RAMAKRISHNA MISSION VIDYAMANDIRA
(Residential Autonomous College affiliated to University of Calcutta)

B.A./B.Sc. FIFTH SEMESTER EXAMINATION, MARCH 2021
THIRD YEAR [BATCH 2018-21]
Date : 20/03/2021
PHYSICS (HONOURS)
Time : 11 am - 1 pm
Paper : VI [Gr. B]
Full Marks : 50

Answer **<u>any five</u>** questions: [5 × 10]

1. a) Find the number of atoms per unit cell of SC, FCC and BCC types of crystal. [5]

   b) Metallic iron from BCC to FCC structure at 910°C. At this temperature the atomic radii of the iron in the two structures are 1.258Å and 1.292Å respectively. Calculate the change in volume available per atom. [5]

2. a) Find the dielectric constant of a solid in which local field has the form $\vec{E}_{eff} = \vec{E} + \dfrac{\vec{P}}{3_{\in 0}}$, assuming N atoms per unit volume each of polarizability α. [5]

   b) Show that the velocity of an electron moving in a periodic potential in one dimension vanishes at the zone boundaries. [3]

   c) For a BCC lattice of identical atom with a lattice constant of 5 Å. Calculate the maximum packing fraction and the radius of the atoms treated as hard spheres with the nearest neighbours touching. [2]

3. a) Estimate the Debye temperature of gold if its atomic weight is 197, the density is 1.9×10^4 kg/m^3 and the velocity of sound in its is 2100m/s. [5]

   b) Find the relation between electron concentration and wavelength associated with an electron having an energy equal to average kinetic energy of an electron. [5]

4. a) Find the relation between the Miller indices*(hkl)*of a crystal face and direction cosines m_a, m_b and m_c of the normal of this face with respect to the $\vec{a}$, $\vec{b}$ and $\vec{c}$ axes. [5]

   b) The mobility of electron and holes in a sample of intrinsic germanium at 300K is 0.39 and $0.19 m^2 V^{-1} s^{-1}$ respectively. Find the forbidden energy band of germanium of the conductivity of this sample is $2.32 \Omega^{-1} m^{-1}$. [5]

5. a) Find the expression for density of vibrational mode of a linear monatomic chain and show that at low temperature the heat capacity varies linearly with temperature. [5]

   b) The length of primitive translation vectors of a three dimensional lattice a = 1 Å, b = 3Å and c = 2Å. If angle between a and b is 150° find primitive translational vectors (a*, b* and c*) in the reciprocal space and angle between a* and b*. [5]

6. a) Find the lowest energy band using Kronig-Penny model for P<<1. [5]

   b) The variation of space charge density of a pn junction with in – W/2 to W/2 is given by $\rho(x) = eCx$, where C is constant and W width of the space charge region. Find the contact potential of this junction. [5]

7. a) Write a short note on the Hysteresis loop. [6]

   b) What is the critical temperature and Meissner effect? [4]

8. a) What is the difference between Diamagnetic, Paramagnetic, and Ferromagnetic materials? [4]

b) Using the Schrodinger equation under an external magnetic field $\vec{B} = (0, 0, B_0)$ explain the Diamagnetic properties of a material. [6]

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[2]