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SEAT No._____

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SARDAR PATEL UNIVERSITY
VALLABH VIDYANAGAR
First Semester of M. Sc. (Physics) (NC) Examination
Day: Wednesday **Date:** 27-03-2019 **Time:** 2.00 PM to 5.00 PM
Subject code:PS01EPHY21 **Subject:** Elements of Solid State Physics and Error Analysis

Total Marks: 70

Q.1 Choose the correct answer from the given choices. Only one choice is allowed. (08)

(1) The number of atoms in a unit cell of FCC crystal is _____.
(A) 1 (B) 2 (C) 3 (D) 4

(2) The intercepts of a crystallographic plane on the three crystallographic axes are found to be 2a, 4b and 4c. The Miller indices for this plane will be _____.
(A) (211) (B) (244) (C) (122) (D) (212)

(3) The group velocity of the lattice waves in solid is given by _____.
(A) ω/k (B) $d\omega/dk$ (C) ωk (D) k/ω

(4) In a diatomic lattice, the frequency of the lattice vibrations in the optical branch will be proportional to _____.
(A) $[M_1 + M_2]^{1/2}$ (B) $[M_1 + M_2]^{-1/2}$ (C) $\left[\frac{1}{M_1} + \frac{1}{M_2}\right]^{1/2}$ (D) $\left[\frac{1}{M_1} + \frac{1}{M_2}\right]^{-1/2}$

(5) In dilation, the fractional volume associated with the deformation of solid _____.
(A) does not change (B) increases (C) decreases (D) remains uncertain.

(6) Peltier coefficient for electron is calculated using equation_____.
(A) $\pi_e = \left(E_c - \mu + \frac{3}{2}k_BT\right)/e$ (B) $\pi_e = \left(E_c + \mu + \frac{3}{2}k_BT\right)/e$
(C) $\pi_e = -\left(E_c - \mu + \frac{3}{2}k_BT\right)/e$ (D) $\pi_e = -\left(E_c - \mu - \frac{3}{2}k_BT\right)/e$

(7) Ogive is a curve that represents the frequency distribution of numerical data when plotted as
(A) cumulative frequency Vs. class mid-points
(B) class frequency Vs. class mid-points
(C) relative frequency Vs. class mid-points
(D) absolute frequency Vs. class mid-points

(8) An equation of a straight line is $y = a_0 + a_1x$. a_1 represents _____.
(A) intercept on X-axis (B) intercept on Y-axis
(C) slope of the line (D) none of these

Q.2 Answer any SEVEN of the following questions in brief. (14)

(1) Write the types of crystal systems. What is the number of Bravais lattice? How?
(2) Explain the difference between the tetrahedral and octahedral voids.
(3) Describe the diamond crystal structure and write example of the material with similar structure.
(4) What happens to the lattice waves at the boundary of first Brillouin zone? Explain.
(5) Explain the inelastic scattering of neutrons by phonons in solids.
(6) For elastic stiffness constant, prove that $C_{44} = 1/S_{44}$.
(7) How do the donor state and the accepter state form in a semiconductor? Explain.
(8) Derive elastic stiffness and compliance constant of a solid.
(9) What is a histogram? Mention requirements of histogram.

[P.T.O]

Q.3 (a) Which are the different types of symmetries that exist in crystals? Describe each of them briefly. (6)

(b) Describe the packing of hard spheres in a FCC lattice. Derive the expression for the packing efficiency and prove that it is 74%. (6)

OR

(b) Write Pauling's rules for the packing of hard spheres and explain it using appropriate illustrations. (6)

Q.4 (a) Derive the dispersion relation for the propagation of lattice vibrations in a monatomic lattice. Prove that the frequency of the lattice vibrations is directly proportional to the wavevector in the long-wavelength limit. (6)

(b) Explain the propagation of lattice vibrations in a diatomic lattice and derive the expressions for the dispersion relations. (6)

OR

(b) Discuss quantization of elastic waves and explain the phonon momentum. (6)

Q.5 (a) What is Hall effect? Discuss the physical origin of this effect using necessary diagram and obtain the expressions to determine different parameters for electrons and holes. Write the applications of Hall effect. (6)

(b) Obtain an expression for the energy of strain cubic crystal, Show that, when crystal is under hydrostatic pressure, the energy per unit volume can be expressed as $u = \frac{1}{2}\frac{(C_{11}+2C_{12})}{3}\Delta v^2$, where Δv is the change in volume. Also prove that the bulk modulus of solid is given by $B = \frac{1}{3}(C_{11} + 2C_{12})$. (6)

OR

(b) Draw block diagram of ultrasonic pulse echo-technique used for the determination of elastic constants and the velocity of sound. (6)

Q.6 (a) Describe the procedure of Chi-square test to determine the goodness of fit and write the criteria for goodness of fit. (6)

(b) Describe method of linear least-square curve fitting and derive the expressions for the slope and the intercept of the line. (6)

OR

(b) Using necessary diagram, explain Gaussian distribution and determine the mean value from it. Write the properties of Gaussian distribution. (6)

X

(2)