5

    (Q) Derive Maxwell's distribution law of molecular speeds.   4

    (R) Explain the term 'Thermodynamic Probability'.   3

EITHER

4. (A) What are the basic postulates of B.E. statistics ?   3

    (B) Explain how B-E statistics differ from F-D statistics.   3

    (C) Derive Bose-Einstein distribution law.   6

OR

5. (P) Derive Planck's radiation formula.   4

    (Q) Derive expression for Fermi-Dirac distribution law.   6

    (R) What is Fermi Function ?   2

EITHER

6. (A) Derive Bragg's Law for X-ray diffraction.   3

    (B) State the difference between crystalline and amorphous solids.   3

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

OR

7. (P) What are line defects ? What is edge dislocation ? Explain with diagram. 5
   (Q) What are Miller indices ? Calculate the Miller indices for crystal plane which intercepts at $(3a, -2b, -3c)$. 5
   (R) What is co-ordination number ? 2

EITHER

8. (A) Define electrical conductivity. State its unit. 2
   (B) Define density of states. Obtain an expression for density of states. 6
   (C) Derive an expression for electrical conductivity of metal. 4

OR

9. (P) Explain the concept of Fermi energy. 2
   (Q) Discuss the classification of solids as insulator, semiconductor and conductor on the basis of band theory of solids. 6
   (R) State and explain Bloch theorem. 4

EITHER

10. (A) Define :
    (i) Magnetic susceptibility
    (ii) Magnetic permeability. 2
    (B) State the properties of diamagnetic material. 4
    (C) Obtain an expression for susceptibility of diamagnetic material. 6

OR

11. (P) What is hysteresis ? Explain hysteresis loop. 4
    (Q) State and explain Curie-Weiss Law. 4
    (R) Explain Ferromagnetism on the basis of domain theory. 4

EITHER

12. (A) Explain :
    (i) Critical temperature in superconductor
    (ii) Critical magnetic field in superconductor. 4
    (B) Explain Type-I and Type-II superconductors. 4
    (C) Explain any four applications of superconductors. 4

OR

13. (P) Explain the quantum size effect of nanoparticles. 4
    (Q) What is Copper pair ? 3
    (R) State any five applications of nanomaterials. 5