

[This question paper contains 2 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 2931

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Unique Paper Code : 2222513601

Name of the Paper : Solid State Physics

Name of the Course : **B.Sc. Prog. – Physical Sciences with Physics_NEP:
UGCF-2022**

Semester : VI (DSC Paper)

Duration : 2 Hours

Maximum Marks : 60

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt **four** questions in all.
3. Question No. **1** is compulsory.
4. Non-programmable scientific calculators are allowed.

Q. 1 Answer any *five* of following: (3x5 = 15)

- (a) Determine the Miller indices of a plane having intercept of $8a$, $4b$ and $2c$ on the a -, b - and c -axes respectively.
- (b) What is Ewald's sphere? What does its radius represent?
- (c) What is a phonon? Name the kinds of phonons present in vibrational spectrum of a diatomic lattice.
- (d) State the conditions under which superconductivity can be destroyed.
- (e) Distinguish between diamagnetism, paramagnetism and ferromagnetism.
- (f) Explain why the dielectric constant of a ferroelectric material changes with frequency and temperature.

Q. 2 (a) Discuss the construction of a reciprocal lattice? How are the reciprocal lattice vectors related to those of a direct lattice? A monochromatic X-ray of wavelength $1.4 \text{ \AA}$ is incident on a crystal which is having interatomic spacing as $1.5 \text{ \AA}$. Calculate the maximum possible order of diffraction. (7)

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- (b) What are Brillouin Zones? Draw the first three Brillouin Zones for a two-dimensional square lattice. (8)
- Q. 3 (a) Consider a one-dimensional diatomic linear chain consisting of two types of atoms with masses m_1 and m_2 , arranged alternately and connected by identical springs of spring constant C . Derive the dispersion relation for lattice vibrations in the crystal. Sketch the dispersion curves (ω versus k) for acoustic and optical branches. (12)
- (b) A dielectric material is placed in an external electric field of 2.0×10^5 V/m with polarization 3.0×10^{-3} C/m². Calculate the local electric field acting at an atom. (3)
- Q. 4 (a) What is the effective mass of an electron? Derive the expression for the effective mass of an electron and explain how it differs from the mass of a free electron. Draw the variation of (i) Energy, (ii) velocity of electron and (iii) effective mass of electron with respect to the wave vector k . (10)
- (b) Copper has an FCC structure and the atomic radius is 1.245 Å. Determine the interplanar spacing for (111) planes. (5)
- Q. 5 (a) Explain the Langevin theory of paramagnetism and derive the expression for the magnetic susceptibility of a paramagnetic substance. Explain its dependence on temperature. (12)
- (b) Define polarizability and state the Clausius-Mossotti relation. (3)