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[A-34]

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SARDAR PATEL UNIVERSITY

M. Sc. (Semester – IV) CBCS Examination

Thursday, 23rd April 2015

10.30 a.m. to 1.30 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] Diamond is an example of,

(a) solid with hydrogen bonding, (b) covalent solid,
(c) electrovalent solid (d) amorphous solid

[ii] The crystal system of a compound with unit cell dimensions $a = 0.387$, $b = 0.387$ *and* $c = 0.504$ *and* $\alpha = \beta = 90°$, $\gamma = 120°$;

(a) Triclinic (b) Rhombohedra
(c) Hexagonal (d) Orthorhombic

[iii] The positions of lighter elements like H or D in solids can be obtained by'

(a) neutron diffraction, (b) electron diffraction
(c) X-ray diffraction, (d) γ - rays

[iv] Na atom crystallise in BCC lattice with cell edge, $a = 4.29$ Å. The radius of Na atom is;

(a) 18.6 Å, (b) 1.86 Å , (c) 1.86 pm , (d) 1.860 pm

[v] For silicone to behave like a *n*-type semiconductor, the impurity to be added must have valence electrons equal to ;

(a) 4, (b) 3, (c) 5, (d) 6

[vi] In *p*-type semiconductor, Fermi level is located;

(a) between conduction band and valence band (b) near to valence band
(c) near to conductance band (d) difficult to measure accurately

[vii] When $m < m^*$, $\partial\Delta G/\Delta m =$ _____

(a) positive, (b) negative, (c) zero, (d) half integer

[viii] The time lapse between excitation and emission is $\geq 10^{-8}$ sec, the process is known as _____.

(a) fluorescence, (b) phosphorescence,
(c) thermal quenching, (d) scattering

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

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

[a] Explain "X-rays have better penetration power".

[b] Define : rotoreflection, organic metals

[c] What is superconductivity ? How would you explain superconductivity in metals?

[d] Give limitations of solid state reactions.

[e] What is law of rational indices ? How are they determine?

[f] X-rays of wavelength 154 pm are diffracted by the (2 0 0) plane of AgCl crystal. At what angle would the maximum reflection occurs? (Given a = 555 pm)

[g] What are intrinsic semiconductors ? Discuss briefly with appropriate diagram.

[h] Explain working principle of thermister ?

[i] Give brief about fullerenes.

Q . 3 **[a]** Define defects in crystal. What is the cause of Frenkel defects ? Derive an expression for the number of Frenkel defects. **[06]**

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

[ii] What are improper rotations? With the help of appropriate diagrams correlate roto-inversion and roto-reflection. **[03]**

OR

[b] [i] Write a note on "Molecular solid". **[03]**

[ii] The average energy required to create a Schottky defect in an ionic crystal, $A^{2+}B^{2-}$ is 1.6 eV. Calculate the ratio of the number of Schottky defects at 25 °C and 200 °C in 1 g of the crystal. **[03]**

Q . 4 **[a]** Explain variation in carrier concentration and conductivity as a function of temperature for semiconducting materials. **[06]**

[b] [i] Justify "Na is metallic in nature". **[03]**

[ii] Write a note on "*p-n junctions*". **[03]**

OR

[b] [i] Explain band structure of silicone on the basis of molecular orbital theory approach. **[03]**

[ii] Write a note on "Hoping Conductance". **[03]**

Q . 5 **[a]** Discuss the mechanism of the following reaction occurs at the interface of Al_2O_3 and MgO. **[06]**

$$4\,MgO + 4\,Al_2O_3 \rightarrow 4\,MgAl_2O_4$$

Also explain Kirkindall effect.

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

[b] [i] Write a note on "Sol-gel method". [03]

[ii] Discuss working principle of lasers. [03]

OR

[b] Using potential energy diagram, explain spill over point and thermal quenching which are responsible for decrease in luminescence efficiency. [06]

Q . 6 [a] Metallic iron (Fe) at 1100 °C is studied by the Bragg method reflections are first obtained at $\theta = 9.8^{\circ}, 12.57^{\circ}, 7.55^{\circ}$. What type of cubic lattice does iron have at 1100 °C ? The density of iron at 1100 °C is 5.86 $g.cm^{-3}$. What is the side length of the unit cell at 1100 °C. What is the wavelength of X-rays used? (Atomic weight of iron = 55.85 $g.mol^{-1}$) [06]

[b] [i] What are the factors which affect intensity of X-rays? [03]

[ii] Give differences between electron and neutron diffraction. [03]

OR

[b] [i] Derive Bragg equation. [03]

[ii] Density of NaCl at 25 °C is 2.163×10^{3} $kg.m^{-3}$. When X-rays from a palladium target having a wavelength of 58.1 pm are used, the (2 0 0) reflection of NaCl occurs at an angle of 5.91°. Calculate the number of Na^{+} and Cl^{-} ions in the unit cell. (Molecular weight of NaCl = 58.45 $g.mol^{-1}$) [03]