

**SARDAR PATEL UNIVERSITY**  
**M. Sc. (Semester – IV) CBCS Examination**  
**Thursday, 12<sup>th</sup> April 2018**  
**2:00 p.m. to 5:00 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] Which one of the following is not a strong bond?  
(a) Covalent bond (b) Metallic bond  
(c) Vander Waals Bond (d) Ionic bond
- [ii] Diffraction is a/an \_\_\_\_\_.  
(a) Constructive interference (b) Destructive interference  
(c) Occurs from the surface (d) out phase phenomena
- [iii] The atomic diameter of a FCC crystal (If  $a$  is lattice parameter) is,  
(a)  $a$  (b)  $a/2$   
(c)  $\sqrt{\frac{3}{2}} a$  (d)  $\frac{1}{\sqrt{2}} a$
- [iv] Florescence occurs within \_\_\_\_\_.  
(a)  $\leq 10^{-5}$  s, (b)  $\leq 10^{-5}$  ms, (c)  $\leq 10^{-5}$   $\mu$ s, (d)  $\leq 10^{-5}$  ns
- [v] Which one of the following is a stoichiometric defect?  
(a) Schottky (b) Self-interstitial  
(c) Vacancy (d) Charge compensation
- [vi] In the point group,  $Im\bar{3}m$ ,  $I$  stance for \_\_\_\_\_ crystal system.  
(a) Body centred (b) Face centred  
(c) Simple (d) Primitive cell
- [vii] Zeolite is a composed of \_\_\_\_\_.  
(a) Al, Na, Si (b) Al, Li, Si  
(c) Al, Na, Ge (d) Mg, Na, Si
- [viii] Energy band gap size for semiconductors is in the range of \_\_\_\_\_.  
(a) between 1 and 2 (b) between 2 and 3  
(c) between 3 and 4 (d)  $> 4$

(C.P.T.O.)

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

- [a] Why solid state reactions are less popular ?
- [b] Calculate " $d$ " for (1 1 1) plane provided that the lattice parameter  $a = 813$  pm (picometer).
- [c] Explain working principle of fluorescence lamp.
- [d] Give brief about color centre.
- [e] What are semiconductors? Explain extrinsic semiconductors.
- [f] Discuss advantages of neutron diffraction.
- [g] Show that Frenkel defect is combination of vacancy and self-interstitial.
- [h] What is Kirkindall effect ?
- [i] What are Miller indices ? How are they determine ?

Q . 3 [a] Define defects and Schottky defects. Derive the equation for number of Schottky defects. [06]

$$n = N \exp \left( - \frac{\bar{E}_s}{2 k_B T} \right)$$

- [b] [ i ] Write a note on "Covalent solids". [03]
- [ ii ] Discuss Aliovalent impurities as defect in solids. [03]

OR

- [b] [ i ] What is symmetry? Discuss plane of symmetry in cubic crystal system. [03]
- [ ii ] Show that ratio of the number of Schottky defects at 20 °C and 300 °C i.e.  $n_{293}/n_{573}$  is  $1.33 \times 10^{-6}$  (Given the average energy required to create defect in ionic crystal is 1.4 eV). [03]

Q . 4 [a] Discuss band structure of silicone (pure) and when it is doped with tri-valent and penta-valent atoms. [06]

- [b] Explain "Why only some of energy levels are allowed for occupation of electrons". Draw appropriate figure to explain the same. [06]

OR

- [b] [ i ] Explain Fermi energy, Fermi level and Work function. [03]
- [ ii ] Discuss  $p - n$  junction and its applications. [03]

Q . 5 [a] [ i ] Explain Wagner mechanism for solid state reactions. [03]

- [ ii ] Discuss sol-gel method for preparation of solids. [03]

[b] Write a note on followings; [06]

- [ i ] Nd : YAG laser
- [ ii ] Polypyrrole as organic metal

OR

- [b] [i] Discuss various types of solid state reactions. Also explain variation of degree of decomposition as a function of time. [03]
- [ii] Explain working principle of LASER. [03]
- Q.6 [a] [i] Discuss factors affecting intensity of X-rays. [03]
- [ii] Ag crystallizes in a cubic lattice. The density is  $10.7 \times 10^3 \text{ kg.m}^{-3}$ . If the edge length of the unit cell is 405 pm (picometer), determine the type of the lattice (atomic weight of Ag =  $107.87 \text{ g.mol}^{-1}$ ). [03]
- [b] [i] Derive the relation,  $n \lambda = 2 d \sin \theta$ . Explain necessary conditions to derive this relation. [03]
- [ii] A crystal with BCC unit lattice has an edge length of 4.29 Å. Calculate the angle at which a second and third order reflection maxima ( $n = 2$  and  $n = 3$ ) may be expected for the (1 1 1), (1 0 0) and (0 1 1) lines, when X-rays of 1.5 Å wavelength are used. [03]

OR

- [b] [i] Give difference between neutron and X-ray diffraction. (Any six points). [03]
- [ii] Calculate the spacing between (1 1 0) planes of KCl viewed as a simple cubic lattice, with the  $\text{K}^+$  and  $\text{Cl}^-$  ions taken as identical and the (1 0 0) plane spacing is 3.125 Å. At what angles must first and second order reflections from (1 0 0) and (1 1 0) planes be observed? (The wavelength of X-ray used is 1.537 Å). [03]

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