**ST. JOSEPH’S COLLEGE (AUTONOMOUS), BANGALORE-27**

**M.Sc. CHEMISTRY: IV SEMESTER**

**SEMESTER EXAMINATION-APRIL 2019**

**CH 0415: SOLID STATE CHEMISTRY**

**Time: 2½ hours Max Marks: 70**

*This question paper contains 2 pages and 3 parts*

**PART-A**

Answer any ***SIX*** of the following questions: **6 x 2 = 12**

1. Explain isotopic effect in superconductors.
2. What are polycrystalline materials?
3. Identify the type of lattice in each case based on the observed Bragg’s reflection from

(i) (110), (200), (103), (202), (211) planes

(ii) (111), (200), (113), (220), (222) planes.

1. What is structure factor? Give the mathematical equation and explain the terms therein.
2. What are order-disorder phase transitions? Give an example.
3. Show that the Bloch function is modulated by the periodicity of the lattice.
4. Define piezoelectric constant of a crystal. Write the expression for electric displacement when a piezoelectric crystal is subjected to a mechanical stress.
5. Draw the unit cell of LiNbO3.

**PART-B**

Answer any ***FOUR*** of the following questions: **4 x 12 = 48**

1. a) With the help of Frolich diagram, explain the type of interaction involved in superconductors.

b) Give the characteristics of Type II superconductors.

c) What is Patterson’s function? How is it used to extract the phases of reflection? (4 + 4 + 4)

1. a) How is Bragg’s law verified in reciprocal space?

b) What is limiting sphere? Calculate the number of X-ray reflections that can be obtained for the unit cell with dimensions a = 8 Å, b = 10 Å, c = 20 Å; α = γ = 90°, β = 110°, if CuKα (λ = 1.5418 Å) and MoKα (λ = 0.711 Å) radiations are used. Comment on the results obtained. (6 + 6)

1. a) What are plane lattices? Draw and explain all the five types of plane lattices.

b) Derive the equation cos φ = N/2 and verify whether n = 1, 2, 3, 4, 5, 6 are possible for a perfect crystalline substance (φ = rotation angle, n = order of the axis and N is an integer) (6 + 6)

1. a) What are glide planes? Explain the various types of glide planes present in crystals?

b) What are the advantages and disadvantages of neutron diffraction compared to X-ray diffraction?

c) Show that the Fermi energy varies with temperature for a n-type semiconductor. (4 + 4 + 4)

13. a) What are Brilluoin zones? Plot the first two Brilluoin zones of a square lattice.

b) What are stacking faults? Why are these faults predominant in layered solids?

c) Discuss non-stoichiometric point defects with examples. (4 + 4 + 4)

14. a) What are the possible chemical compositions of olivine oxides? (List the type of atoms that would occupy the different lattice sites and give examples.)

b) Considering a solid to be made of two independent sublattices of opposite spins arrive at the relation, χ = C/(T+θ), for an antiferromagnetic solid.

c) Given the Lorentz field, Eloc = E + (4π/P), where E is the applied field, derive Clausius-Mosatti equation. (4 + 4 + 4)

**PART-C**

Answer any ***TWO*** of the following questions: **2 x 5 = 10**

1. Using Euler’s equation check whether each of the following combination of rotation axes is allowed or not: (i) 642; (ii) 322
2. a) What information can be drawn with respect to systematic absences by calculating Fhkl in the case of Pc and P21 space groups? For c glide the atomic positions are (x, y, z) and x, -y, z+0.5). For 21 screw axis parallel to b axis the atomic positions are (x, y, z) and (-x, y + 0.5, -z)

b) Identify the type of material (metal, insulator, intrinsic/n-type/p-type semiconductor) in the following cases.

(i) Resistivity decreases with temperature; Fermi energy increases with temperature.

(ii) Plot of logσ against 1/T gives two intersecting straight lines with negative slopes; Hall coefficient is negative. (3 + 2)

1. a) Match the following:

|  |  |
| --- | --- |
|  **A** | **B** |
| Pyroelectricity | Solids with Schottky defects |
| Conductivity by movement of vacancies | Ionic solids |
| Seebeck effect | Non-centrosymmetric crystal classes |
| Electrolytic breakdown | Metal-metal junction |
| Polarization catastrophe | Cubic BaTiO3 |
| Paraelectricity | Ferroelectric solids |

b) Show that the majority charge carriers in Ge (Eg = 0.72 eV) doped with 1 ppm of As (whose donor states lie 0.012 eV below the bottom of the conduction band) is electrons. The Fermi level lies 0.16 eV below the bottom of the conduction band at 300 K. (kT at 300 K is 0.025 eV) (3 + 2)