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3408

Your Roll No.

M.Tech. / II Sem.

A

NANO SCIENCE AND NANO TECHNOLOGY
Paper : NSNT-203 : Solid State Physics/Chemistry

Time : 3 Hours

Maximum Marks : 38

*(Write your Roll No. on the top immediately
on receipt of this question paper.)*

Attempt all parts.

PART A

Note: Answer any **three** questions.

3×4=12

1. Explain by giving suitable examples the 3 fold axis of rotation and the $\bar{4}$ inversion axis.
2. Show the phase diagram for a simple binary eutectic system.
3. Bring out the relation between the magnitude of the band gap and the differences in the electronegativity between the anion and the cation in the case of an ionic solid.

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4. Give reasons for the absence of (100) reflection in the powder X-ray diffraction pattern of a body centered cubic substance.

PART B

Note: Answer any two questions.

2×4=8

5. (a) For paramagnetic materials, assuming classical statistics, derive the expression for magnetization. Explain the discrepancy between the theoretical and experimental data and how is it removed.
- (b) Explain the two types of normal thermodynamic defects with appropriate examples.
6. (a) Compare the magnetic interaction energy of an electron spin magnetic dipole moment with $k_B T$ at room temperature and show that the approximation $k_B T / \mu_B H$ is valid. (Magnetic field = 10^4 Gauss)
- (b) If ΔH_s for the formation of Schottky defects in MX crystal is 200 kJ/mol, calculate n_s/N for the temperatures 300, 500, 700 and 900 K.

7. (a) For a curved circular loop of radius R , what is the magnetic moment ? What is the advantage of having a helical winding in place of a single loop?
- (b) Explain the types of dislocations that are commonly observed in solids.

PART C

Note: Answer any **three** questions. 3×6=18

8. (a) Derive the expression for the acceleration of an electron moving in a one-dimensional periodic lattice.
- (b) TiO (black in color) and NiO (pale green in color) have rock salt structures with electronic conductivities $\sim 10^3 \text{ ohm}^{-1} \text{ cm}^{-1}$ and $\sim 10^{-14} \text{ ohm}^{-1} \text{ cm}^{-1}$ respectively. Explain the reason for the observed conductivities.
9. (a) Derive an expression for the magnitude of separation between Zeeman levels.
- (b) A cubic alkali metal halide has its first six lines with d spacing 4.08, 3.53, 2.50, 2.13, 2.04 and 1.77 Å. Assign Miller indices to the lines and calculate the value of the cell dimension.

10. (a) Derive an expression for the Langevin function for paramagnetic materials. What are the important conclusions of the Langevin theory?
- (b) Show the phase diagram for the formation of binary compounds with congruent and incongruent melting points.
11. (a) Derive an expression for V_{oc} for an illuminated p-n junction.
- (b) Discuss the methods by which the crystallite size reduction results in improving the reactivity of the solids.