Register Number:
Date: 19-11-2020

ST. JOSEPH'S COLLEGE (AUTONOMOUS), BANGALORE-27
M.Sc. Physics - III SEMESTER
SEMESTER EXAMINATION: NOVEMBER 2020
PH9218 – SOLID STATE PHYSICS

Time- 2 1/2 hrs Max Marks-70

This paper contains TWO printed pages and TWO sections and includes physical constants.

Section – A

Answer any FIVE from the following questions. Each question carries 10 Marks.

(5 x 10 = 50)

1. Derive an expression for the specific heat of a solid based on the Einstein's model and show that at low temperature it drops exponentially with decreasing temperature. [8+2]
2. Discuss the Kronig Penney model for the motion of an electron in periodic potential with suitable diagrams. Apply the following conditions (i). $P \to 0$ & $(ii). P \to \infty$. [8+2]
3. (a). Explain the polarization in the ferroelectric material by applying external field.
   (b). With a neat sketch, describe how the crystal structure and orientation of $BaTiO_3$ will change for the given temperatures:
   (i). T > 120°C, (ii). 5°C < T < 120°C, (iii). -90°C < T < 5°C, (iv). T<-90°C. [3+7]
4. Based on single particle tunneling, explain the D.C and A.C Josephson effects.
5. Describe quantum theory for paramagnetic substance and obtain the paramagnetic susceptibility relation for free electron.
6. a). Show that the reciprocal lattice of body centered cubic is the primitive of face centered cubic lattice.
   b). With a neat sketch, describe the Schottky and Frenkel defects. [5+5]
7. a). With a neat sketch, explain the following condition through Fermi Dirac distribution
   (i). T>0K (E=E_F), (ii). T=0K (E>E_F), (iii).T =0K (E<E_F).
   b). Define density of states (DOS). Draw and show the variation of density of states with energy in three dimensions, two dimensions, one dimension and zero dimension. [5+5]

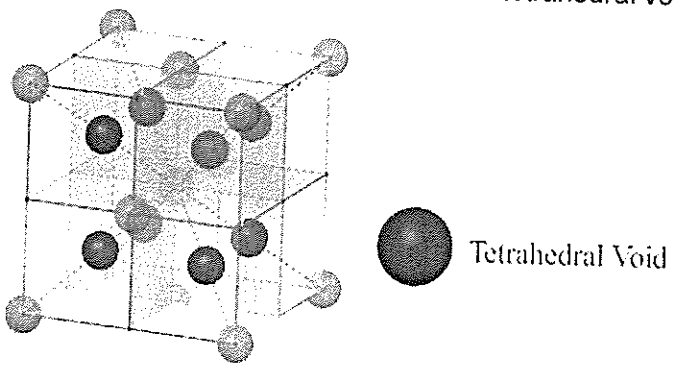
Section B

Answer any FOUR from the following questions. Each question carries 5 Marks.

[4 x 5 = 20]

8. a).A plane cuts x -axis at 3a, the y-axis at 2b and z axis at 4c. Calculate the Miller indices (hkl).
   b). Determine the angle between (110) and (011) plane in a cubic crystal. [3+2]

9. In aluminum, velocity of longitudinal mode ($v_l = 6.32\,x\,10^3 \frac{m}{s}$) and transverse mode ($v_t = 3.1\,x \frac{10^3 m}{s}$), the density of aluminum is 2.7 x 10^3 kg/m^3 and its atomic weight is 26.97. Calculate Debye cut off frequency (ϑ_D) for the aluminum.
10. The London penetration depth of Aluminum (Al) at 3 K and 7.1 K are 39 nm and 179 nm respectively. Calculate the superconducting transition temperatures as well as its penetration depth at 0K.
11. Describe ionic polarizations and obtain the expression for ionic polarizability.
12. In a magnetic material the field strength is found to be 10^6 ampere/m. If the magnetic susceptibility of material is 0.5 x 10^{-5}, calculate the intensity of magnetization and flux density in the material.
13. a). Find out the molecule having C_3 – axis of symmetry for the given compounds and Justify your answer.
    i). BH_2Cl ii). CH_3Cl iii). NH_2Cl iv). HOCl
    b). An element has a face centered cubic (FCC) structure with a cell edge of 'a'. Calculate the distance between the centers of two nearest tetrahedral voids in the lattice.



[3+2]

Physical Constants

[Charge of electron (e): 1.6021 x 10^{-19} C, rest mass of electron (m_e) : 9.109 x 10^{-31} kg, electron volts (eV): 1.602 x 10^{-19} J, Avogadro's number (N_A): 6.02552 x 10^{26} kmol^{-1}, Boltzmann constant (k_B): 1.38054 x 10^{-23} JK^{-1}, thermal energy at 300K (k_BT): 0.0258 J, Planks' Constant (h): 6.626 x 10^{-34} Js, permeability of free space (μ_0):4π x 10^{-7} H/m, permittivity of free space (ε_0):8.854 x 10^{-12} F/m, 1 Angstrom unit (Å): 10^{-10} m.]

PH 9218 _A_ 20