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

DATE: 9-4-19

**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. Give any two features of La2-xSrxCuO4(x = 0.2) that are responsible for its superconductivity.
2. What are polymorphs? Give an example
3. Write the mathematical expression for electron density and explain the terms in it.
4. What is limiting sphere? Give its significance.
5. What are first order phase transitions. Give an example.
6. Define Fermi factor, f(E). Plot f(E) vs E for a free electron solid at 300 K.
7. Write the relationships between dielectric constant and (i) permittivity of the material; (ii) electric susceptibility of the material.
8. List the four distinct processes of self-diffusion.

**PART-B**

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

1. a) How does Cooper’s Model explain the phenomenon of electron pairing in superconductors?

b) Explain the following thermodynamic properties in superconductors and compare these

properties with those of normal metal: (i) entropy; (ii) Free energy.

c)Identify the point group, lattice type and crystal system present in the following spacegroups:

 (i) C2/m; (ii) Imm2. (4 + 4 + 4)

1. a) What is indexing of x-ray data? How is indexing done for a cubic crystal system?

b) Discuss Ewald’s construction and derive Bragg’s diffraction condition in terms of reciprocal lattice

vector. (6 + 6)

1. a) Give the pictorial representations of 41and 43 screw axis using motif ‘7’. Are they

 enantiomorphous to each other? If so, show their handedness with respect to rotation.

b) Give all the point groups that result by combining a parallel mirror plane and

perpendicular mirror plane with a proper rotation axis. Give the stereo graphic projection of any

four of them. (6 + 6)

1. a) Show that the five roto-reflection and roto inversion axes are equivalent in pairs with the help of

stereo graphic projections.

b) How would you estimate the mobility of a charge carrier in a solid by Hall experiment?

c) Describe electron diffraction experiment. What are the disadvantages of electron diffraction

compared to X-ray diffraction? (4 + 4 + 4)

1. a) Show that the number of Schottky defects, n, in a crystal containing N atoms is given by

n = N exp(-Ep/2kT), where Ep is the energy required to remove a pair of atoms from their lattice

sites.

b) Explain edge dislocation with the help of a diagram.

c) Discuss Kronig-Penney model of electrons in periodic potential. Show how forbidden zones arise

according to this model. (4 + 4 + 4)

1. a) Discuss the structure of Ruddlesden-Popper phases.

b) Show that a metal–n-type semiconductor junction is rectifying junction when φmetal>φsemiconductor.

c) Discuss the origin of resistivity in metals. (5 + 4 + 3)

**PART-C**

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

1. a) Verify whether the relation 4.2 = 2 is valid based on Euler’s equation

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 effect is feeble to measure. (3 + 2)

1. a) Explain why in NaCl crystal, the X-ray lines corresponding to odd hkl values have lower intensity

than those of even combinations of hkl. (Derivation of expression for intensity is not needed).

b)Calculate Fhkl values and arrive at systematic absences for a C–centered lattice. (3 + 2)

1. a) Match the following:

|  |  |
| --- | --- |
|  **A** | **B** |
| Piezoelectricity | Solids with Frenkel defects |
| Conductivity by interstitial ions | Semiconductors |
| Temperature-independent weak paramagnetism | Non-centrosymmetric crystal classes |
| Zener breakdown | Metals |
| Asymptotic Curie temperature | Tetragonal BaTiO3 |
| Polarization catastrophe | Antiferromagnetic solids |

b) Calculate the difference in energy between the Fermi level and the top of the valence band for

 an intrinsic semiconductor whose UV-visible absorption onset is 350 nm. (3 + 2)

CH-0415-A-19