Register Number :

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ST. JOSEPH'S COLLEGE (AUTONOMOUS), BANGALORE-27
M.Sc. CHEMISTRY – III SEMESTER
SEMESTER EXAMINATION: NOVEMBER 2020
CH-9418 SOLID STATE CHEMISTRY

Duration: $2\frac{1}{2}$ hours **Max. Marks: 70**

This paper contains TWO printed pages, THREE parts and 17 questions.

PART A

Answer any **SIX** of the following **6 x2=12 marks**

1. What are the drawbacks of the 'heat and beat' synthesis of solids?
2. Identify the handedness of the following screw axes: (i) 4_1 (ii) 6_5
3. The Kα radiation of X-rays is more intense than Kβ radiation. Give reason.
4. The Miller indices of the prominent diffraction planes for two cubic crystals are given below. Identify the lattice type in each case.
   (i) (110), (200), (211), (220), (310)
   (ii) (111), (222), (311), (200), (220)
5. Draw the stereographic projection of the point group 422.
6. How would you identify if a solid has Frenkel or Schottky defects by a simple experiment?
7. State and explain Bloch theorem.
8. Explain Zener electric breakdown.

PART B

Answer any **FOUR** of the following **4 x12= 48 marks**

9. a) Prove that five-fold rotation axis does not exist in crystals.
   b) Explain the following with pictorial representation, using the motif '7'.
   (i) 'a' glide (ii) 2_1 screw axis (6+6)
10. a) Find all the interaxial angles for the point group 432 using Euler's relation.
    b) Compare electron diffraction with XRD.
    c) Using structure factor-intensity relationship, show why there are no systematic absences from a primitive lattice. (5+4+3)
11. a) Discuss the construction of Ewald's sphere and derive the Bragg's diffraction condition in terms of reciprocal lattice vector.
    b) Explain how (i) the phase problem in X-ray diffraction is solved by heavy atom method; (ii) indexing of crystals is done by trial and error method for a cubic crystal system. (6+6)
12. a) Write a note on (i) *chimie douce* reactions (ii) flux synthesis
    b) Draw the unit cell of K_2NiF_4. How is this structure related to that of perovskite and Ruddlesden-Popper phases?
    c) Differentiate between 1st order and 2nd order phase transitions in solids. (4+5+3)

13. a) Explain the following: (i) edge dislocation (ii) stacking faults

    b) Give the equation depicting the solutions of Kronig-Penney treatment of electrons in a periodic potential. Plot this equation and show why certain energies are not allowed. Also show a plot of E vs k for a true solid in condensed zone representation. (5+7)

14. a) Show that, for an intrinsic semiconductor, the fermi energy is midway between the top of the valence band and the bottom of the conduction band.

    b) Show that a metal /n-type semiconductor junction may be either ohmic or rectifying.

    c) Discuss the ferroelectric phase transitions in $BaTiO_3$. (4+5+3)

PART C

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

15. a) Given unlimited supply of nickel nitrate, urea, and water, design any two methods to synthesize NiO.

    b) The point group 322 is written as 32. Give reason. (3+2)

16. Zinc sulphide crystallizes in sphalerite structure, which belongs to the space group $F\bar{4}3m$, with the following atomic co-ordinates.

    Zn : $(0,0,0)$; $(\frac{1}{2}, \frac{1}{2}, 0)$; $(\frac{1}{2}, 0, \frac{1}{2})$; $(0, \frac{1}{2}, \frac{1}{2})$

    S : $(\frac{1}{4}, \frac{1}{4}, \frac{1}{4})$; $(\frac{1}{4}, \frac{3}{4}, \frac{3}{4})$; $(\frac{3}{4}, \frac{1}{4}, \frac{3}{4})$; $(\frac{3}{4}, \frac{3}{4}, \frac{1}{4})$

    Calculate the structure factor for the (202) plane.

17. Based on the properties listed, identify the nature of the solid in each case:

    (i) resistivity decreases with temperature; Hall coefficient is positive

    (ii) shows an asymptotic Curie temperature; $\chi_e \sim 0$

    (iii) resistivity increases with temperature; Hall coefficient is negative

    (iv) ln σ*vs* 1/T curve is two intersecting straight lines; gives a rectifying junction when fused with a n-type semiconductor

    (v) resistivity decreases with temperature; Hall coefficient is insignificant

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