

[4.02]

SEAT No. _____

No. of printed pages : 03

SARDAR PATEL UNIVERSITY
M. Sc. (Semester – IV) Physical Chemistry (CBCS) Examination
Wednesday, 20th March 2019
2:00 p.m. to 5:00 p.m.

PS04CPHC22 Chemistry of Solid Materials

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] In the point group, $Fm\bar{3}m$, the letter 'F' indicates _____ cubic system.
 (a) Simple (b) Face centred
 (c) Body centred (d) Primitive
- [ii] Which of the following bond/interaction is not due to secondary forces ?
 (a) Covalent bond (b) H-bonding
 (c) $\pi - \pi$ interaction (d) van der Waal's forces
- [iii] In the sol-gel method for preparation of solid, precipitation is controlled by;
 (a) controlling pressure (b) controlling pH
 (c) controlling volume (d) controlling molar mass of sol
- [iv] Which one of the following defect is not a stoichiometric defect?
 (a) Frenkel, (b) Schottky, (c) Charge compensation, (d) vacancy
- [v] Constructive interference of X-rays/waves lead to _____ phenomena.
 (a) Diffraction (b) Scattering
 (c) Reflection (d) Refraction
- [vi] According to Bragg equation, $n \lambda = 2 d \sin \theta$, the maximum permissible value of θ should be _____.
 (a) greater than 90° (b) less than 90°
 (c) equal to 0° (d) equal to 90°
- [vii] For insulator, band gap energy is always _____ eV.
 (a) between 1-2 (b) between 2-3
 (c) between 3-4 (d) greater than 4
- [viii] Optical fibre transmit the light effectively for longer distance. Which of the following property of solid is responsible for it ?
 (a) diffraction (b) scattering
 (c) refractive index (d) absorption

C.P.T.02

Conti....2

- Q. 2 Answer the following in short ; (ANY SEVEN) [14]
- [a] Describe glide plane in brief.
 - [b] Deduce Miller indices from the intercepts, 3a, 2b, 2c.
 - [c] Using appropriate figure show (1 1 1) and (1 0 1) planes in cubic crystal.
 - [d] Define intrinsic and extrinsic defects in solids.
 - [e] Discuss advantages of sol-gel method.
 - [f] Calculate d_{111} for orthorhombic crystal system where, $a = 2 \text{ \AA}$, $b = 3.5 \text{ \AA}$ and $c = 4 \text{ \AA}$.
 - [g] Justify "X-ray diffraction is more popular than neutron diffraction".
 - [h] With the help of appropriate figure, explain $p - n$ junction in semiconductor.
 - [i] What are organic metals?

- Q. 3 [a] Define improper rotation. Give differences between "rotoinversion" and "rotoreflexion". [06]
- [b] [i] Write a note on "Hexagonal crystal system." [03]
 [ii] Define lattices. Describe types of lattices in detail. [03]

OR

- [b] [i] Discuss types of symmetry by taking an example of cubic crystal system. [03]
 [ii] Write a note on "Screw axis". [03]

- Q. 4 [a] What are solid state reactions ? Enlist type of solid state reactions. Write down advantages and disadvantages of solids state reactions. [06]
- [b] Considering an example of preparation of MgAl_2O_4 from MgO and Al_2O_3 , describe Wagner mechanism of solid state reaction. [06]

OR

- [b] [i] For the following Frenkel defect equilibria reaction, derive the equation $N_i = N \cdot \text{const} \cdot \text{Exp}(-\Delta G/2RT)$. [03]

$$\text{Ag}^+ + V_i \leftrightarrow \text{Ag}_i^+ + V_{\text{Ag}}$$
- [ii] The density of Schottky defects in a certain sample of NaCl is 5×10^{11} per m^{-3} at 25°C . If the observed interionic ($\text{Na}^+ - \text{Cl}^-$) distance is 2.82 \AA , What is the average energy required to create one Schottky defect? [03]

- Q. 5 [a] [i] Give differences between X-ray and neutron diffraction. [03]
 [ii] Discuss powder method for X-ray diffraction. [03]

Conti....3

- [b] Metallic Iron (Fe) at 20 °C is studied by the Bragg method shows reflections [06]
 at $\theta = 11.11^\circ, 8^\circ, 20^\circ$. What type of cubic lattice does iron have ? Metallic
 iron also forms cubic crystal at 1100 °C with reflections at $9.8^\circ, 12.57^\circ, 7.55^\circ$
 respectively. What type of cubic lattice does iron have at 1100 °C? The
 density of Iron at 20 °C is 7.85 g.cm^{-3} . What is the length of a side for the
 unit cell at 20 °C? (Atomic mass of Fe is $55.847 \text{ g.mol}^{-1}$)

OR

- [b] [i] NaCl crystallises into cubic system with cell dimension (lattice [03]
 parameters/unit length) is 5.64 \AA . The density of NaCl crystal is
 2.165 g.cm^{-3} . Calculate the number NaCl molecules in a unit cell.
 (Atomic mass of NaCl = 58.45 g.mol^{-1})
- [ii] The Debye-Scherrer pattern of Tungston (BCC) is made with Cu.K_α [03]
 radiation. The first four lines on this pattern were observed to have
 following 2θ values.

Line	1	2	3	4
2θ	40.6	58.4	73.4	87.2

Index all the lines with respective plane. ($\lambda = 1.54 \text{ \AA}$).

- Q.6 [a] [i] Using band theory, explain band structure of metals, [03]
 semiconductors and insulators.
- [ii] Write a note on "Conducting property of *cis-* & *trans-* [03]
 polyacetylene".
- [b] Define semiconductors. Discuss doping of semiconductor by considering [06]
 an example of Si.

OR

- [b] [i] What is LASER ? Discuss brief about RUBY LASER. [03]
- [ii] Write a note on "Organic Charge Transfer Complexes". [03]

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