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Total No. of Questions: [11]

Total No. of Printed Pages: 1

M.Sc. (Physics) (Semester-3rd)
CONDENSED MATTER PHYSICS-I
Subject Code: MPHYS1-210
Paper ID: [18220708]

Time: 03 Hours

Maximum Marks: 60

Instruction for candidates:

1. Section A is compulsory. It carries 16 marks. It consists of 4 questions of 4 marks each.
2. Section B consist of 4 questions of 8 marks each. The student has to attempt any 3 questions out of it.
3. Section C consist of 3 questions of 10 marks each. The student has to attempt any 2 questions.

Section – A

(4 marks each)

- Q 1. What are liquid crystals? Classify liquid crystals based on the ordering of atoms or molecules.
- Q 2. State and explain the Wiedemann-Franz law.
- Q 3. Show that in acoustic branch the atoms vibrate in the same direction.
- Q 4. Distinguish between steady-state and non-steady state diffusion with suitable example.

Section – B

(8 marks each)

- Q 5. What are dislocations? Discuss the various types of dislocations. What is the magnitude of the smallest Burgers vector that a dislocation in an FCC crystal can have, if it is parallel to the [111] direction?
- Q 6. Discuss the law of conservation of energy and momentum for phonons. Consider a photon with an energy of 4J is incident along the x-direction and scatters from a solid material. This material has a reciprocal lattice vector $2\hat{i} + 5\hat{j} + 4\hat{k}$ and creates a phonon during the scattering process. If the photon scatters in the $3\hat{j} - 2\hat{k}$ direction and absorbs 3J of energy, determine the direction and energy of the created phonon?
- Q 7. Considering the assumptions of Drude model, derive an expression for the DC electrical conductivity of metals.
- Q 8. State Fick's first and second laws. Given that diffusion coefficients for copper in aluminum at 500 °C and 600 °C are 4.8×10^{-14} and 5.3×10^{-13} m²/s, respectively. Determine the approximate time at 500°C that will produce the same diffusion result (in terms of concentration of Cu at some specific point in Al) as a 10-h heat treatment at 600°C.

Section – C

(10 marks each)

- Q 9. What is an X-ray spectrometer? Discuss its construction and operation? What kind of information can it provide about a material?
- Q 10. Define density of modes? Derive a relation for density of modes for a one dimensional material.
- Q 11. Discuss the assumption of Debye model for the lattice heat capacity of solids and derive the Debye T³ law.