NCERT Exemplar Problems Class 12 Chemistry

Chapter 1 Solid State

Multiple Choice Questions

Single Correct Answer Type

Question 1. Which of the following condition favours the existence of a substance in the solid state?

(a) High temperature (b) Low temperature

(c) High thermal energy (d) Weak cohesive forces

Solution: (b) At low temperature substance exists in solid state due to decrease in molecular motion which leads to strong cohesive forces i.e., forces which hold the constituent particles together.

Question 2. Which of the following is not a characteristic of a crystalline solid?

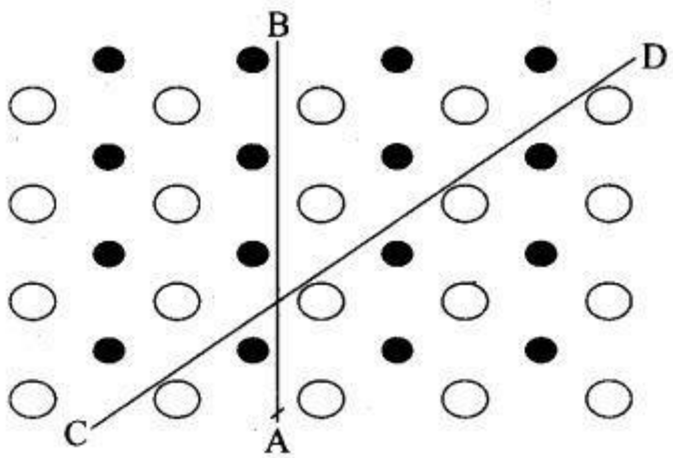
(a) Definite and characteristic heat of fusion

(b) Isotropic nature

(c) A regular periodically repeated pattern of arrangement of constituent particles in the entire crystal

(d) A true solid

Solution: (b) Anisotropy: Crystalline solids are anisotropic in nature, that is some of their physical properties like electrical resistance or refractive index show different values when measured along different directions in the same crystal. This arises from different arrangement of particles in different directions arrangement of particles along different directions



Anisotropy in crystals is due to different arrangement of particles along different directions.

Isotropy: In case of amorphous substances, properties such as electrical conductivity, refractive index, thermal expansion, etc. are identical in all directions just as in case of gases or liquids. This property is called isotropy and the substances showing this property are called isotropic.

Question 3. Which of the following is an amorphous solid?

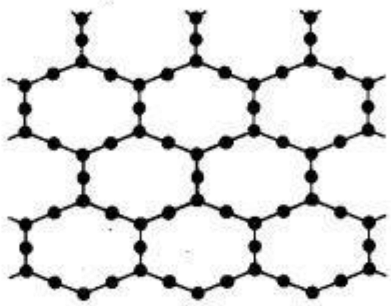
(a) Graphite (C) (b) Quartz glass (SiO_2)

(c) Chrome alum (d) Silicon carbide (SiC)

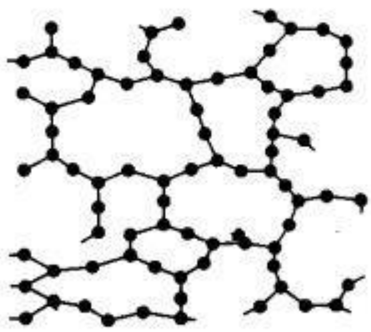
Solution: (b)

StudiesToday.com

	Crystalline Silica (Quartz)	Amorphous Silica (Glass)
1.	Crystalline in nature. Also called quartz.	Light white powder.
2.	All four corners of SiO_4^{4-} tetrahedron are shared by others to give a network solid.	The SiO_4^{4-} tetrahedron are randomly joined giving rise to polymeric chains, sheets or three-dimensional units
3.	High and sharp melting point (1710°C)	Does not have sharp melting point. On heating softens gradually to liquid.

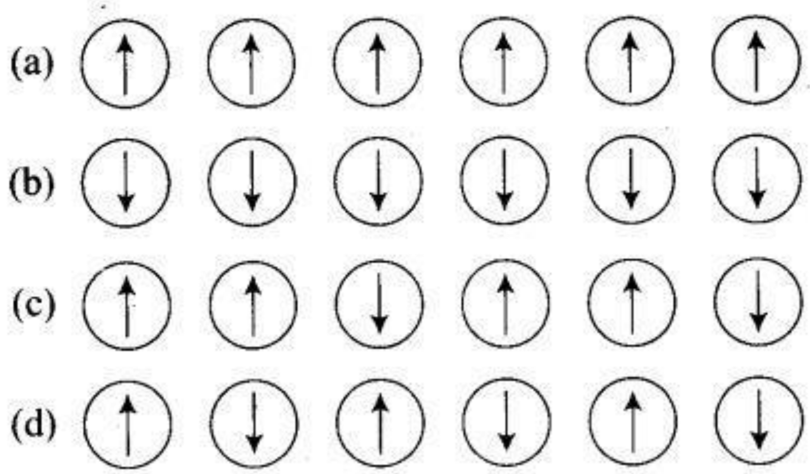


(a)
Crystalline
(Quartz)



(b)
Amorphous
(Quartz glass)

Question 4. Which of the following arrangement shows schematic alignment of magnetic moments of antiferromagnetic substances?



Solution: (d)

Antiferro-magnetic	This arises when net dipole is zero. This arises due to alignment of dipoles in equal and opposite direction.	↑ ↓ ↑ ↓ ↑ ↓ Here dipoles are arranged in compensatory way.	MnO, MnO_2, Mn_2O, FeO, Fe_2O_3, NiC, Cr_2O_3, CoO, Co_3O_4	–

Question 5. Which of the following is true about the value of refractive index of quartz glass?

(a) Same in all directions (b) Different in different directions

(c) Cannot be measured (d) Always zero

Solution: (a) Since quartz glass is an amorphous solid having short range order of constitutents. Hence, value of refractive index is same in all directions, can be measured and not be equal to zero always.

Question 6. Which of the following statement is not true about amorphous solids?

(a) On heating they may become crystalline at certain temperature

(b) They may become crystalline on keeping for a long time

(c) Amorphous solids can be moulded by heating

(d) They are anisotropic in nature

Solution: (d) Amorphous solids are isotropic because they show thermal and optical properties, same in all directions.

Question 7. The sharp melting point of crystalline solids is due to

(a) a regular arrangement of constituent particles observed over a short distance in the crystal lattice .

(b) a regular arrangement of constituent particles observed over a long distance in the crystal lattice

(c) same arrangement of constituent particles in different directions

(d) different arrangement of constituent particles in different directions

Solution:(b) A solid is said to be crystalline if the various constituent structural units (atoms, ions or molecules) of which the solid is made, are arranged in a definite geometrical pattern within the solid.

The type of forces in crystalline solids are of long range order due to which they have sharp melting point. .

Question 8. Iodine molecules are held in the crystals lattice by

(a) London forces (b) dipole-dipole interactions

(c) covalent bonds (d) coulombic forces

Solution:(a) I_2 is a molecular solid

Type of solid	Con-stituent particles	Bonding/ attractive forces	Examples	Physical nature	Electrical conduc-tivity	Melting point
Molecular solids (non-polar)	Mol-ecules	Dispersion or London forces	Ar, CCl_4, H_2,I_2, CO_2	Soft	Insulator	Very low

Question 9. Which of the following is a network solid?

(a) $S0_2$ (solid) (b) I_2

(c) Diamond (d) H_20 (ice)

Solution: (c) Diamond is a three-dimensional network solid in which each carbon atom is tetrahedrally bonded with four carbon atoms.

Question 10. Which of the following solids is not an electrical conductor?

Solution: Together by London force or dispersion force. This is soft and non-conductor of electricity.

Water is a hydrogen bonded molecular solid in which H and O are held together by polar covalent bond and each water molecular held together by hydrogen bonding. Due to non-ionic nature, they are not electrical conductor.

Question 11. Which of the following is not the characteristic of ionic solids?

(a) Very low value of electrical conductivity in the molten state

(b) Brittle nature

(c) Very strong forces of interactions

(d) Anisotropic nature

Solution: (a)

Type of solid	Constituent particles	Bonding/ attractive forces	Examples	Physical nature	Electrical conductivity	Melting point
Ionic solids	Ions	Coulombic or electrostatic	NaCl, MgO, ZnS, CaF_2	Hard but brittle	Insulators in solid state but conductors in molten state and in aqueous solutions	High

Question 12. Graphite is a good conductor of electricity due to the presence of

(a) lone pair of electrons (b) free valence electrons

(c) cations (d) anions

Solution: (b) In graphite one carbon atom is attached to three other carbon atoms. One electron of carbon remains free. Due to this free valence electron graphite is an electrical conductor.

Question.13. Which of the following oxide behaves as conductor or insulator depending upon temperature?

(a) TiO (b) $Si0_2$ (c) TiO3 (d) MgO

Solution: (c) TiO3 behaves as conductor or insulator depending on temperature because of variation of energy gap between valence band and conduction band with the variation of temperature.

Question 14. Which of the following oxide shows electrical properties like metals?

(a)SO_2 (b) MgO

(c)SO_2(s) (d) CrO_2

Solution: (d)CrO_2, TiO and Re03 are some typical metal oxides which show electrical conductivity similar to metal. While SO_2, MgO and SO_2 are oxides of metal, semimetal and non-metal which do not show electrical properties.

Question 15. The lattice site in a pure crystal cannot be occupied by

(a) molecule (b) ion

(c) electron (d) atom

Solution: (c) Pure crystals have constituents i.e., atoms or molecules or ions as lattice points which are arranged in fixed stoichiometric ratio. Electron can occupy the lattice site only when there is imperfection in solid and not in a pure crystal.

Hence, existence of free electrons are not possible, it is possible on in case of imperfection in solid.

Question 16. Graphite cannot be classified as

(a) conducting solid (b) network solid

(c) covalent solid (d) ionic solid

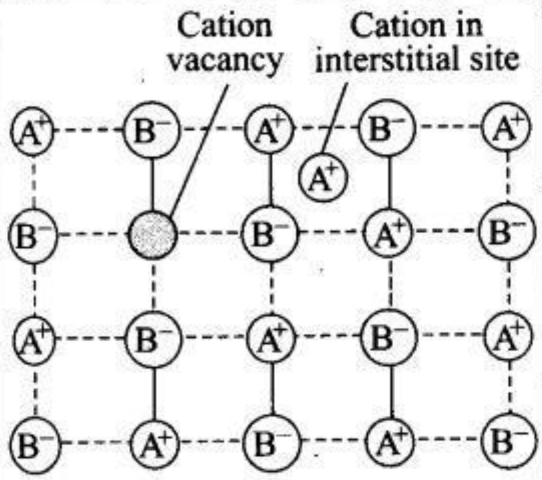
Solution: (d) Constituent units of graphite are carbon atoms, held together by covalent bonding in 2D network structure. Thus, it is not an ionic solid.

Question 17. Cations are present in the interstitial sites in

(a) Frenkel defect (b) Schottky defect

(c) vacancy defect (d) metal deficiency defect .

Solution: (a)

Defect	Definition	Type of solid	Effect of defect on density of substance	Structure of crystal (with defect)
Frenkel Defect or dis-location defect	A crystal is said to have Frenkel defect if cation is missing from the normal lattice position and is occupying interstitial site.	Ionic solid	Remain same	 Frenkel defect

Question 18. Schottky defect is observed in crystals when

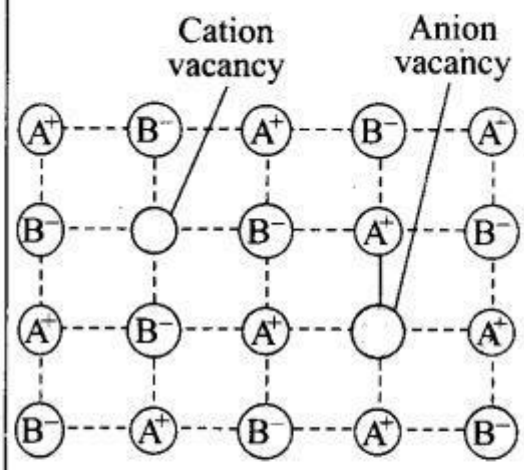
(a) some cations move from their lattice site to interstitial sites

(b) equal number of cations and anions are missing from the lattice

(c) some lattice sites are occupied by electrons

(d) some impurity is present in the lattice

Solution: (b)

Defect	Definition	Type of solid	Effect of defect on density of substance	Structure of crystal (with defect)
Schottky defect	A crystal is said to have Schottky defect if equal number of cations and anions are missing from their normal lattice site there by creating vacancies or holes.	Ionic solid	Decreases	 Schottky defect in a crystal

Question 19. Which of the following is true about the charge acquired by p-type semiconductors?

(a) Positive

(b) Neutral

(c) Negative

(d) Depends on concentration of p impurity

Solution: (b) p-Type semiconductors are neutral but they conduct electricity through positive holes.

Question 20. To get a n-type semiconductor from silicon, it should be doped with a substance with valency

(a) 2 (b) 1

(c) 3 (d) 5

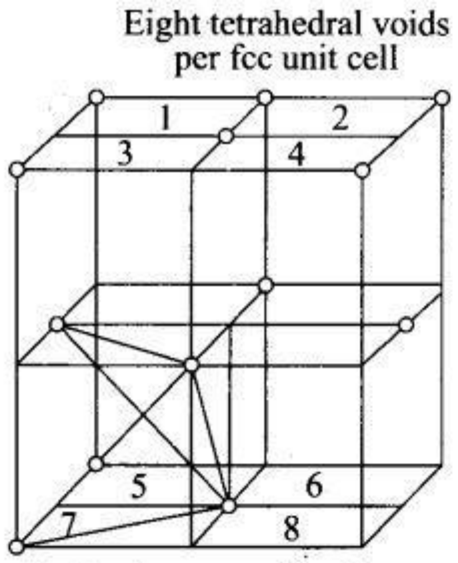
Solution: (d) Impurity of higher group is doped to get n-type semiconductor. Thus, silicon (valency = 4) should be doped with the element with valency equal to 5.

Question 21. The total number of tetrahedral voids in the face centered unit cell is

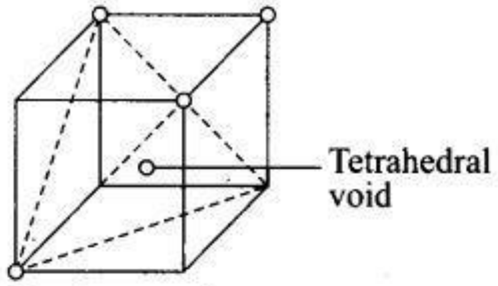
(a) 6 (c) 10

(b) 8 (d) 12

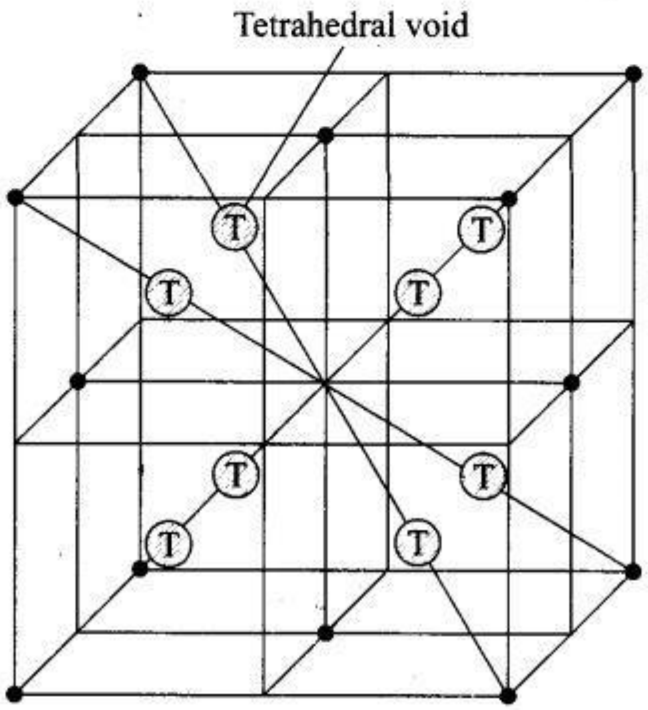
Solution: (b) Fee unit cell contains 8 tetrahedral voids at centre of each 8 smaller cube of a unit cell as shown below



Each cube represented by numeric 1, 2, 3, 4, 5, 6, 7, 8 contains one tetrahedral void.



Each cube contains one tetrahedral void at its body centre as shown above



Question 22. Which of the following point defects are shown by AgBr (s) crystals?

(A) Schottky defect (B) Frenkel defect

(C) Metal excess defect (D) Metal deficiency defect

(a) A and B (b) C and D

(c) A and C (d) B and D

Solution: (a) AgBr shows both Schottky and Frenkel defects. In AgBr, both Ag^+ and Br ions are absent from the lattice causing Schottky defect. However, Ag^+ ions are mobile so they have a tendency to move aside the lattice and trapped in interstitial site, hence cause Frenkel defect. ‘

Question 23. In which pair most efficient packing is present?

(a) hep and bcc (b) hep and ccp

(c) bcc and ccp (d) bcc and simple cubic cell

Solution: (b) Packing efficiency: It is the percentage of total filled space by particles

$$\text{Packing efficiency} = \frac{\text{Volume occupied by four spheres in the unit cell}}{\text{Total volume of unit cell}} \times 100$$

Since, packing efficiency for hep or ccp is calculated to be 74% which is maximum among all type of crystals.

Question 24. The percentage of empty space in a body centered cubic arrangement is

(a) 74 (b) 68 (c) 32 (d) 26

Solution: (c) Packing efficiency for bcc arrangement is 68% which represents total filled space in the unit cell. Hence, empty space in a body centered arrangement is 100 – 68 = 32%.

Question 25. Which of the following statement is not true about the hexagonal close packing?

(a) The coordination number is 12

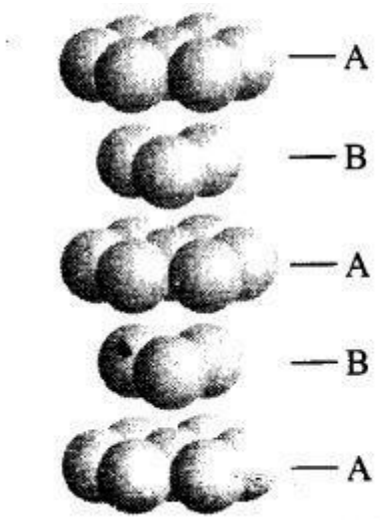
(b) It has 74% packing efficiency

(c) Tetrahedral voids of the second layer are covered by the spheres of the third layer

(d) In this arrangement, spheres of the fourth layer are exactly aligned with those of the first layer.

Solution: (d) Hexagonal close packing can be arranged by two layers

A and B one over another which can be diagrammatically represented as



Hexagonal Close Packing

Here, we can see easily that 1st layer and 4th layer are not exactly aligned. Thus, statement (d) is not correct while other statements (a), (b) and (c) are true.

Question 26. In which of the following structure coordination number for cations and anions in the packed structure will be same?

(a) Cl^- ions form fee lattice and Na+ ions occupy all octahedral voids of the unit cell.

(b) Ca^{2+} ions form fee lattice and F- ions occupy all the eight tetrahedral voids of the unit cell

(c) O^{2-} ions form fee lattice and Na^+ ions occupy all the eight tetrahedral voids of the unit cell

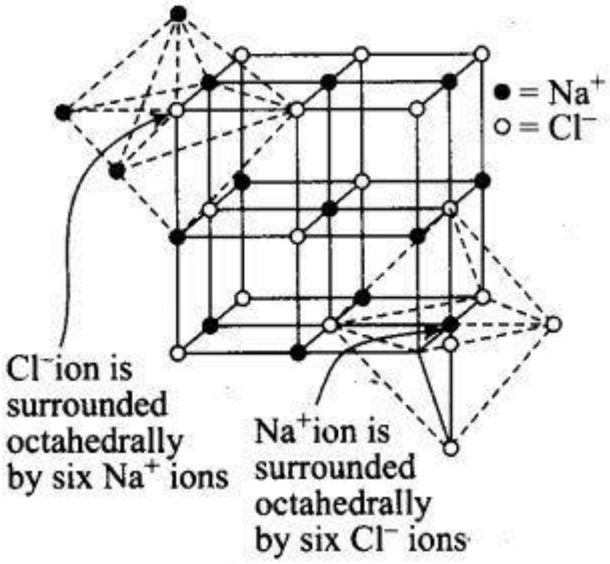
(d) S^{2-} ions form fee lattice and Zn^{2+} ions go into alternate tetrahedral voids of the unit cell.

Solution: (a) NaCl crystals have rock salt structure having fee lattice in which Cl^- ions are present at fee lattice points and face centre and Na^+ occupies all the octahedral voids of given unit cell.

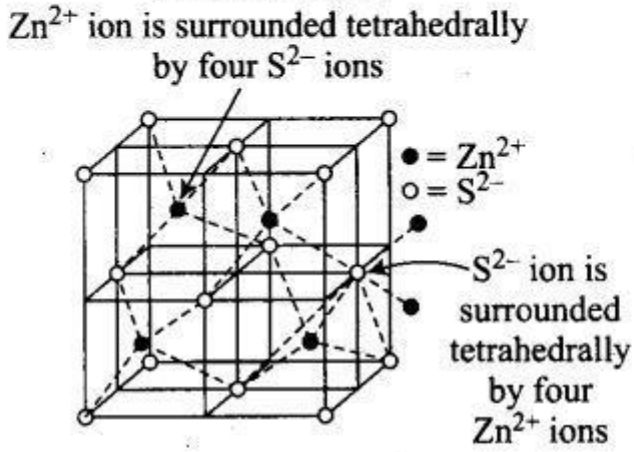
Where, coordination number of Na^+ = 6

Coordination number of Cl^- = 6

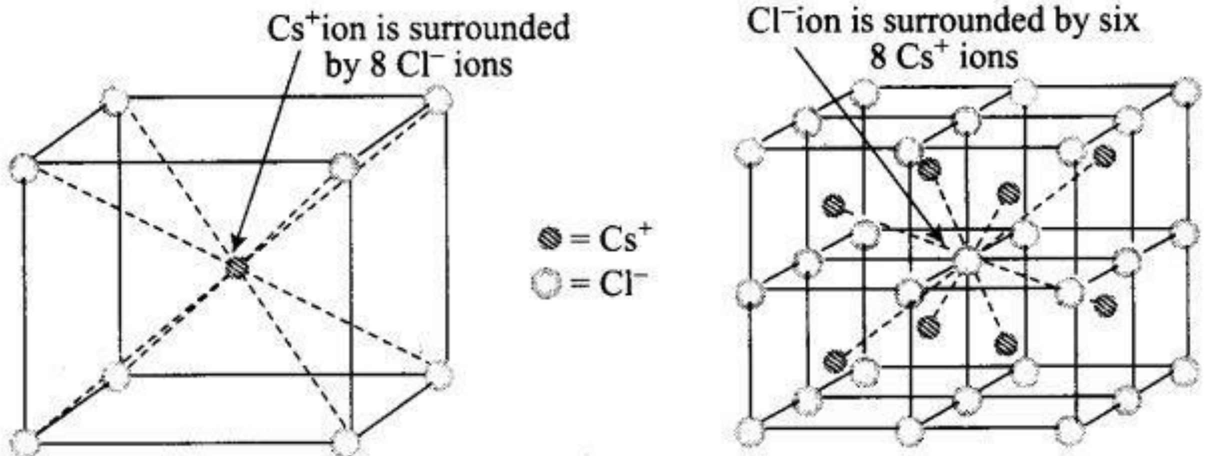
NaCl Structure



ZnS Structure



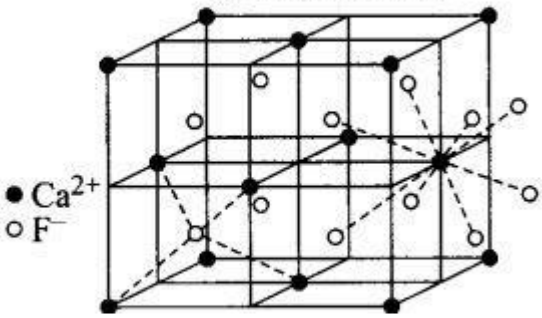
CsCl Structure



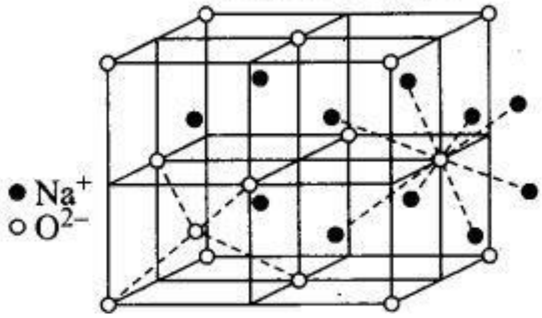
(a) One unit cell

(b) 8 unit cells

CaF_2 Structure

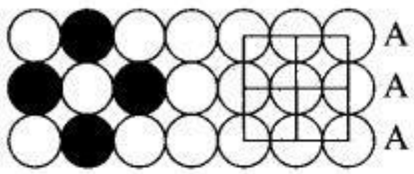


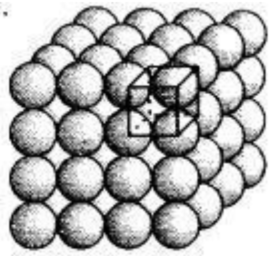
Na_2O Structure



Question 27. What is the coordination number in a square close packed structure in two dimensions? (a) 2 (b) 3 (c) 4 (d) 6

Solution: (c) Coordination number in a square closed packed structure in two dimensions is equal to 4 is shown as:





Question 28. Which kind of defect is introduced by doping?

(a) Dislocation defect (b) Schottky defect

(c) Frenkel defect (d) Electronic defect

Solution: (d) When electron rich or electron deficient impurity is added to a perfect crystal, it introduces electronic defect in them.

Question 29. Silicon doped with electron rich impurity forms

(a) p-type semiconductor (b) n-type semiconductor

(c) intrinsic semiconductor (d) insulator

Solution: (b) Silicon has four valence electrons. If it is doped with an electron rich impurity, the extra electron becomes delocalised and increases the conductivity. Since the increase in conductivity is due to negatively charged electron, hence it is called n-type semiconductor.

Question 30. Which of the following statement is not true?

(a) Paramagnetic substances are weakly attracted by magnetic field

(b) Ferromagnetic substances cannot be magnetized permanently

(c) The domains in antiferromagnetic substances are oppositely oriented with respect to each other

(d) Pairing of electrons cancel their magnetic moment in the diamagnetic substances.

Solution: (b) Ferromagnetic species are strongly attracted in the magnetic field and can be permanently magnetised.

Hence, choice (b) is the correct answer while other three choices are correct.

Question 31. Which of the following is not true about the ionic solids?

(a) Bigger ions form the close packed structure

(b) Smaller ions occupy either the tetrahedral or the octahedral voids depending upon their size

(c) Occupation of all the voids is not necessary

(d) The fraction of octahedral or tetrahedral voids occupied depends upon the radii of the ions occupying the voids.

Solution: (d) The fraction of octahedral or tetrahedral voids occupied depends upon the radii of the ions present at the lattice points. As we know the radii of octahedral or tetrahedral void is related to radii of atoms (r) as Radius of octahedral void (R_0) = 0.414 r .

Radius of tetrahedral void (R_1) = 0.225 r Where, r = radius of bigger atom involved.

Question 32. A ferromagnetic substance becomes a permanent magnet when it is placed in a magnetic field because

(a) all the domains get oriented in the direction of magnetic field

(b) all the domains get oriented ill the direction opposite to the direction of magnetic field

(c) domains get oriented randomly

(d) domains are not affected by magnetic field.

Solution:(a) Ferromagnetic solids can be permanently magnetised and then all the domains get oriented in the direction of applied magnetic field.

Question 33. The correct order of the packing efficiency in different types of unit cells is…………

(a) fee < bee < simple cubic (b) fee > bee simple cubic

(c) fee < bee > simple cubic (d) bee < fee > simple cubic

Solution:(b) Packing efficiency in different types of unit cells can be tabulated as

Unit cell	Packing efficiency
fcc	74%
bcc	68%
Simple cubic	52%

Hence, correct order is fee (74%) > bee (68%) > simple cubic (52%).

Question 34. Which of the following defects is also known as dislocation defect?

(a) Frenkel defect (b) Schottky defect

(c) Non-stoichiometric defect (d) Simple interstitial defect

Solution: (a) In Frenkel defect, some cations occupy interstitial site and hence it is also called dislocation defect.

Question 35. In the cubic close packing, the unit cell has

(a) 4 tetrahedral voids each of which is shared by four adjacent unit cells

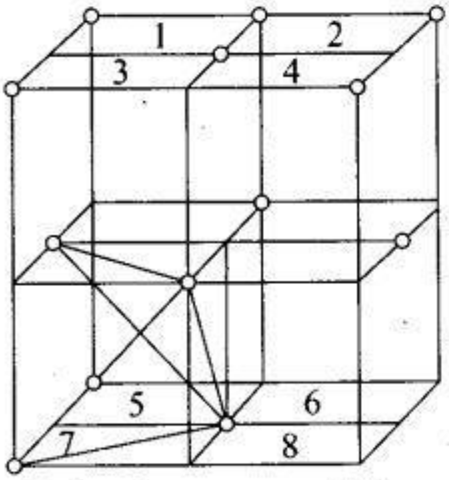
(b) 4 tetrahedral voids within the unit cell

(c) 8 tetrahedral voids each of which is shared by four adjacent unit cells

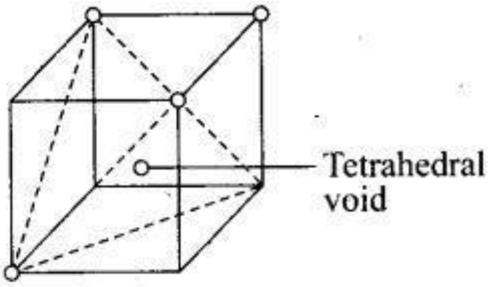
(d) 8 tetrahedral voids within the unit cells.

Solution: (d) In the cubic close packing the unit cell has 8 tetrahedral voids within it and are located at each eight smaller cube of a unit cell.

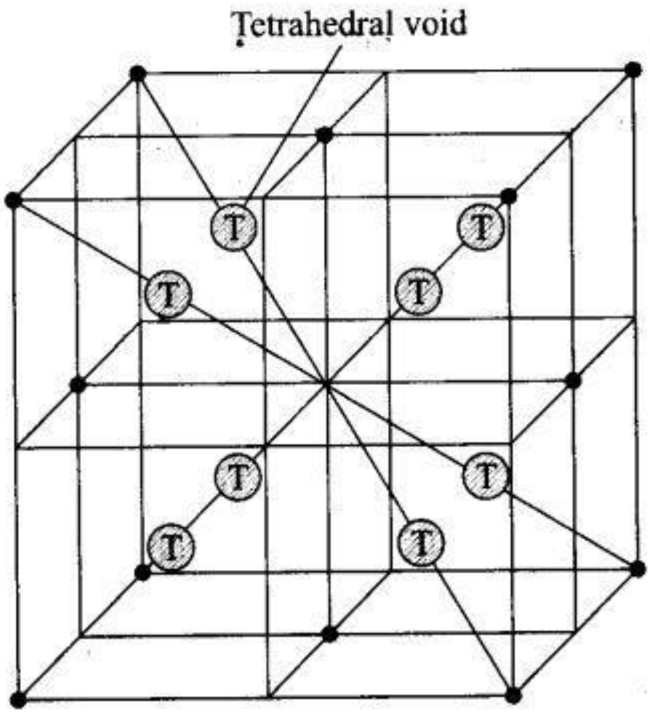
Eight tetrahedral voids
per fcc unit cell



Each cube represented by
numeric 1, 2, 3, 4, 5, 6, 7, 8
contains one tetrahedral void.



Each cube contains one
tetrahedral void at its body
centre as shown above



Question 36. The edge lengths of the unit cells in terms of the radius of spheres constituting fee, bcc and simple cubic unit cells are respectively

(a) $2\sqrt{2}r, \frac{4r}{\sqrt{3}}, 2r$

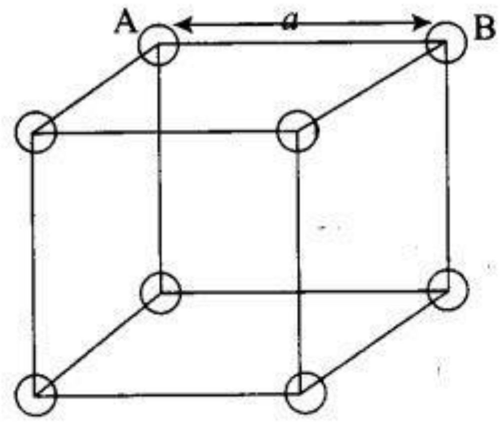
(b) $\frac{4r}{\sqrt{3}}, 2\sqrt{2}r, 2r$

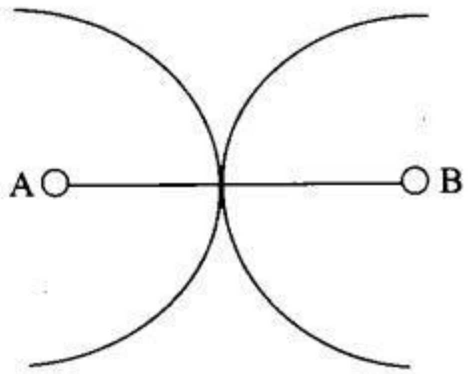
(c) $2r, 2\sqrt{2}r, \frac{4r}{\sqrt{3}}$

(d) $2r, \frac{4r}{\sqrt{3}}, 2\sqrt{2}r$

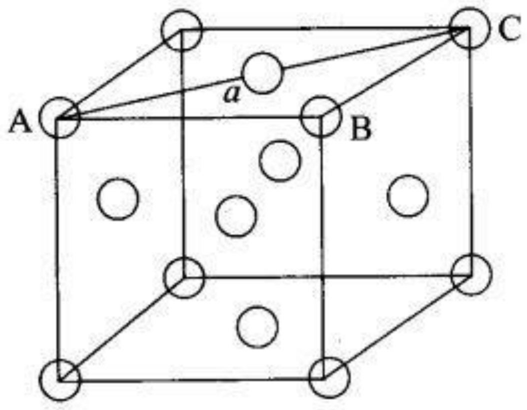
Solution: (a) Note: Distance between two atoms is always measured from their centres

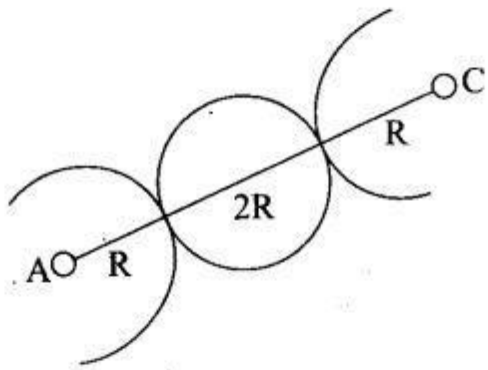
(i) If the crystal lattice consists of SCC, the atom which is present at the comers touch each other



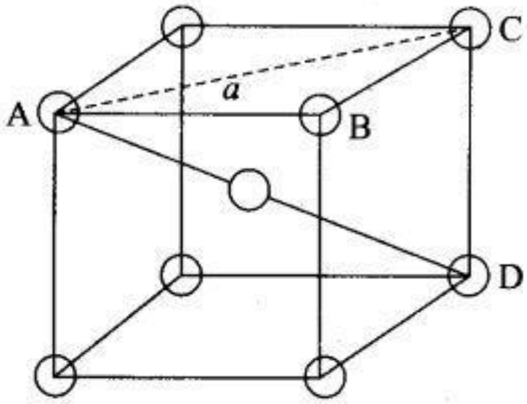


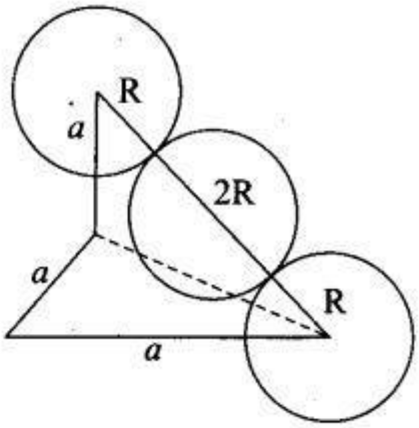
(ii) In case of FCC, atom present at the comer and the centre of the face touch each other.





(iii)In case of BCC atom present at the corner and center of the body touch each other





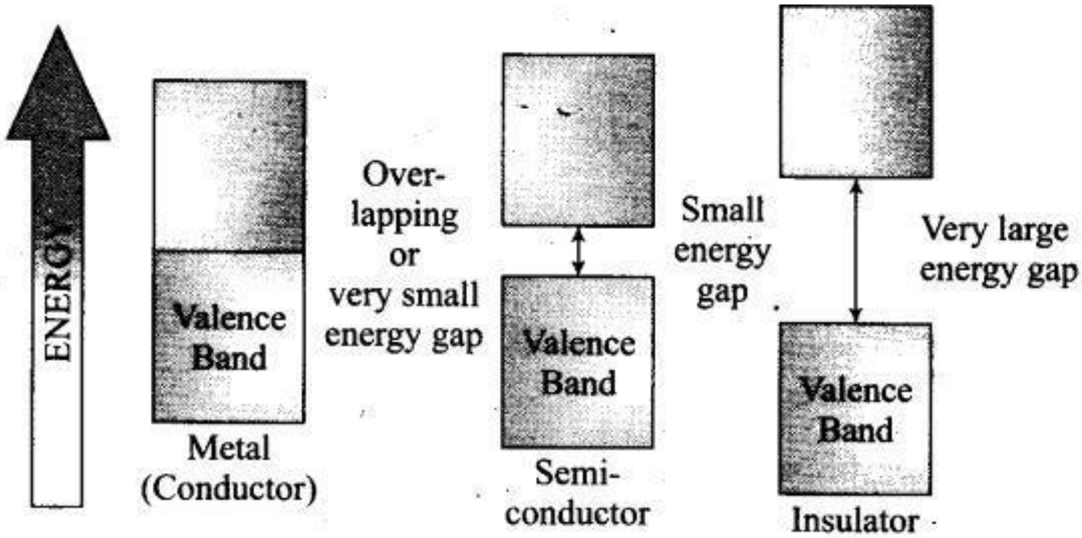
Edge length for different types of unit cells can be tabulated as

Type of Unit cell	Edge length
fcc	$2\sqrt{2}r$
bcc	$\frac{4}{\sqrt{3}}r$
scc	$2r$

Question 37. Which of the following represents correct order of conductivity in solids?

(a) $\kappa_{metals} >> \kappa_{insulators} < \kappa_{semiconductors}$
(b) $\kappa_{metals} << \kappa_{insulators} < \kappa_{semiconductors}$
(c) $\kappa_{metals} < \kappa_{semiconductors} > \kappa_{insulators} = \text{zero}$
(d) $\kappa_{metals} < \kappa_{semiconductors} > \kappa_{insulators} \neq \text{zero}$

Solution: (a) Conductivity of metal, insulator and semiconductors can be represented in the term of k (Kappa) which depends upon energy gap between valence band and conduction band.



Valence and conductance bands in metals, semiconductors and insulators.

	Valued $\kappa(\Omega^{-1}\ m^{-1})$
Metal	10^4 to 10^7
Insulator	10^{-20} to 10^{-10}
Semiconductor	10^{-6} to 10^4

Question 38. Which of the following is not true about voids formed in three dimensional hexagonal close packed structure?

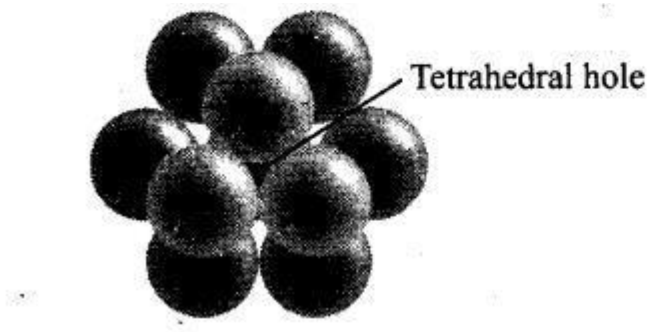
(a) A tetrahedral void is formed when a sphere of the second layer is present above triangular void in the first layer

(b) All the triangular voids are not covered by the spheres of the second layer

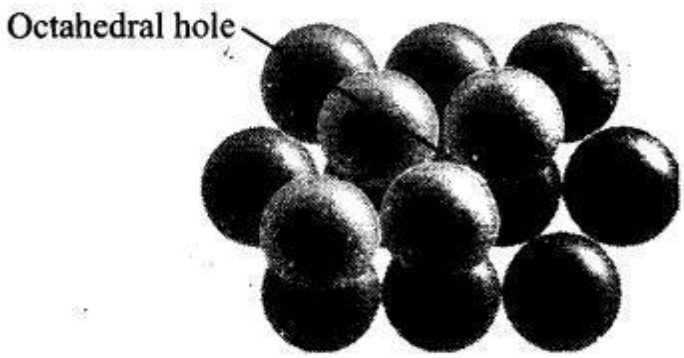
(c) Tetrahedral voids are formed when the triangular voids in the second layer lie above the triangular voids in the first layer and the triangular voids in the first layer and the triangular shapes of these voids do not overlap

(d) Octahedral voids are formed when the triangular voids in the second layer exactly overlap with similar voids in the first layer.

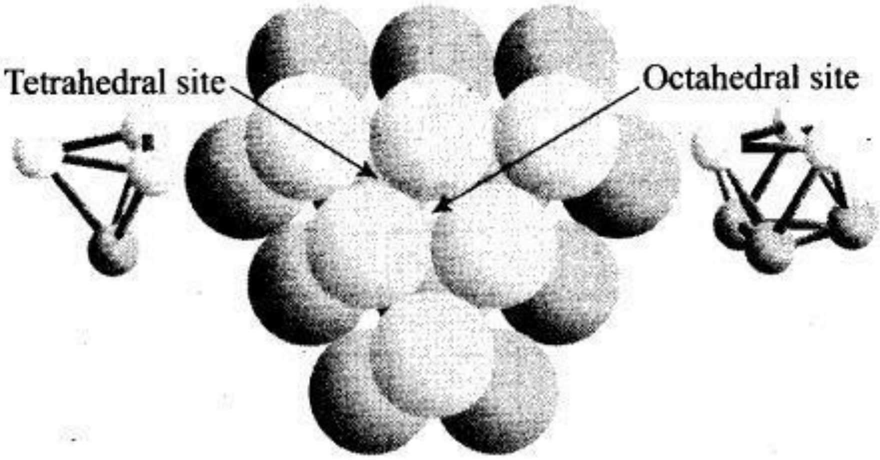
Solution: (c, d) Tetrahedral voids are formed when the triangular void in the second layer lie exactly above the triangular voids in the first layer and the triangular shape of these voids oppositely overlap.

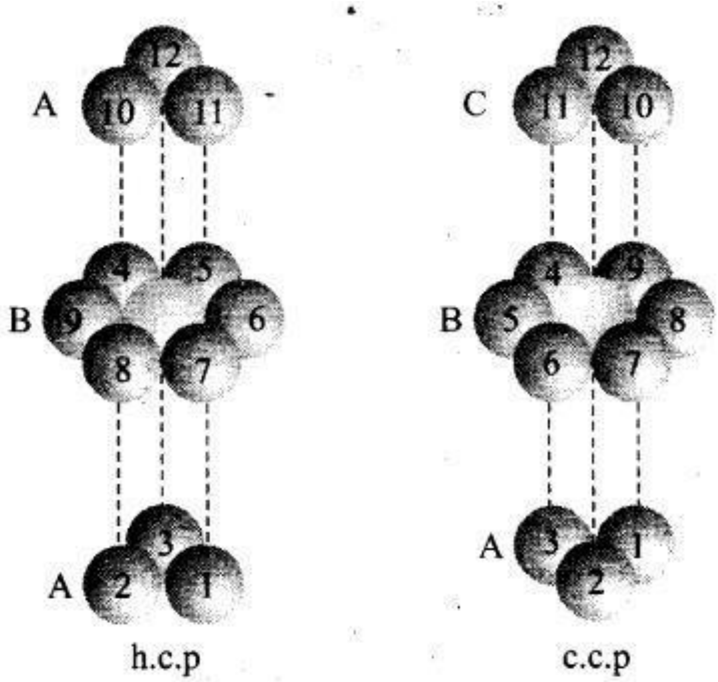


Octahedral voids are formed when triangular void of second layer is not exactly overlap with similar void in first layer.



Cubic close-packed structure





Co-ordination number in hcp and ccp

Question 39. The value of magnetic moment is zero in the case of antiferromagnetic substances because the domains …

(a) get oriented in the direction of the applied magnetic field

(b) get oriented opposite to the direction of the applied magnetic field

(c) are oppositely oriented with respect to each other without the application of magnetic field

(d) cancel out each other's magnetic moment

Solution: (c, d) In the case of antiferromagnetic substances, the magnetic moment becomes zero because the domains are oppositely oriented with respect to each other without the application of magnetic field which cancel out each other.

Antiferromagnetic	This arises when net dipole is zero. This arises due to alignment of dipoles in equal and opposite direction.	↑↓↑↓↑↓ Here dipoles are arranged in compensatory way.	MnO, MnO_2, Mn_2O, FeO, Fe_2O_3; NiO, Cr_2O_3, CoO, Co_3O_4	–

Question 40. Which of the following statements are not true?

(a) Vacancy defect results in a decrease in the density of the substance

(b) Interstitial defects results in an increase in the density of the substance

(c) Impurity defect has no effect on the density of the substance

(d) Frenkel defect results in an increase in the density of the substance

Solution: (c, d) Statements (c) and (d) can be correctly written as (c) Impurity defect changes the density of substance as impurity has different than the ion present on perfect crystal e.g., When $SrCl_2$ is added to the NaCl crystal, it causes impurity defect, (d) Frenkel defect results neither decrease nor increase in density of substance.

Question 41. Which of the following statements are true about metals?

(a) Valence band overlap with conduction band

(b) The gap between valence band and conduction band is negligible

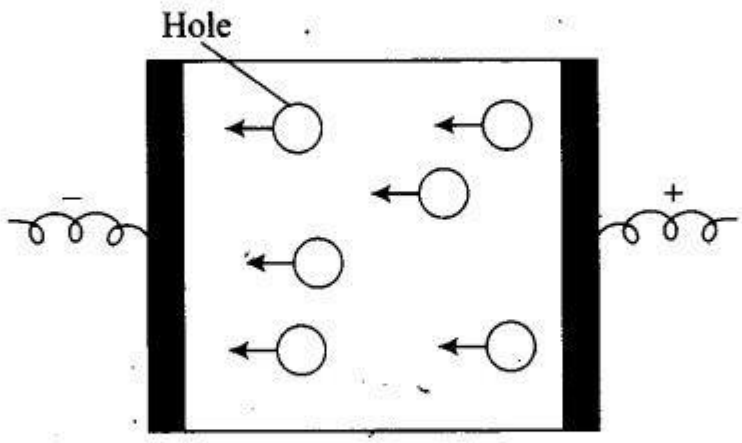
(c) The gap between valence band and conduction band cannot be determined

(d) Valence band may remain partially filled.

Solution: (a, b, d) In metal, valence band overlap with conduction band. The gap between valence band and conduction band is negligible and valence band may remain partially filled.

Question 42. Under the influence of electric field, which of the following statements are true about the movement of electrons and holes in a p-type semiconductor?
(a) Electron will move towards the positively charged plate through electron holes
(b) Holes will appear to be moving towards the negatively charged plate
(c) Both electrons and holes appear to move towards the positively charged plate
(d) Movement of electrons is not related to the movement of holes
Solution: (a, b) In p-type semiconductor, the conductivity is due to existence of hole. When electric field is applied to p-type semiconductor hole starts moving towards negatively charged plate and electron towards positively charged plate.
Flow of holes in p-type semiconductors Hole .

Flow of holes in *p*-type semiconductors



p-type semiconductor
(Flow of holes like positive change)

Question 43. Which of the following statements are true about semiconductors?
(a) Silicon doped with an electron rich impurity is a p-type semiconductor
(b) Silicon doped with an electron rich impurity is an n-type semiconductor
(c) Delocalised electrons increase the conductivity of doped silicon
(d) An electron vacancy increases the conductivity of type semiconductor
Solution: (b, c) Silicon (valence electron – 4) doped with electron rich impurity is an n-type semiconductor due to extra electron and the delocalised electrons increase the conductivity of doped silicon.

Question 44. An excess of potassium ions makes KCl crystals appear violet or Lilac in colour since

(a) some of the anionic sites are occupied by an unpaired electron

(b) some of the anionic sites are occupied by a pair of electrons

(c) there are vacancies at some'anionic sites

(d) F-centres are created which impart colour to the crystals

Solution: (a, d) .

When KC1 is heated in vapour of K, some of the Cl" leave their lattice site and create anion vacancies. This chloride ion wants to combine with K vapour to form potassium chloride. For doing so K atom loses electrons form K ions. This released electron diffuses into the crystal to get entrapped in the anion vacancy called F-centre. When visible light falls on the crystal, this entrapped electron gains energy, goes to the higher level when it comes back to the ground state, energy is released in the form of light.

Question 45. The number of tetrahedral voids per unit cell in NaCl crystal is

(c) twice the number of octahedral voids

(d) four times the number of octahedral voids

Solution: (b, c) NaCl has fee arrangement of CF ions. Thus,

Number of CF ions in packing per unit cell = 4

Number of tetrahedral voids = 2 x No. of particles present in close packing

=2×4=8

Number of tetrahedral voids = 2 x No. of octahedral voids

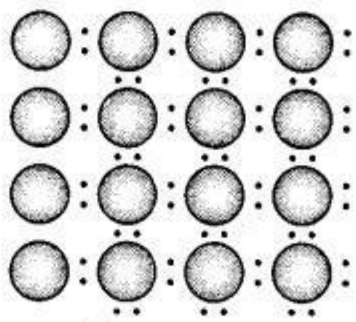
Question 46. Amorphous solids can also be called

(a) pseudo solids (b) true solids

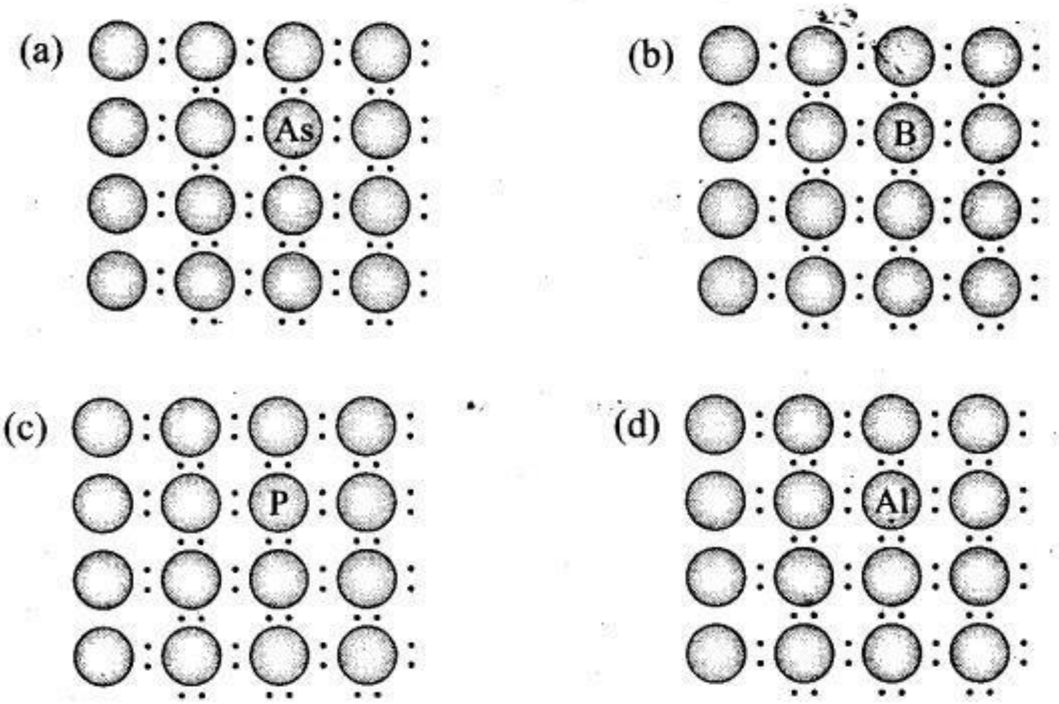
(c) super cooled liquids (d) super cooled solids

Solution: (a, c) Amorphous solid has short range order which has a tendency to flow very slowly. Hence, it is also known as pseudo solids or super cooled liquids. Glass panes fixed to windows or doors of old buildings are invariably observed to be thicker at bottom than at the top. These are examples of amorphous solids.

Question 47. A perfect crystal of silicon (fig) is doped with some elements as given in the options. Which of these options show n-type semiconductors?



Pure crystal



Solution: (a, c)

When group 15 elements are doped into a perfect crystal, it leads to the formation of n-type semiconductor.

Here, in (a) as (group 15, period 3) is doped to perfect Si-crystal and in (c) as (group 15, period 2) is doped to perfect Si-crystal.

Question 48. Which of the following statements are correct?

(a) Ferrimagnetic substances lose ferrimagnetism on heating and become paramagnetic

(b) Ferrimagnetic’substances do not lose ferrimagnetism on heating and remain ferrimagnetic

(c) Antiferromagnetic substances have domain structure similar to ferromagnetic substances and their magnetic moments are not cancelled by each other

(d) In ferromagnetic substances, all the domains get oriented in the direction of magnetic field and remain as such even after removing magnetic field.

Solution: (a, d) Ferrimagnetic substances lose ferrimagnetism on heating and become paramagnetic. In ferromagnetic substance, domains are aligned in parallel and antiparallel direction in unequal numbers.

In ferromagnetic substances, all the domains get oriented in the direction of magnetic field and remain as such even after removing magnetic field.

Question 49. Which of the following features are not shown by quartz glass?

(a) This is a crystalline solid

(b) Refractive index is same in all the directions

(c) This has definite heat of fusion

(d) This is also called super cooled liquid

Solution: (a, c) Quartz glass is an amorphous solid so it has not definite heat of fusion. This is due to short range order of molecule while quartz glass is also known as super cooled liquid and isotropic in nature.

	Crystalline Silica (Quartz)	Amorphous Silica (Glass)
1.	Crystalline in nature. Also called quartz.	Light white powder.
2.	All four corners of SiO_4^{4-} tetrahedron are shared by others to give a network solid.	The SiO_4^{4-} tetrahedron are randomly joined giving rise to polymeric chains, sheets or three – dimensional units
3.	High and sharp melting point (1710°C)	Does not have sharp melting point. On heating softens gradually to liquid.

Question 50. Which of the following cannot be regarded as molecular solid?

(a) SiC (b) AIN

(c) Diamond (d) I_2

Solution: (a, b, c) SiC, AIN and diamond are examples of network solid as they have three dimensional structure while, I_2 is a molecular solid, because such solid particles are held together by dipole-dipole interactions. SiC and AIN are interstitial solids. s

Question 51. In which of the following arrangements octahedral voids are formed?

(a) hep (b) bcc (c) simple cubic (d) fee

Solution: (a, d) In hep and fee arrangement, octahedral voids are formed. In fee, the octahedral voids are observed at edge and centre of cube while in bcc and simple cubic, no any octahedral voids are observed. In bcc, cubic voids formed.

Question 52. Frenkel defect is also known as
(a) stoichiometric defect (b) dislocation defect
(c) impurity defect (d) non-stoichiometric defect
Solution: (a, b) In Frenkel defect, dislocation of cations takes place and there is no change in stoichiometry of the crystal.

Question 53. Which of the following defects decrease the density?
(a) Interstitial defect (b) Vacancy defect
(c) Frenkel defect (d) Schottky defect
Solution: (b, d) Vacancy and Schottky defect which lead to decrease the density both are the types of a stoichiometric defect. In case of Frenkel defect and interstitial defect, there is no change in density of substance.

Short Answer Type Questions

Question 54. Why are liquids and gases categorized as fluids?
Solution: The liquids and gases have a property to flow i.e., the molecules of liquids and gases can easily move fast and tumble over one another freely. Because of their tendency to flow, these have been categorized as fluids.

Question 55. Why are solids incompressible?
Solution: The intemuclear distance between the constituent particles (atoms, molecules or ions) in solids are very less. On bringing them further closer, there will be large repulsive force between electron clouds of these particles. Therefore, solids cannot be compressed.

Question 56. In spite of long range order in the arrangement of particles why are the crystals usually not perfect?
Solution:Crystals have long range in the arrangement of particles but usually the crystals are not perfect this is because when crystallisation occurs at a fast rate or moderate rate, the constituent particles may not get sufficient time to arrange themselves in a perfect order.

Question 57. Why does table salt, NaCl sometimes appear yellow in colour?

Solution: The yellow colour of sodium chloride crystals is due to metal excess defect. In this defect, the unpaired electrons get trapped in anion vacancies. These sites are called F-centres. The‘yellow colour results by excitation of these electrons when they absorb energy from the visible light falling on the crystals.

Question 58. Why is FeO(s) not formed in stoichiometric composition?

Solution: Iron oxide (FeO) has rock salt structure.

In this case, O2 ions adopt on sites and Fe2+ ions should occupy non- stoichiometric. This is the ideal arrangement.

This oxide is always non-stoichiometric i.e., the composition of Fe2+ and O2 ions is not 1 : 1. It is 0.95 : 1 i.e. Fe0 95O(Wustite)

This composition can be obtained if a small number of Fe2+ ions are replaced by two-thirds of’Fe3+ ions in Oh sites.

Eventually there would be less amount of metal as compared to stoichiometric composition.

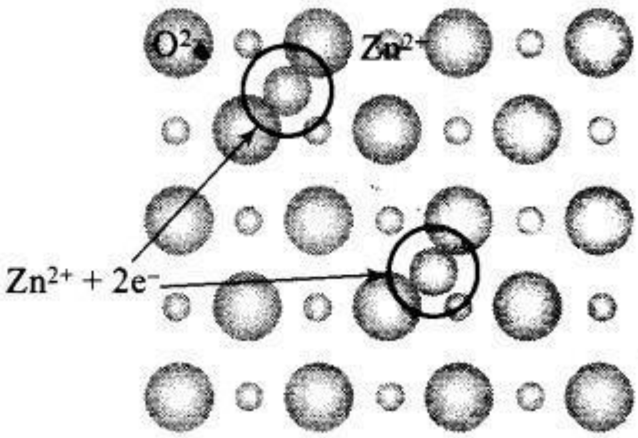
Question.59. Why does white ZnO (s) become yellow upon heating?

Solution: When ZnO is heated, it splits up to give Zn2+, electrons and colour because of the following reasons:

The excess Zn ions thus formed get entrapped in the interstitial site and electron in the neighborhood vacant interstitial sites. This electron is responsible for the colour and electrical conductivity in crystals.

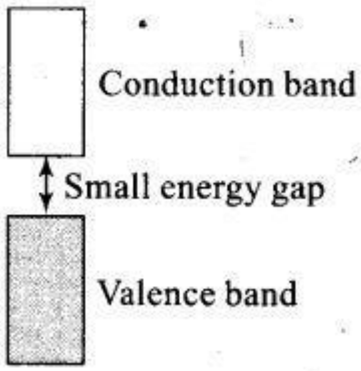
$$ZnO \longrightarrow Zn^{2+} + \frac{1}{2}O_2 + 2e^-$$

- ZnO heated in Zn vapour $\rightarrow Zn_yO$ ($y > 1$)
- The excess cations occupy interstitial voids
- The electrons ($2e^-$) released stay associated to the interstitial cation



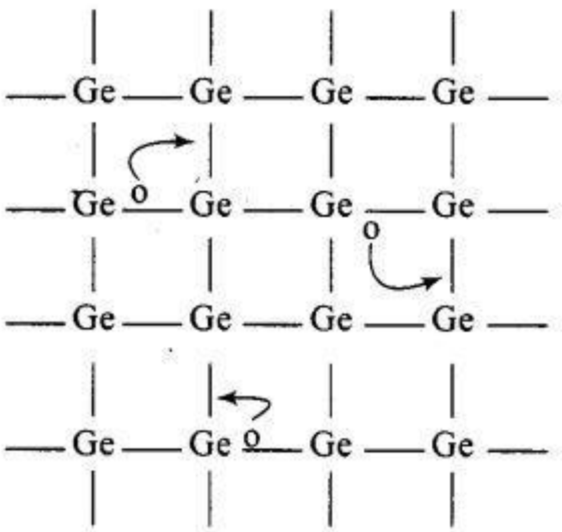
Question 60. Why does the electrical conductivity of semiconductors increase with rise in temperature?

Solution: The energy gap between valence band and conduction band is small. At room temperature, they do not conduct electricity but when temperature is raised large number of electron from valence band get sufficient energy to jump to conduction band. This is known as thermodynamic conduction in intrinsic semiconductors. Thus, they become more conducting as the temperature increases.



Question 61. Explain why does conductivity of germanium crystals increase on doping with gallium?

Solution: p-type semiconductor:



- When Ge is doped with group 13 elements, for example, gallium, the structure of crystal lattice does not change.
- 3 valence electrons of gallium are used up in the normal covalent bond.
- For one dopant atom, one hole is created because the place where fourth electron is missing is called vacancy or hole and is responsible for conduction of germanium doped with gallium.

Electron from neighbouring atom comes and fills the hole, thereby creating a hole in its original position.

Under the influence of electric field electrons move towards positively charged plates through these and conduct electricity. The holes appear to move towards negatively charged plates.

Question 62. In a compound, nitrogen atoms (N) make cubic close packed lattice and metal atoms (M) occupy one-third of the tetrahedral voids present. Determine the formula of the compound formed by M and N?

Solution: In ccp, no. of atoms per unit cell = 4

Thus, of tetrahedral voids = 2 x No. of atoms in ccp =2 x 4=8

Only one-third of tetrahedral voids are occupied by metal M. No. of

No. of metal atoms, $M = \frac{1}{3} \times 8$

$$M:N = \frac{8}{3}:4 = 2:3$$

Thus, formula is M_2N_3.

Question 63. Under which situations can an amorphous substance change to crystalline form?

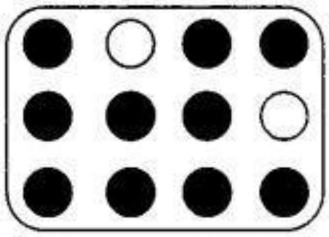
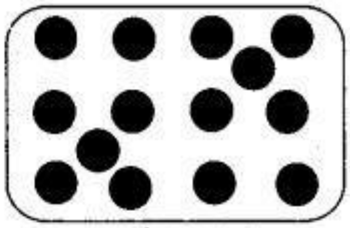
Solution: An amorphous solid on heating at some temperature may become crystalline. Slow heating and cooling over a long period makes an amorphous solid acquires some crystalline character.

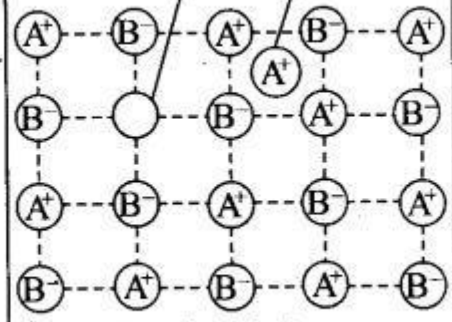
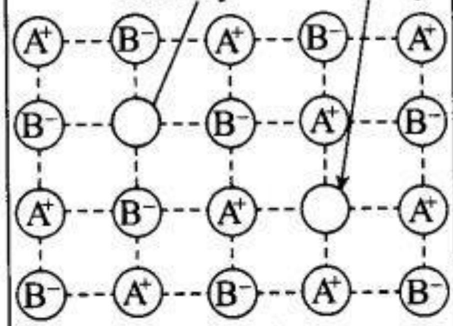
Matching Column Type Questions

Question 64. Match the defects given in Column I with the statements given in Column II.

Column I		Column II	
(i)	Simple vacancy defect	(a)	Shown by non-ionic solids and increases density of the solid
(ii)	Simple interstitial defect	(b)	Shown by ionic solids and decreases density of the solid
(iii)	Frenkel defect	(c)	Shown by non-ionic solids and density of the solid decreases
(iv)	Schottky defect	(d)	Shown by ionic solids and density of the solid remains the same

Solution: (i) -> (c); (ii) -> (a); (iii) ->(d); (iv) ->(b)

	Defect	Definition	Type of solid	Effect of defect on density of substance	Structure of crystal (with defect)
(i)	Vacancy defect	When some of the lattice sites are vacant the crystal is said to have vacancy defect	Non-ionic solid	Decreases	 Vacancy defects
(ii)	Interstitial defect	When some of the constituent atoms occupied the interstitial site, the crystal is said to have interstitial defects.	Non-ionic solid	Remains same	 Interstitial defects

(iii)	Frenkel defect or dislo-cation defect	A crystal is said to have Frenkel defect if cation is missing from the normal lattice position and is occupying interstitial site.	Ionic solid	Remains same	
(iv)	Schottky defect	A crystal is said to have Schottky defect if equal number of cations and anions are missing from their normal lattice site there by creating vacancies or holes.	Ionic solid	Decreases	

Question 65. Match the type of unit cell given in Column I with the features given in Column II.

Solution: (i) —>(b, c); (ii) —>(c, d); (iii) —>(c, e); (iv) —> (a, d)

(i) For primitive unit cell, a = b = c

Total number of atoms per unit cell = 1/8 x 8 = 1

Here, 1/8 is due to contribution of each atom present at comer.

(ii) For body centered cubic unit cell, a = b = c.

This lattice contains atoms at comer as well as body centre. Contribution due to atoms at comer = 1/8 x 8 = 1 contribution due to atoms at body centre = 8

(iii) For face centered unit cell, a = b = c

Total constituent ions per unit cell present at corners = $\frac{1}{8} \times 8 = 1$

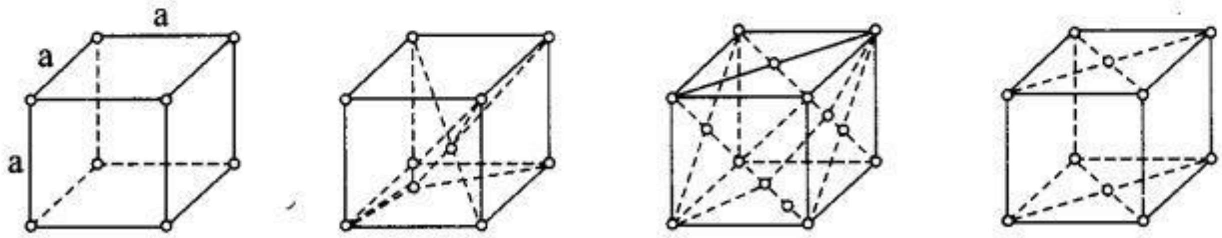
Total constituent ions per unit cell present at face centre = $\frac{1}{2} \times 6 = 3$

(iv) For end centered orthorhombic unit cell, $a \neq b \neq c$

Total contribution of atoms present at corner = $\frac{1}{8} \times 8 = 1$

Total contribution of atoms present at end centre = $\frac{1}{2} \times 2 = 1$

Hence, other than corner it contains total one atom per unit cell.



Primitive (or simple) | Body centred | Face centred | End centred

Question 66. Match the types of defect given in Column I with the statement given in Column II.

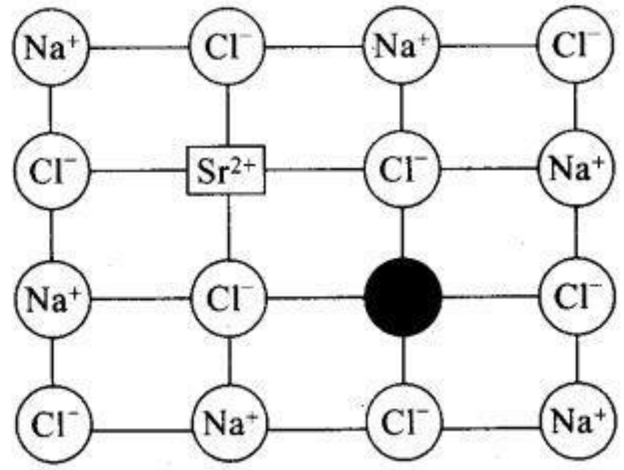
Column I		Column II	
(i)	Impurity defect	(a)	NaCl with anionic sites called F-centres
(ii)	Metal excess defect	(b)	FeO will Fe^{3+}
(iii)	Metal deficiency defect	(c)	NaCl with Sr^{2+} and some cationic sites vacant

Solution: (i) —>(c); (ii) —>(a); (iii) —> (b)

(A) (i) Impurity defects: The defects introduced in the crystal lattice due to presence of the certain impurity are called impurity defects.

Example: Substitution of Na^+ ions in NaCl by Sr^{2+} ions.

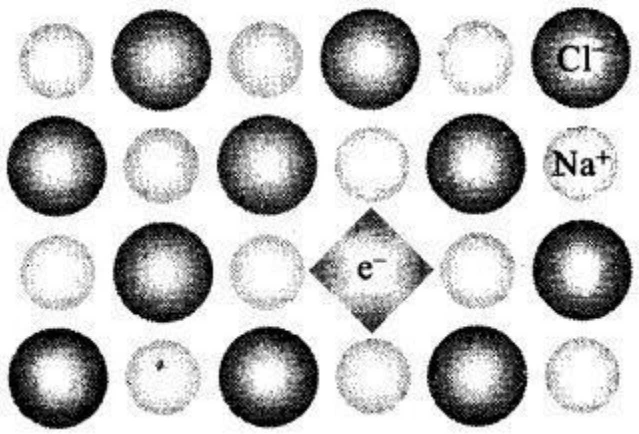
Structure with defect:



Impurity defect due to substitution of Na^+ ions in NaCl by Sr^{2+} ions (Cation vacancy)

'Schottky Defect'

(B) When NaCl is heated in vapour of sodium some of the Cf leave their lattice site and create anion vacancies. This chloride ion wants to combine with sodium vapour to form sodium chloride. For doing so sodium atom loses electrons form Na+ ions. This released electron diffuses into the crystal to get entrapped in the anion vacancy called F-centre.



(C) Metal deficiency is caused due to cation vacancy created by replacement of some lower valent ions by its higher valentions.

Note: Cation vacancies are found in crystals in which metals have different oxidation states.

Example: FeO, FeS, NiO

Question 67. Match the items given in Column I with the items given in Column II.

Column I		Column II	
(i)	Mg in solid state	(a)	*p*-type semiconductor
(ii)	$MgCl_2$ in molten state	(b)	*n*-type semiconductor
(iii)	Silicon with phosphorus	(c)	Electrolytic conductors
(iv)	Germanium with boron	(d)	Electronic conductors

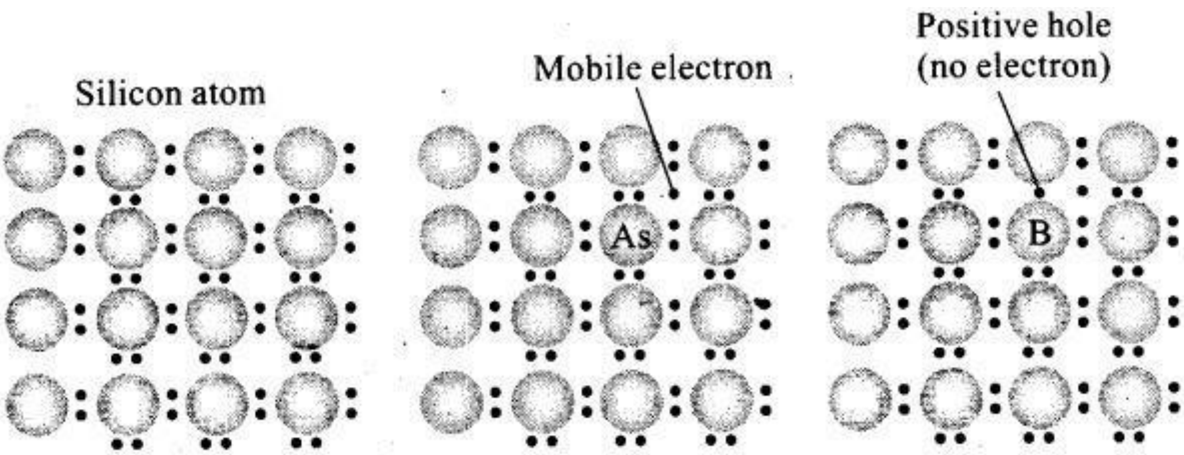
Solution:(i) -> (d); (ii)-> (c); (iii)->(b); (iv) ->(a)

(i) Mg in solid state show electronic conductivity due to presence of free electrons hence, they are known as electronic conductors.

(ii) $MgCl_2$ in molten state show electrolytic conductivity due to presence of electrolytes in molten state.

(iii) Silicon doped with phosphorus contain one extra electron due to which it shows conductivity under the influence of electric field and known as p-type semiconductor.

(iv) Germanium doped with boron contains one hole due to which it shows conductivity under the influence of electric field and known as n-type semiconductor.



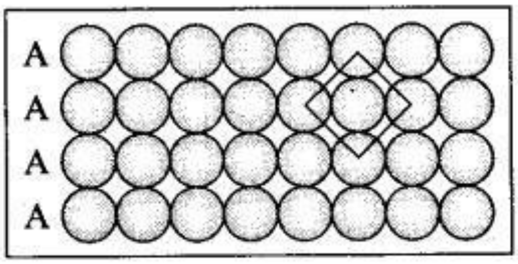
Perfect crystal (a) — *n*-type semiconductor (b) — *p*-type semiconductor (c)

Question 68. Match the type of-packing given in Column I with the items given in Column II.

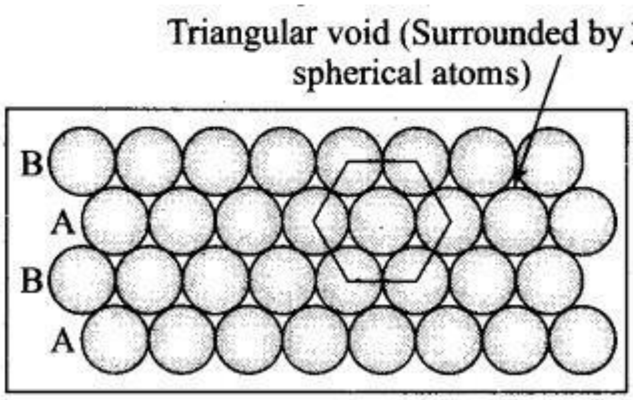
	Column I		Column II
(i)	Square close packing in two dimensions	(a)	Triangular voids
(ii)	Hexagonal close packing in two dimensions	(b)	Pattern of spheres is repeated in every fourth layer
(iii)	Hexagonal close packing in three dimensions.	(c)	Coordination number = 4
(iv)	Cubic close packing in three dimensions	(d)	Pattern of sphere is repeated in alternate layers.

Solution: (i) —> (c); (ii) —> (a); (iii) —>(d); (iv) —> (b)

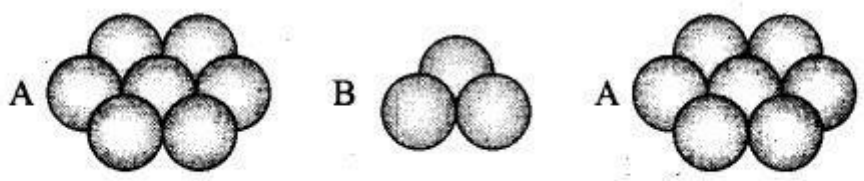
(i) Square close packing in two dimensions each sphere have coordination number 4, as shown below.



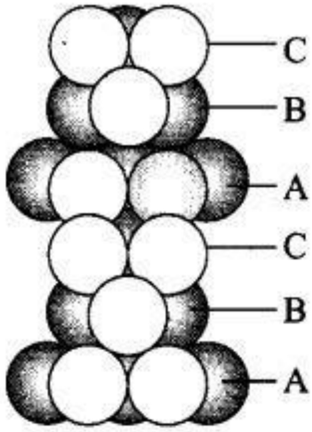
(ii) Hexagonal close packing in two dimensions each sphere has coordina¬tion number 6 as shown below and creates a triangular void



(iii)Hexagonal close packing in 3 dimensions is a repeated pattern of sphere in alternate layers also known as ABAB pattern



(iv) Cubic close packing in a 3 dimensions is a repeating pattern of sphere in every fourth layer.



Assertion and Reason Type Questions:

In the following questions, a statement of Assertion (A) followed by a statement of Reason (R) is given. Choose the correct answer out of the following choices.

(a) Assertion and Reason both are correct statements and Reason is the correct explanation for Assertion.

(b) Assertion and Reason both are correct statements but Reason is not the correct explanation for Assertion.

(c) Assertion is correct but Reason is wrong.

(d) Assertion is wrong but Reason is correct.

Question 69. Assertion (A): The total number of atoms present in a simple cubic unit cell is one.

Reason (R): Simple cubic unit cell has atoms at its comers, each of which is shared between eight adjacent unit cells.

Solution: (a) In simple cubic unit cell, only comers are occupied by atoms. Thus, total number of atoms present in the unit cell will be one.

$$\left(Z=\frac{1}{8}\times 8=1\right).$$

Question 70. Assertion (A): Graphite is a good conductor of electricity, however, diamond belongs to the category of insulators.
Reason (R): Graphite is soft in nature on the other hand diamond is very hard and brittle.
Solution: (b) Diamond is bad conductor of electricity because all valence e of carbon are involved in bonding. In graphite however 3 out of 4 valence electrons are involved in bonding, fourth electron remains free between adjacent layers which makes it a good conductor.
Graphite is soft because parallel layers are held together by week van der Waals force. However, diamond is hard due to compact three-dimensional network of bonding.

Question 71. Assertion (A): Total number of octahedral voids present in unit cell of cubic close packing including the one that is present at the body centre, is four. Reason (R): Besides the body centre, there is one octahedral void present at the centre of each ofthe six faces of the unit cell and each of which is shared between two adjacent unit cells.
Solution:(c) All edge centres and body centre represent octahedral void.
Total number of octahedral voids = 12 x 1/4 +1 = 4

Question 72. Assertion (A): The packing efficiency is maximum for the fee structure. Reason (R): The coordination number is 12 in fee structures.
Solution: (b) In fee unit cell, there is cep arrangement with packing efficiency of 74.01% which is maximum. In cep arrangement, coordination number is 12.

Question 73. Assertion (A): Semiconductors are solids with conductivities in the intermediate range from

$$10^{-6}-10^{4}\ \text{ohm}^{-1}\ \text{m}^{-1}.$$

Reason (R): Intermediate, conductivity in semiconductor is due to partially filled valence band.
Solution: (c) Conductance of semiconductors lies between metals and insulators, i.e., in the

range of

$$10^{-6} - 10^{4}\ \text{ohm}^{-1}\ \text{m}^{-1}.$$

Long Answer Type Questions

Question 74. With the help of a labelled diagram show that there are four octahedral voids per unit cell in a cubic close packed structure.

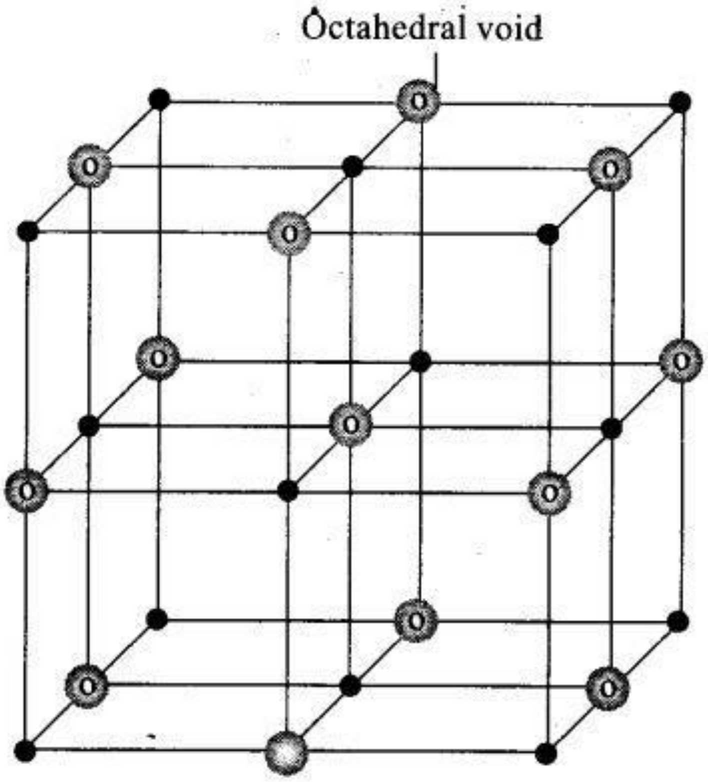
Solution: In cep, each cube consists of eight cubic components, number of atoms per unit cell in ccp is

Where N_c = No. of atoms at corner

N_f = No. of atoms at face centre

$= N_c \times \text{contribution} + N_f \times \text{contribution}$

$$= 8 \times \frac{1}{8} + 6 \times \frac{1}{2} = 4$$



Position of octahedral voids = Edge centre and body centre

Number of octahedral voids per unit cell in cubic close packing

$$= N_e \times \frac{1}{4} + N_b \times 1$$

$$= 12 \times \frac{1}{4} + 1 \times 1 = 4$$

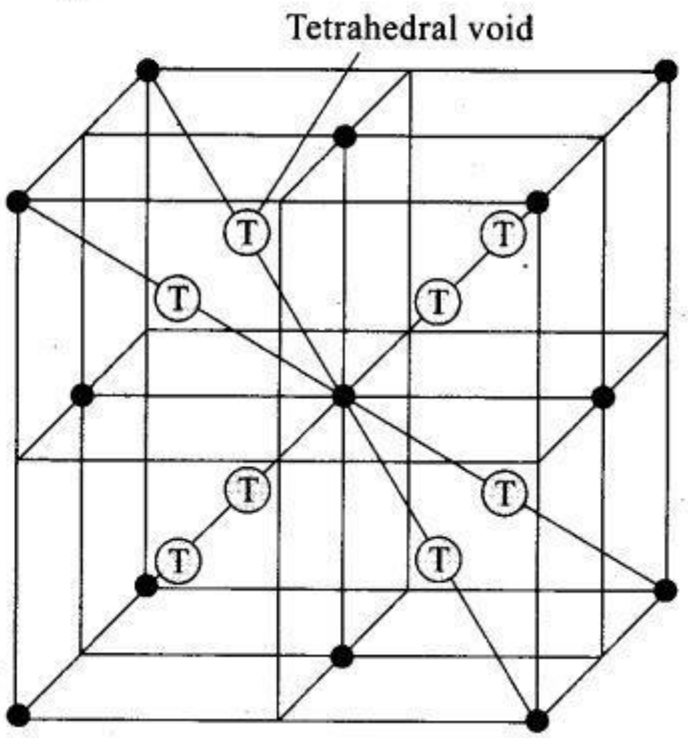
$\Rightarrow$ Number of octahedral voids = 4.

Question.75. Show that in a cubic close packed structure, eight tetrahedral voids are present per unit cell.

Solution: In ccp, each cube consists of eight cubic components. Number of atoms per unit cell in ccp is

$N_c \times$ contribution $+ N_f \times$ contribution

$$8 \times \frac{1}{8} + 6 \times \frac{1}{2} = 4$$



Position of tetrahedral Voids = At the centre of each cubic component Number of tetrahedral voids per unit cell in cubic close packing = 8×1=8 Number of tetrahedral Voids = 8.

Question 76. How does the doping increase the conductivity of semiconductors?
Solution:The conductivity of semiconductors is increased by adding an appropriate amount of suitable impurity or doping. Doping can be done with an impurity which is electron rich or electron deficient as compared to the intrinsic semiconductor, silicon or germanium. Such impurities introduce electronic defects in them. When silicon is doped with electron rich impurities the extra electron becomes delocalized. These delocalized electrons increase the conductivity of doped silicon due to the negatively charged electron, hence silicon doped with electron-rich impurity is called n-type semiconductor while electron-deficit impurities increase the conductivity through positive holes and this type of semiconductors are called /?-type semiconductors.

Question 77. A sample of ferrous oxide has actual formula $Fe_{0.93}\ O_{1.00}$. In this sample, what fraction of metal ions are Fe^{2+} ions? What is the type of non-stoichiometric defect present in this sample? '

Solution:

Let number of $O^{2-} = 100$

Number of $Fe^{2+} = x$

Number of $Fe^{3+} = 93 - x$

To maintain electrical neutrality net positive charge is equal to net negative charge

$$2x + 3(93 - x) = 2 \times 100$$

$$2x + 279 - 3x = 200$$

$$x = 79$$

$$\Rightarrow \quad Fe^{2+} = 79$$

$$\Rightarrow \quad \frac{Fe^{2+}}{Fe^{2+} + Fe^{3+}} = \frac{79}{93} = 0.849$$

Metal deficiency defect is present in the sample because iron is less in amount than that required for stoichiometric composition.