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[55/A-7]

SEAT No._____   No. of Printed Papers: 02

SARDAR PATEL UNIVERSITY
M.Sc. (Physics) 4st Semester Examination
Wednesday, 20th March, 2019
Subject: PS04CPHY02 (Theoretical Solid State Physics)

Time: 10:00 am to 01:00 pm   **Total Marks: 70**

Q-1 Eight multiple choice questions. (MCQ)   **[01 mark each]**

1. The Fermi wave vector k_F is given by
   (a) $(3\pi^2 V/N)^{1/3}$ (b) $(3\pi^2 V/N)^{2/3}$ (c) $(3\pi^2 N/V)^{2/3}$ (d) $(3\pi^2 N/V)^{1/3}$

2. A plasma oscillation in a metal is a _____ excitation of the conduction electrons.
   (a) collective transverse (b) collective longitudinal (c) transverse (d) longitudinal

3. Near the forbidden band the curvature of E versus k becomes
   (a) negative (b) constant (c) zero (d) positive

4. $2\pi/a$ defines the boundary between which Brillouin Zones
   (a) Origin and first (b) second and third (c) first and second (d) None

5. The classical Debye-Huckel screening length is proportional to
   (a) $(N_0 e^2/T)^{-1/2}$ (b) $(N_0 e^2/T)^2$ (c) $(N_0 e^2/T)^{1/2}$ (d) $(N_0 e^2/T)$

6. In aluminum the core states are associated with
   (a) d shells (b) $1s^2\,2s^2\,2p^6$ (c) $3s^2\,3p$ (d) $1s^2\,2s^2\,2p^6\,3s^1$

7. Angular frequency of AC Josephson effect is _____
   (a) $2\pi q V_0/h$ (b) $2\pi e V_0/h$ (c) $4\pi e V_0/h$ (d) None of these

8. The BCS energy gap is given as _____
   (a) $K_b T_C$ (b) $3.52 K_b T_C$ (c) $1/K_b T_C$ (d) $4.1\,K_b T_C$

Q -2 Attempt any 7 of the following 9 question briefly.   **[02 marks each]**

1. Explain origin of energy gap.
2. State Bloch's theorem. Sketch Bloch's function.
3. How is a reciprocal lattice obtained from direct lattice?
4. Show with the help of a diagram how an OPW is obtained.
5. What are Friedel oscillations?

(P.T.O.)

6. What is anomalous skin effect?
7. Define coherence length and penetration depth of superconductor.
8. Explain isotope effect.
9. Describe soft and hard superconductor with appropriate diagram.

Q-3
  (a) Write notes on (i) screened Coulomb potential (ii) Umklapp process   [06]
  (b) Derive an expression for the band effective mass of an electron and interpret the concept of hole.   [06]

OR

  (b) Formulate the Kronig- Penny model and establish the relation,   [06]

$$p \, \frac{\sin(\alpha.a)}{(\alpha.a)} + \cos(\alpha.a) = \cos(k.a)$$

Q-4
  (a) Explain (i) formation of energy bands (ii) Reduced zone scheme.   [06]
  (b) Describe the plane wave method of band structure calculation.   [06]

OR

  (b) Describe the tight binding method of band structure calculation.   [06]

Q-5
  (a) What is Fermi surface? Write a note on dHvA effect.   [06]
  (b) Name various methods for the experimental mapping of Fermi surface and discuss any one method in detail.   [06]

OR

  (b) Obtain an expression for the Lindhard screening function. Also determine its limiting values for q $\longrightarrow$ 0 and q $\longrightarrow$ ∞ [06]

Q-6
  (a) Describe Bardeen-Cooper-Schrieffer theory of superconductivity in detail.   [06]
  (b) Obtain the change in Gibbs free energy, entropy and specific heat at superconducting transition.   [06]

OR

  (b) Discuss the two fluid model of superconductor and derive London's equation and London's penetration depth.   [06]