Registration Number:

Date & session:

ST. JOSEPH'S COLLEGE (AUTONOMOUS), BENGALURU -27

M.Sc. CHEMISTRY– III SEMESTER

SEMESTER EXAMINATION: OCTOBER 2022

(Examination conducted in December 2022)

CH 9422 : SOLID STATE CHEMISTRY

Time: 2 ½ Hours **Max Marks: 70**

This paper contains THREE printed pages and THREE parts.

PART-A

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

1. How is roto-reflection operation different from roto-inversion operation?
2. There exists 230 space groups in crystallography. However there are only 32 point groups. Give reason.
3. Draw the stereographic projection for the point group 222.
4. Why does K_α radiation of X-rays appear at a longer wavelength than K_β radiation?
5. What is combustion synthesis? Give one example of a fuel used in combustion synthesis.
6. Write the general formula of garnet. Give one application of garnet.
7. What do you mean by lambda transformation?
8. What are first order phase transitions? Draw the plot of specific heat versus absolute temperature for a first order phase transition.

PART B

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

9. a) Explain the following with pictorial representation, choosing '7' as the motif.

   (i) 'b' glide

   (ii) 4_1 screw axis

   b) Explain Euler's relation *A.B=C*, with respect to symmetry operation. Find all the inter-axial angles for the point group 422. **(6+6)**

10. a) What is indexing of reflections? The 2θ values for the diffraction peaks in powder patterns of cubic substances are given below. Index the pattern.

Peak No.	1	2	3	4	5
2θ (deg)	44.51	51.9	76.45	93.05	98.50

b) Explain the construction of Ewald's sphere of reflection and derive Braggs' diffraction condition in terms of reciprocal lattice vector. **(6+6)**

11. a) What is phase problem in crystallography? How is it solved by heavy atom method?
    b) Write all the point groups that are obtained by the combination of a rotation axis with two mirror planes. What is the angle between the mirror planes for each of these point groups.
    c) Neutron diffraction has several advantages over X-ray diffraction. Explain. **(4+4+4)**
12. a) What is Fermi energy? Show that the Fermi energy of an intrinsic semiconductor is halfway between the top of the valence band and the bottom of the conduction band.
    b) How many types of dislocation are found in solids? Explain edge dislocation with the help of a diagram. **(6+6)**
13. a) Show mathematically that for very large light intensities, the voltage varies logarithmically with the photocurrent.
    b) Draw the Brillouin zones showing overlapping for the following: i) when the first zone is partially occupied by the electrons; ii) when the first zone is completely filled; and iii) when the first zone overlaps with the second zone. **(6+6)**
14. a) Discuss the structure of Ruddlesden-Popper phases. Give their application over the traditional pervoskites.
    b) Plot curves for the following: i) total magnetization (M) versus temperature (T) in case of paramagnetic substances and ii) paramagnetic susceptibility (χ_p) versus temperature (T).
    c) Explain sol-gel method for synthesis of solid materials. Give one advantage of this method. **(4+4+4)**

PART C

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

15. Sodium chloride (NaCl) has a cubic lattice with four Na^+ ions and four Cl^- ions per unit cell. In addition, Na^+ ions occupy the corner of a unit cell as well as the centre of the plane, whereas Cl^- ions occupy the centre of the cube as well as the midpoint of each edge-line. The eight ions in the unit cell of NaCl have co-ordinates as follows:

    Na^+ : (0,0,0) ; $(\frac{1}{2}, \frac{1}{2}, 0)$; $(\frac{1}{2}, 0, \frac{1}{2})$; $(0, \frac{1}{2}, \frac{1}{2})$

    Cl^- : $(0, \frac{1}{2}, 0)$; $(\frac{1}{2}, 0, 0)$; $(0, 0, \frac{1}{2})$; $(\frac{1}{2}, \frac{1}{2}, \frac{1}{2})$

    i) Compute the structure factor F_{hkl} ,assuming that the scattering factors of Na and Cl are expressed by f_{Na} and f_{Cl}, respectively.

    ii) Compute the structure factors of planes (111) and (200).

16. a) The point group 233 is written as 23. Give reason.

b) Explain the statement ‘An anomalous behaviour is encountered in case of Fe, Co and Ni which are paramagnetic at elevated temperature but become ferromagnetic below the transition temperature’. **(3+2)**

17 a) Given unlimited supply of $Zn(NO_3)_2$, $Al(NO_3)_3$, urea and water, design any two methods to synthesize $ZnAl_2O_4$. Give relevant chemical equations.

b) 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’. **(3+2)**

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