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 are *chimie douce* reactions? Give an example.
2. While the point group arrived at by combining a two-fold axis and a parallel mirror plane is symbolized 2mm, the same obtained by combining a three-fold axis and a parallel mirror plane is called 3m. Why?
3. What are the different types of glide planes possible in crystals?
4. What is indexing of X-ray diffraction pattern?
5. Describe phase problem in X-ray diffraction.
6. Depict edge dislocation pictorially.
7. Why do metals, in general, exhibit weak paramagnetism?
8. Describe Zener electric breakdown.

PART B

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

9. a) Explain the following synthesis methods with a suitable example for each.
   (i) Combustion synthesis (ii) Sol-gel synthesis
   b) Describe the graphical method of indexing the X-ray diffraction pattern of a cubic solid.
   c) What are the limitations of electron diffraction? (6+3+3)
10. a) Using Euler's construction, show that $4 \cdot 3 = 2$. Find the angles between the different axes of rotation.
    b) What are space groups? How are they arrived at from point groups?
    c) Give the point groups formed by the combination of improper axes ($\bar{3}$ and $\bar{4}$) with proper rotation axes. Depict any one of these by stereographic projection. (5+4+3)
11. a) Using Ewald's construction, derive Bragg's law in reciprocal space.
    b) What is structure factor? How is intensity of Bragg reflection related to it? Calculate the intensities of the Bragg reflections of a c-centered lattice and arrive at systemic absences. (6+6)
12. a) What are Ruddlesden-Popper phases? Draw the unit cell of Sr_2RuO_4.
    b) What are screw axes in crystals? Give a pair of screw axes that are enantiomorphous to each other. Show the perspective diagram of any one of these axes.
    c) What are second order phase transitions? Give an example. (5+4+3)

13. a) What are stacking faults? Why are they common in layered solids such as graphite?
    b) Show that the ionic conductivity of an ionic solid, $\sigma_{ionic} = \left[\frac{e^2 N D_0}{kT}\right] \exp\left(-\frac{E_a}{kT}\right)$. Plot $ln\sigma$ against 1/T and explain the features of the plot.
    c) Show that a metal/n-type semiconductor junction is ohmic when the work function of the metal is less than that of the semiconductor. (5+4+3)
14. a) Discuss the origin of resistivity in metals. How does the resistivity of a metal vary with temperature? Why?
    b) Describe any one method to find the band gap of an intrinsic semiconductor.
    c) Derive an expression for the Fermi energy of an intrinsic semiconductor. (6+3+3)

PART C

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

15. a) Density of MCl, which crystallizes in face centered cubic lattice with a = 6. 28 Å, is 2.16 gcm^{-3}. Calculate the atomic mass of M (atomic mass of Cl = 35.5).
    b) Give a method of synthesis (other than simple solid state synthesis) for the following.
    (i) CuS (ii) TiO_2 (starting from $K_2Ti_4O_9$) (3+2)
16. a) Identify the lattice type, crystal class and minimal symmetry elements for the space groups, (i) $I\bar{4}2m$ and (ii) $P6mm$.
    b) What are the 'throw' and 'pitch' of the screw axis 8_2? (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 decreases with temperature
    Case B: Fermi energy is constant; conductivity increases with temperature
    Case C: Resistivity increases with temperature; Hall coefficient is positive
    b) The absorption onset of a semiconductor in its UV-visible spectrum is 400 nm. If E_v is 0 eV, calculate E_c and E_0. (3+2)
