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No. of printed pages : 03

SARDAR PATEL UNIVERSITY

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

PS04CPHC02 Solid State Chemistry (Physical 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] Among the following the molecular solid is;

(a) silicon, (b) ice, (c) diamond, (d) brass

[ii] Monoclinic sulphur has the unit cell dimensions ;

(a) $a = b \neq c$, $\alpha = \beta = \gamma = 90^o$, (b) $a \neq b \neq c$, $\alpha = \gamma = 90^o$, $\beta \neq 90^o$
(c) $a = b = c$, $\alpha = \beta = \gamma \neq 90^o$ (d) $a = b = c$, $\alpha = \beta = \gamma = 90^o$

[iii] A certain precious metal crystallizes in FCC and has a radius of 1.44×10^{-10} m. Its edge length (in metres) is,

(a) 3.2×10^{-10} , (b) 1.8×10^{-10}, (c) 4.1×10^{-10}, (d) 2.1×10^{-10}

[iv] Germanium doped with arsenic gives rise to a;

(a) *p*-type semiconductor, (b) hole (electron vacancy),
(c) *n*-type semiconductor, (d) rectifier

[v] When a Schottky defect occurs in a crystal ;

(a) an ion from normal site occupies an interstitial site,
(b) the density of the crystal decreases
(c) the density of the crystal does not change
(d) an electron is trapped in an anion vacancy

[vi] A crystal contains phases which are 3.42×10^{-10} m aparts. When X-ray of certain wavelength gave a first order at an angle of $\theta = 13^o$ for the (1 0 0) plane. What is the wavelength of X-ray used ?

(a) 1.54×10^{-10} m, (b) 3.42×10^{-10} m (c) 1.24×10^{-10} m, (d) 4.23×10^{-10} m

[vii] Solid state reactions are less popular because;

(a) large induction period, (b) low % yield of product,
(c) required high temp., (d) all of above

[viii] In thermistors, semiconductor must show _____ dependent conductivity;

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

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

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

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

[b] Using appropriate figure, explain point group 4/m 2/m 2/m.

[c] Explain "Density of Crystal remains un alter by introducing Frenkel defects".

[d] Enlist factors affecting magnitude of the electrical conductivity.

[e] Explain Fermi level and Work function.

[f] Define induction period in solid state reactions.

[g] Explain, $m > m^*$ condition in solid state reactions.

[h] Discuss constructing interference in X-ray diffraction.

[i] Justify "Neutron diffraction is used to find position of lighter element in solids".

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

$$\log\left({}^{N_i}/_{N}\right) = \log\ (const.) - \frac{\Delta H}{2\,R\,T}$$

[ii] A metal (atomic mass = 40 $g.mol^{-1}$) in FCC has an edge length of 5.6×10^{-10} m. If it has 0.5% Schottky defects, Calculate its density (in $Kg.m^{-3}$). **[03]**

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

[ii] Explain different types of symmetry in solids. Define symmetry. **[03]**

OR

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

[ii] Explain color centre and vacancy defects. **[03]**

Q . 4 **[a]** What are semiconductors ? Enlist types of semiconductors. Discuss nature of semiconductor after dopping. **[06]**

[b] Draw a graph of energy, E against, K for the different wavelengths. Explain allowed and forbidden energy region. Define Brillouin Zone. **[06]**

OR

[b] [i] Explain the statement "As bond length increases, E_g decreases". Draw appropriate figure. **[03]**

[ii] Write a note on *p-n* junctions and enlist their applications. **[03]**

Q . 5 **[a]** [i] For following solid state reaction, write down its mechanism which includes the reactions occurs at different interfaces at solids along with overall reaction. **[03]**

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

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

Q . 5 [a] [ii] Discuss importance of pH and ageing in sol-gel method for preparation of solids. **[03]**

Q . 5 [b] [i] Write about Synthetic metals with examples. **[03]**

[ii] Explain role of host, activators and sensitizer in photoluminescence phenomena. **[03]**

OR

[b] [i] Explain working principle of "LASERS". **[03]**

[ii] For following solid state reactions, explain variation of degree of decomposition as a function of time. **[03]**

(i) $A_{(s)} \rightarrow B_{(s)} + C_{(g)}$
(ii) $A_{(s)} \rightarrow B_{(g)} + C_{(g)}$

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

[ii] First, second, third and fourth order reflections are possible for (1 1 1) plane of NaCl crystal using Cu.K_α. X-ray radiation. Show that 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 (1 1 1) reflection in the powder pattern of KCl has zero intensity but in the powder pattern of KF it is fairly strong. Explain. **[03]**

[ii] 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]**

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