

Registration Number:

Date & Session:



ST JOSEPH'S UNIVERSITY, BENGALURU - 27
M.Sc. CHEMISTRY – III SEMESTER
SEMESTER EXAMINATION: OCTOBER 2023
(Examination conducted in November/December 2023)
CH 9423: Solid State Chemistry
(For current batch students only)

Time: 2 Hours

Max Marks: 50

This paper contains TWO printed pages and THREE parts.

PART-A

Answer any EIGHT of the following. Each question carries 2 marks. [2×8=16]

1. Identify the lattice type and crystal system present in the space group: $P\bar{6}2m$.
2. Mention any two reagents that can be used as starting materials for oxide synthesis using high temperature solid state synthesis?
3. How is electron density related to structure factor? Give the mathematical equation.
4. Show that $2/m$ generates center of inversion.
5. What is first order phase transformation for solids? Give an example.
6. Calculate the cell volume and the separation of (111) planes of a cubic cell with side, $a = 0.58$ nm.
7. What is phase problem in crystallography?
8. What is sol-gel synthesis? List one advantage of this synthesis.
9. Give an example for fuel and oxidant that are used in combustion synthesis of solids.
10. State band theory of solids.

PART-B

Answer any TWO of the following. Each question carries 12 marks. [2×12=24]

11. a) Draw the unit cell for K_2NiF_4 structure. Mention one of its similarities with the structure of a perovskite.
b) What is meant by line defect for crystalline solids? Explain screw dislocation in a crystalline solid with a suitable diagram.
c) Explain how resistivity is affected by composition of metals in Cu-Au alloy system. Draw a labeled diagram to explain this system. How does annealing help reduce resistivity?
(4+4+4)
12. a) What are point groups? Why is the point group 322 written as '32'? Draw the stereographic projection of this point group.
b) Draw Ewald's sphere and derive Bragg's law in reciprocal lattice space.
c) Compare electron diffraction with X-ray diffraction.
(5+4+3)

13. a) What is meant by indexing of X-ray data? The X-ray measurements for a cubic system, using Cu-K α ($\lambda = 0.1542$ nm) show diffraction peaks at 2θ given below. Index the pattern and find the lattice parameter.

Peak No.	1	2	3	4	5	6
2θ (degrees)	44.44	64.64	81.80	98.24	115.42	135.46

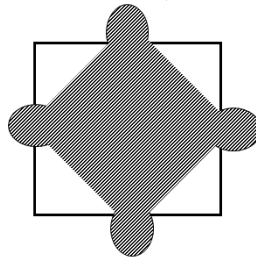
- b) Mathematically prove that Fermi energy lies halfway between the donor states and the bottom of the conduction band at absolute zero. **(6+6)**

PART-C

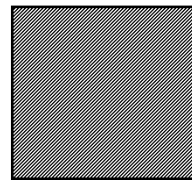
Answer any TWO of the following. Each question carries 5 marks.

[2×5=10]

14. a) Justify the statement 'a positively charged electron moving with a velocity v_i produces exactly the same current density that is produced by all the electrons after one of them has been removed'.
- b) Calculate the mobility of the conduction electrons when the conductivity of the material is $1 \text{ ohm}^{-1} \text{ cm}^{-1}$ at 300 K. The total number of conduction electrons is $10^{16}/\text{cm}^3$. [Charge of one electron = 1.6×10^{-19} C/s]. **(3+2)**
15. Cu₃Au is known to have cubic lattice, where the Cu and Au atoms are arranged to form a perfectly ordered phase, in which each unit cell contains one Au atom and three Cu atoms. Their positions are as follows:
 Au : (000)
 Cu : $(\frac{1}{2}\frac{1}{2}0)$, $(\frac{1}{2}0\frac{1}{2})$, $(0\frac{1}{2}\frac{1}{2})$
- i) Derive the expression for structure factor, F of Cu₃Au, in terms of h,k,l.
 ii) Obtain the expression for F, when h,k,l is unmixed.
 iii) Obtain the expression for F, when h,k,l is mixed.
16. a) Which among the following belong to overlapping and non-overlapping Brillouin zones? Identify I and II as semiconductor, conductor or insulator. Justify your answer.



I



II

- b) Identify the right-handed screw axis/axes from the following: 3₁, 4₃, 6₂, 6₅. Justify your choice. **(3+2)**

*****END OF QUESTIONS *****