Reg. No.: ____________________

ST. JOSEPH'S COLLEGE (AUTONOMOUS), BANGALORE – 27
M.Sc. CHEMISTRY- III SEMESTER
SEMESTER EXAMINATION – OCTOBER 2019
CH 9418- SOLID STATE CHEMISTRY

Time: 2 ½ hours **Max. Marks: 70**

This question paper has ***two*** *printed pages and* ***three*** *parts*

PART A

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

1. What is homogeneous precipitation? Give an example.
2. While the point group 322 can be written as 32, the group 422 cannot be written as 42. Explain.
3. Give the translational component of (i) diagonal glide plane; (ii) diamond glide plane.
4. What are polycrystalline solids?
5. What is reciprocal lattice? How is it related to k-space?
6. Depict Frenkel and Schottky defects pictorially.
7. State and explain Bloch theorem.
8. What are piezoelectric crystals? Give any one application of these crystals.

PART B

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

9. a) Explain the following synthesis methods with a suitable example for each.
   (i) Solvothermal synthesis (ii) Flux synthesis
   b) Calculate the intensity of the (100) reflection of a body centered cubic lattice.
   c) What are the advantages of neutron diffraction over X-ray diffraction? (6+3+3)
10. a) Arrive at the point groups formed when a mirror plane (perpendicular to the axis) is combined with different axes of rotation. Identify the redundant groups. Give the stereographic representations of the non-redundant groups.
    b) List the screw axes possible in crystals. Identify enantiomorphic pairs among them.
    c) Using Euler's construction, verify if $2 \cdot 2 = 3$ is possible. If yes, find the angles between the different axes of rotation. (5+3+4)
11. a) How is phase problem in X-ray diffraction solved using the heavy atom method?
    b) Calculate the number of Bragg reflections that can be obtained from a hexagonal solid with unit cell dimensions a = b = 4 Å; c = 8 Å, when CuK_α radiation (λ = 1.542 Å) is used. How will this number change when MoK_α radiation (λ = 0.717 Å) is used?
    c) Describe any one method of indexing the XRD pattern of a cubic solid. (4+4+4)
12. a) How are ilmenite and $LiNbO_3$ structurally related to corundum? Draw the unit cell of any one of these solids.
    b) Show that 5-fold axis of symmetry is not possible in crystalline solids.
    c) What are displacive and reconstructive phase transitions? Give examples. (5+4+3)

13. a) Explain the two types of line defects in solids. In any one case, depict the Burger vector in the lattice around the line of dislocation.

b) Discuss the ferroelectric transitions in $BaTiO_3$.

c) Show that a metal/n-type semiconductor junction is a rectifying junction when the work function of the metal is greater than that of the semiconductor. (5+4+3)

14. a) Discuss Kronig-Penney treatment of electrons in periodic potential. Explain the origin of forbidden energies. Plot the energy bands in condensed zone representation.

b) Plot $ln\sigma$ against $1/T$ for (i) intrinsic semiconductor; (ii) n-type semiconductor; (iii) p-type semiconductor.

c) What is Hall effect? Define Hall angle. (6+3+3)

PART C

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

15. a) What is the probable lattice type of each of the following crystals that exhibit the indicated Bragg reflections?

Crystal A: 110, 200, 103, 202, 211

Crystal B: 111, 200, 113, 220, 210

Crystal C: 100, 110, 111, 200, 210

b) Give a method of synthesis (other than simple solid state synthesis) for the following.

(i) $MgCr_2O_4$ (ii) WO_3 (starting from Na_2WO_4) (3+2)

16. a) Combining the point groups, lattice types and screw axes, arrive at the space groups of triclinic and monoclinic systems.

b) Are the symmetry elements, $\bar{1}$ and $\tilde{2}$ identical? Justify. (3+2)

17. a) Identify the nature of the solid (metal, intrinsic/n-type/p-type semiconductor or insulator) in the following cases.

Case A: Fermi energy increases with temperature

Case B: Fermi energy is constant; conductivity decreases with temperature

Case C: Resistivity decreases with temperature; no Hall effect

b) The conductivity of an intrinsic semiconductor is 4 x 10^{-5} $ohm^{-1}cm^{-1}$ at 300K. If the mobility of the holes at this temperature is 400 $cm^2V^{-1}s^{-1}$ find the mobility of the conduction electrons. (3+2)
