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SEAT No. _____

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SARDAR PATEL UNIVERSITY

M.Sc. (Physics)(IIIrd Semester) Examination

Date : 26/10/2018, Day : Friday, Time : 2:00 p.m. to 5:00 p.m.

Subject : Crystallography and Material Science, Paper No. PS03EPHY21

CBCS(choice based credit system)

Important Note : Q.1 : Multiple choice questions (MCQ) carries one mark each.

Q.2 : Short questions carries two marks each (attempt any seven out of nine)

Q.3 to Q.6 : Long questions carries 12 marks .

Total Marks : 70

Q.1 Choose the appropriate options from the following in Q.1

(8)

- 1 Scattering factor decreases as the quantity _____ increases
(a) $\sin\theta/\lambda$ (b) $\lambda^2/\sin\theta$ (c) $\lambda/\sin\theta$ (d) $\sin\theta/\lambda^2$
- 2 For Hexagonal closed pack structure (hkl) reflection is absent if $(h+2k) =$ _____ and l is _____
(a) $3n$, even (b) $3n\pm 1$, odd (c) $3n$, odd (d) $3n\pm 1$, even
- 3 The reciprocal lattice of a FCC lattice is
(a) simple cubic lattice (b) BCC lattice (c) FCC lattice (d) HCP lattice
- 4 The Bragg's formulation of X-ray scattering is defined in terms of scattering from _____, whereas the von Laue formulation is defined in terms of scattering from _____ respectively.
(a) planes of lattice; points of lattice (b) points of lattice; planes of lattice (c) planes of lattice; points of reciprocal lattice (d) planes of reciprocal lattice; points of lattice
- 5 If the reflectance is known at all frequencies, which important parameter can be calculated of the reflected wave.
(a) amplitude (b) phase angle (c) Electric field (d) None of these
- 6 Which principle explains the central question of why do the electron travel long distances without colliding with each other ?
(a) Pauli (b) LST (c) Eienstein (d) Fermi
- 7 Which of the following molecule of fullerenes family do no possess pentagons ?
(a) C_{60} (b) C_{84} (c) C_{70} (d) C_{20}
- 8 If one of the hydrogen atoms in ethylene is replaced by some other atoms , then which property of the polymer is influenced the most
(a) mechanical (b) electrical (c) optical (d) thermal

(P.T.O.)

(1)

- Q.2 Answer any seven questions out of nine in Q.2 (14)**
- 1 Write a short note on Rochelle salt.
 - 2 Calculate the structure factor for Base centered cubic cell and generalized the rules for possible reflections.
 - 3 Explain in brief Ferroelectricity and Ferroelectric domain.
 - 4 How quasi crystals differ from other class of crystals ? Give examples of the materials showing this behaviour and explain what is penrose tiling.
 - 5 What are amorphous ferromagnets ? Explain them with examples.
 - 6 What are GMR-CMR materials ? State the applications where they can be used.
 - 7 What is Polaron ? Differentiate between large and small polaron.
 - 8 With appropriate example, prove the equivalence of Bragg's and Laue's equations.
 - 9 Explain the importance of stereographic projection in crystallography.
- Q.3(a) For a reciprocal lattice, prove the following: (6)**
- (i) Every reciprocal lattice vector \vec{G} is normal to the plane of the crystal lattice. (ii) The reciprocal of the reciprocal lattice is a direct lattice. (iii) Volume of the unit cell of the reciprocal lattice is inversely proportional to that of corresponding direct lattice.
- Q.3(b) Describe the geometrical interpretation of Bragg's law. Explain Ewald construction and derive the Bragg's law in vector form in the reciprocal space. (6)**
- OR**
- Q.3(b) Describe the geometrical construction of reciprocal lattice. Prove that the reciprocal lattice vector can be expressed as $\vec{G} = h\vec{a}^* + k\vec{b}^* + l\vec{c}^* = \vec{\sigma}_{hkl}$ where h, k, l are the Miller indices of crystal planes. \vec{a}^*, \vec{b}^* and \vec{c}^* are primitive translation vectors along the crystallographic axes in reciprocal space. (6)**
- Q.4(a) Derive Thomson equation for the scattering of an X-ray beam by a single electron with necessary diagram. Show that the scattering intensity depends on the scattering angle. (6)**
- Q.4(b) Discuss thermodynamic theory of the ferroelectric transition and derive free energy and heat capacity for second order transitions of ferroelectric crystal. (6)**
- OR**
- Q.4(b) Describe principle and working of wavelength dispersion spectrometer. What is the difference between wavelength-dispersive and energy dispersive methods of chemical analysis? (6)**
- Q.5(a) What are excitons? Discuss in detail about Mott-Wannier and Frenkel Excitons. (6)**
- Q.5(b) By considering the coupling of the electric field of the photon with the dielectric polarization of the TO phonon obtain the expression for Lydanne-Sachs-Teller relation. (6)**
- OR**
- Q.5(b) How integral quantum Hall effect differs from normal Hall effect ? Explain integral quantum Hall effect with necessary expressions and diagrams. (6)**
- Q.6(a) What are liquid crystals ? Explain how application of magnetic field can affect the liquid crystals. (6)**
- Q.6(b) With proper examples explain how nanofluids can improve heat transfer process. Also explain any two applications of ferrofluids known to you. (6)**
- OR**
- Q.6(b) Differentiate between positional and compositional disorder in amorphous semiconductors and discuss its band structure and electronic conduction mechanism. (6)**