

**Navrachana University**  
**School of Liberal Studies and Education, M.Sc. Program**  
**End Semester Examination May, 2017**  
**First Year and Second Semester**  
**Solid State Chemistry, CH-125**

Date: 15/05/2017

Total Marks: 40

Time: 10.30 AM to 12.30 PM

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**Instructions:**

- Answer all sections
  - Use of scientific non-programmable calculator is permitted.
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**A. Answer any eight of the following questions (2X8=16 Marks)**

1. Explain Wagner reaction mechanism of formation of  $MgAl_2O_4$  spinel from the solid state reaction between  $MgO$  and  $Al_2O_3$  crystals.
2. Show that the reciprocal lattice to simple cubic lattice itself a simple cubic lattice.
3. Through Ewald sphere construction obtain Bragg's diffraction condition in terms of reciprocal lattice vector  $G$ .
4. What are systematic absent reflections in XRD? What information can be obtained through the analysis of systematic absences?
5. Justify the following statement  
"In x-ray diffraction of crystals, satisfying Bragg's equation is necessary but not sufficient"
6. Write two factors on which form factor of an atom is dependent on?
7. Sketch the variation of electrical conductivity with respect to temperature for a semiconductor and explain various regions which could be observed in the plot.
8. What are Brillouin zones? Construct two dimensional Brillouin zone for a cubic lattice indicating clearly first and second Brillouin zones.
9. Explain how antiferromagnetism is explained on the basis of super exchange interaction in  $NiO$ .
10. The Bragg angle corresponding to a reflection for which  $h^2+k^2+l^2 = 8$  is found to be  $14.35^\circ$ . Determine the lattice parameter of the crystal. X-rays of wavelength  $0.71 \text{ \AA}$  are used. If there are only two other reflections with smaller Bragg angle, what could be the possible crystal structure?

**B. Answer any six questions (4x6=24 Marks)**

1. From a powder camera of diameter 114.6 mm, using an X-ray beam of  $\lambda = 1.54 \text{ \AA}$ , the following 's' (separation between pair of arcs in Debye-Scherrer film) values in mm are obtained for a material

- 86, 100, 148, 180, 188, 232 and 272. Determine the crystal structure and lattice parameter.
- Calculate the structure factor for face centered cubic cell.
  - What are the three main film techniques employed in single crystal x-ray diffraction?
    - Discuss briefly how space group can be identified through precession method?
  - Explain the origin of energy bands in solids.
    - Through band theory of solids, explain n-type and p-type semiconductors.
  - Discuss in detail Weiss molecular field theory of ferromagnetism.
  - Sketch the variation of magnetic susceptibility with respect to temperature for paramagnetic, ferromagnetic and antiferromagnetic materials and explain.
  - Explain with proper diagram the sequence of symmetry operations for trigonal point group  $\bar{3}2$ .
  - The results of an x-ray diffraction experiment using x-rays with  $\lambda = 0.7107 \text{ \AA}$  show that diffracted peaks occur at the following  $2\theta$  angle.

Peak	$2\theta$ ( $^\circ$ )
1	20.20
2	28.72
3	35.36
4	41.07
5	46.19
6	50.90
7	55.28
8	59.42

Determine the crystal structure, the indices of the plane producing each peak and the lattice parameter.

**Good Luck**