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SARDAR PATEL UNIVERSITY

M. Sc. (Semester – IV) CBCS Examination
Thursday, 7th April 2016
2.30 p.m. to 5.30 p.m.

PS04CINC02 Solid State Chemistry (Inorganic Chemistry)

Total Marks : 70

Note : Figures to the right indicate full marks.
(Useful constants are, $h = 6.63 \times 10^{-34}$ J.s , $R = 1.987$ cal. $K^{-1}.mol^{-1}$, $k = 1.38 \times 10^{-23}$ J. K^{-1}, $k = 0.695$ cm^{-1}, $k = 8.625 \times 10^{-5}$ eV.K^{-1}, $N_A = 6.023 \times 10^{23}$ $molecule^{-1}$)

Q . 1 Select the correct answer from the alternatives given below to the each question; [08]

[i] Which among the following is a covalent solid ?

(a) copper, (b) caesium fluoride,
(c) silicon carbide (d) magnesium oxide

[ii] A *n*-type semiconductor is formed when Gallium is doped with;

(a) boron (b) aluminium
(c) arsenic (d) silicon

[iii] A certain metal having a molar mass of 0.184 kg crystallises is BCC lattice. Its density is 19300 $kg.m^{-3}$. The radius of the metal atom (in metres) is;

(a) 1.73×10^{-10} , (b) 3.71×10^{-10}, (c) 2.74×10^{-10}, (d) 1.37×10^{-10}

[iv] When X-ray of wavelength 1.542×10^{-10} m strike a crystal whose planes are 9.51×10^{-10} m a part, first order diffraction is observed. The glacing angle is;

(a) 51°4' (b) 41°5', (c) 45°1', (d) 54°1'

[v] Which of the following is true for Frenkel defects ?

(a) they occur in pure alkali halides, (b) they do not occur in silver halides,
(c) density of crystal does not change, (d) F-centres arise in such crystal

[vi] Rate of solid state reactions depends on ;

(a) nucleation (b) growth
(c) contact surface area (d) all of above

[vii] In photoconductor, semiconductor must show ___ dependent conductivity;

(a) temperature, (b) photon, (c) hole, (d) phonon

[viii] Graphite exits in hexagonal lattice form. Its lattice parameters are;

(a) $a = b = c$, $\alpha = \beta = 90°$, $\gamma = 120°$ (b) $a = b \neq c$, $\alpha = \gamma = 90°$, $\beta \neq 90°$
(c) $a = b = c$, $\alpha = \beta = \gamma \neq 90°$ (d) $a = b = c$, $\alpha = \beta = \gamma = 90°$

Cont..... 2.....

Q . 2 Answer the following in short ; **(ANY SEVEN)** **[14]**

[a] Justify $\bar{6} = \bar{3}$.

[b] Using appropriate figure, explain point group 6/m 2/m 2/m.

[c] Explain "Density of crystal decreases by introducing Frenkel defects".

[d] Enlist drawbacks of free electron theory.

[e] Explain Fermi energy, ionization potential.

[f] How to eliminate induction period in solid reaction.

[g] Explain, $m < m^*$ condition in decomposition reactions.

[h] Discuss "*in phase*" situation in X-ray diffraction.

[i] Justify "X-ray diffraction is used to find positions of heavier elements in solids".

Q . 3 **[a]** [i] Considering an example of NaCl crystal, derive following relation for Schottky defects. **[03]**

$$\log (N_V) = \log (N) - \frac{\Delta H}{2\,R\,T}$$

[ii] A metal (atomic mass = 40 $g.mol^{-1}$) in FCC has an edge length of 5.6×10^{-10} m. If it has 0.75% Schottky defects, Calculate its density (in $Kg.m^{-3}$). **[03]**

[b] [i] Write a note on "Tetragonal crystal system". **[03]**

[ii] Explain extrinsic symmetry along with definition of symmetry. **[03]**

OR

[b] [i] Write a note on "Roto-reflection". **[03]**

[ii] Explain F-centres and self-interstitial defects. **[03]**

Q . 4 **[a]** Define semiconductors. Discuss extrinsic semiconductors in detail with example. **[06]**

[b] Draw dispersion curves and explain allowed and forbidden regions of first Brillouin zone between $k = -\pi/a$ to $k = \pi/a$. **[06]**

OR

[b] [i] Considering group IV elements, explain why E_g decreases with increase in bond length. **[03]**

[ii] Discuss effect of temperature on carrier concentration and conductivity. **[03]**

Q . 5 **[a]** [i] Considering Wagner mechanism for following solid state reaction, explain factors affecting the reactions. **[03]**

$$4\,MgO_{(s)} + 4\,Al_2O_{3\,(s)} \rightarrow 4\,MgAl_2O_{4\,(s)}$$

Cont..... 3.....

Q.5 [a] [ii] Explain sol-gel method for preparation of solid. Discuss effect of pH during sol-gel process. **[03]**

[b] [i] With appropriate examples explain synthetic metals. **[03]**

[ii] What are inorganic phosphors ? Explain Stokes shift. **[03]**

OR

[b] [i] Justify "LASERS are high flux light source". **[03]**

[ii] With the help of graphs on variation of degree of decomposition as a function of time, explain various types of solid state reactions. **[03]**

Q.6 [a] [i] Enlists advantages of neutron and X-ray diffraction. **[03]**

[ii] Considering an example of NaCl crystal and λ = 1.541 Å and d_{111} = 3.255 Å. Prove that first, second, third and fourth order reflections are possible while fifth order reflection is not possible. **[03]**

[b] At 20 °C, Fe is body centered cubic, Z = 2, a = 2.866 Å. At 950 °C, Fe is face centered cubic, Z = 4, a = 3.656 Å. At 1425 °C, Fe is again body centered cubic, Z = 2, a = 2.940 Å. At each temperature, calculate (a) the density of iron, (b) the metallic radius of iron atoms. [Atomic weight of Fe = 55.93 $g.mol^{-1}$] **[06]**

OR

[b] [i] The density of LiF is 2.601 $g.cm^{-3}$. The (1 1 1) first order reflection in the X-ray diffraction from LiF occurs at 8°44' when X-ray of wavelength 70.8 pm (1 pm = 10^{-12} m) are used. If there are four LiF molecules per unit cell, Calculate Avogadro's number. LiF crystallises in the cubic system. [Li = 6.939 $g.mol^{-1}$, F = 18.998 $g.mol^{-1}$]. **[03]**

[ii] The (1 1 1) reflection in the powder pattern of KCl has zero intensity but in the powder of KF it is fairly strong. Explain. **[03]**