[191] SEAT No._____ [No. of Printed Pages.: 02]

SARDAR PATEL UNIVERSITY

M.Sc. Physics I[st] Semester Examination

Wednesday, Date : 27/03/2019, Time: 02:00 p.m. to 05:00 p.m.

Subject: PHYSICS, Title: Elements of Solid State Physics

Subject Code: PS01EPHY01 (OLD)

Instructions:

(a) Figures to the right indicate marks.

(b) Answer of all the questions (including MCQs) should be written in the provided answer book only.

Total Marks: 70

Q.1 Write answer of all questions by showing your choice against the question number. [8]

(1) The total number of Bravais lattice is :
(a) 7 (b) 14 (c) 20 (d) 24

(2) Which of the following lattice has highest packing efficiency for hard spheres?
(a) simple cubic (b) body-centered cubic (d) face-centered cubic (d)None

(3) The quanta of lattice waves is _____ .
(a) phonon (b) photon (c) proton (d) None of these

(4) The optical branch of dispersion of lattice waves exists in
(a) monatomic lattice (b) diatomic lattice (c) both (a) and (b) (d) None

(5) The Fermi level trivalent impurity doped pure semiconductor lies at :
(a) middle of valence band and conduction band
(b) Just above the valence band
(c) Just below conduction band
(d) in the valence band

(6) If the elastic waves propagate in [100] direction, then the velocity of the longitudinal (V_L) wave is determined by _____ .
(a) $(\rho/C_{11})^{-1/2}$ (b) $(\rho/C_{11})^{1/2}$ (c) $(C_{11}/\rho)^{-1/2}$ (d) $(C_{11}/\rho)^{1/2}$

(7) Substance having positive susceptibility is called _____ material.
(a)Diamagnetic (b) paramagnetic (c)ferromagnetic (d) ferrimagnetic

(8) Effective mass of a semiconductor is positive at the :
(a) bottom of the Valance band (b) top of the valence band
(c) middle of the valence band (d) None of these

Q.2 Attempt any Seven of the following questions: [14]

(1) Explain the procedure for obtaining the Miller indices of crystal planes using appropriate example.

(2) Define group velocity of lattice waves. Show that the group velocity of the lattice waves in a monatomic lattice is zero at the boundary of the first Brillouin zone.

(3) Write the type of symmetry elements in crystal systems.

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(4) Describe the CsCl crystal structure and write example of the material with similar structure.

(5) Explain in brief ferromagnetic order.

(6) What is Hall effect? Mention applications of Hall effect.

(7) Define dilation and prove that dilation (δ) = $\epsilon_{xx} + \epsilon_{yy} + \epsilon_{zz}$.

(8) Describe experimental method to determine dielectric constant.

(9) Explain in brief effective masses in semiconductors.

Q.3(a) Write the classification of different crystal systems in terms of lattice parameters. Draw necessary diagrams. [6]

Q.3(b) Explain the packing of hard spheres in a unit cell of bcc lattice. What will be the number of atoms in the unit cell and the coordination number? Derive the expression for the packing efficiency and find its value. [6]

OR

Q.3(b) Explain the difference between the tetrahedral void and octahedral void. For a tetrahedral void, prove that the maximum radius (r) of the impurity atom that can get filled in the void is equal to 0.225R, where R is the radius of the atoms on the lattice. [6]

Q.4(a) Explain the propagation of lattice vibrations in a monatomic lattice and derive the dispersion relation. [6]

Q.4(b) Derive the dispersion relation for the lattice waves in a diatomic lattice. How is it different from the monatomic case? [6]

OR

Q.4(b) Explain the quantization of elastic waves and describe the scattering of neutrons by phonons. [6]

Q.5(a) Differentiate between intrinsic and extrinsic semiconductor and derive expression $n_i = 2\left(\frac{2\pi kT}{h^2}\right)^{3/2}\left(m_h^* \times m_e^*\right)^{3/4}\exp\left(-\frac{E_g}{2kT}\right)$ for intrinsic semiconductor. [6]

Q.5(b) Using elastic stiffness constants, prove that : $(C_{11}-C_{12}) = 1/(S_{11}-S_{12})$ and $C_{44} = 1/S_{44}$ [6]

OR

Q.5(b) Obtain the expression for longitudinal and transverse waves that is propagating in [110] direction for cubic crystal. [6]

Q.6(a) What is hole? Using energy wave vector relation, prove that (i) $k_h = -k_e$ (ii) $\epsilon_h(k_h) = -\epsilon_e(k_e)$ (iii) $V_h = V_e$ and (iv) $m^*_h = -m^*_e$ at the same point of energy band. [6]

Q.6(b) What is susceptibility? Using suitable diagram explain paramagnetic susceptibility of conduction electrons in detail. [6]

OR

Q.6(b) What is polarization? Discuss in detail depolarizing field and local electric field at an atom. [6]

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