

1



Solid State

I. MULTIPLE CHOICE QUESTIONS (TYPE-I)

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

- (i) High temperature (ii) Low temperature
(iii) High thermal energy (iv) Weak cohesive forces

Ans. (ii) Low temperature

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

- (i) Definite and characteristic heat of fusion.
(ii) Isotropic nature.
(iii) A regular periodically repeated pattern of arrangement of constituent particles in the entire crystal.
(iv) A true solid

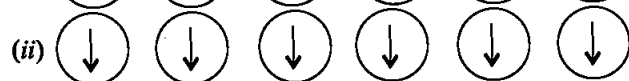
Ans. (ii) Isotropic nature.

3. Which of the following is an amorphous solid?

- (i) Graphite (C) (ii) Quartz glass (SiO_2)
(iii) Chrome alum (iv) Silicon carbide (SiC)

Ans. (ii) Quartz glass (SiO_2)

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



Ans. (iv)

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

- (i) Same in all directions (ii) Different in different directions
(iii) Cannot be measured (iv) Always zero

Ans. (i) Same in all directions

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

- (i) On heating they may become crystalline at certain temperature.
- (ii) They may become crystalline on keeping for long time.
- (iii) Amorphous solids can be moulded by heating.
- (iv) They are anisotropic in nature.

Ans. (iv) They are anisotropic in nature.

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

- (i) a regular arrangement of constituent particles observed over a short distance in the crystal lattice.
- (ii) a regular arrangement of constituent particles observed over a long distance in the crystal lattice.
- (iii) same arrangement of constituent particles in different directions.
- (iv) different arrangement of constituent particles in different directions.

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

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

- (i) london forces
- (ii) dipole-dipole interactions
- (iii) covalent bonds
- (iv) coulombic forces

Ans. (i) London forces

9. Which of the following is a network solid?

- (i) SO_2 (Solid)
- (ii) I_2
- (iii) Diamond
- (iv) H_2O (Ice)

Ans. (iii) Diamond

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

- (A) Mg (s) (B) TiO (s) (C) I_2 (s) (D) H_2O (s)
- (i) (A) only
- (ii) (B) Only
- (iii) (C) and (D)
- (iv) (B), (C) and (D)

Ans. (iii) (C) and (D)

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

- (i) Very low value of electrical conductivity in the molten state.
- (ii) Brittle nature.
- (iii) Very strong forces of interactions.
- (iv) Anisotropic nature.

Ans. (i) Very low value of electrical conductivity in the molten state.

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

- (i) lone pair of electrons
- (ii) free valence electrons
- (iii) cations
- (iv) anions

Ans. (ii) free valence electrons

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

- (i) TiO (ii) SiO₂
 (iii) TiO₃ (iv) MgO

Ans. (iii) TiO₃

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

- (i) SiO₂ (ii) MgO
 (iii) SO₂(s) (iv) CrO₂

Ans. (iv) CrO₂

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

- (i) molecule (ii) ion
 (iii) electron (iv) atom

Ans. (iii) electron

16. Graphite cannot be classified as _____.

- (i) conducting solid (ii) network solid
 (iii) covalent solid (iv) ionic solid

Ans. (iv) ionic solid

17. Cations are present in the interstitial sites in _____.

- (i) Frenkel defect (ii) Schottky defect
 (iii) Vacancy defect (iv) Metal deficiency defect

Ans. (i) Frenkel defect

18. Schottky defect is observed in crystals when _____.

- (i) some cations move from their lattice site to interstitial sites.
 (ii) equal number of cations and anions are missing from the lattice.
 (iii) some lattice sites are occupied by electrons.
 (iv) some impurity is present in the lattice.

Ans. (ii) equal number of cations and anions are missing from the lattice.

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

- (i) positive (ii) neutral
 (iii) negative
 (iv) depends on concentration of *p* impurity

Ans. (ii) neutral

20. To get a *n*-type semiconductor from silicon, it should be doped with a substance with valence _____.

- (i) 2 (ii) 1
 (iii) 3 (iv) 5

Ans. (iv) 5

21. The total number of tetrahedral voids in the face centred unit cell is _____.

- (i) 6 (ii) 8
 (iii) 10 (iv) 12

Ans. (ii) 8

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
 (i) (A) and (B) (ii) (C) and (D)
 (iii) (A) and (B) (iv) (B) and (D)

Ans. (i) (A) and (B)

23. In which pair most efficient packing is present?

- (i) *hcp* and *bcc* (ii) *hcp* and *ccp*
 (iii) *bcc* and *ccp* (iv) *bcc* and simple cubic cell

Ans. (ii) *hcp* and *ccp*

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

- (i) 74 (ii) 68
 (iii) 32 (iv) 26

Ans. (iii) 32

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

- (i) The coordination number is 12.
 (ii) It has 74% packing efficiency.
 (iii) Tetrahedral voids of the second layer are covered by the spheres of the third layer.
 (iv) In this arrangement spheres of the fourth layer are exactly aligned with those of the first layer.

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

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

- (i) Cl^- ion form *fcc* lattice and Na^+ ions occupy all octahedral voids of the unit cell.
 (ii) Ca^{2+} ions form *fcc* lattice and F^- ions occupy all the eight tetrahedral voids of the unit cell.
 (iii) O_2^- ions form *fcc* lattice and Na^+ ions occupy all the eight tetrahedral voids of the unit cell.
 (iv) S^{2-} ions form *fcc* lattice and Zn^{2+} ions go into alternate tetrahedral voids of the unit cell.

Ans. (i) Cl^- ion form *fcc* lattice and Na^+ ions occupy all octahedral voids of the unit cell.

27. What is the coordination number in a square close packed structure in two dimensions?

- (i) 2 (ii) 3
 (iii) 4 (iv) 6

Ans. (iii) 4

28. Which kind of defects are introduced by doping?

- (i) Dislocation defect (ii) Schottky defect
 (iii) Frenkel defects (iv) Electronic defects

Ans. (iv) Electronic defects

29. Silicon doped with electron-rich impurity forms _____.

- (i) *p*-type semiconductor (ii) *n*-type semiconductor
 (iii) intrinsic semiconductor (iv) insulator

Ans. (ii) *n*-type semiconductor

30. Which of the following statements is not true?

- (i) Paramagnetic substances are weakly attracted by magnetic field.
 (ii) Ferromagnetic substances cannot be magnetised permanently.
 (iii) The domains in antiferromagnetic substances are oppositely oriented with respect to each other.
 (iv) Pairing of electrons cancels their magnetic moment in the diamagnetic substances.

Ans. (ii) Ferromagnetic substances cannot be magnetised permanently.

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

- (i) Bigger ions form the close packed structure.
 (ii) Smaller ions occupy either the tetrahedral or the octahedral voids depending upon their size.
 (iii) Occupation of all the voids is not necessary.
 (iv) The fraction of octahedral or tetrahedral voids occupied depends upon the radii of the ions occupying the voids.

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

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

- (i) all the domains get oriented in the direction of magnetic field.
 (ii) all the domains get oriented in the direction opposite to the direction of magnetic field.
 (iii) domains get oriented randomly.
 (iv) domains are not affected by magnetic field.

Ans. (i) all the domains get oriented in the direction of magnetic field.

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

- (i) $fcc < bcc < \text{simple cubic}$ (ii) $fcc > bcc > \text{simple cubic}$
 (iii) $fcc < bcc > \text{simple cubic}$ (iv) $bcc < fcc > \text{simple cubic}$

Ans. (ii) $fcc > bcc > \text{simple cubic}$

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

- (i) Frenkel defect (ii) Schottky defect
 (iii) Non-stoichiometric defect (iv) Simple interstitial defect

Ans. (i) Frenkel defect

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

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

(ii) 4 tetrahedral voids within the unit cell.

(iii) 8 tetrahedral voids each of the which is shared by four adjacent unit cells.

(iv) 8 tetrahedral voids within the unit cells.

Ans. (iv) 8 tetrahedral voids within the unit cells.

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

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

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

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

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

Ans. (i) $2\sqrt{2}r, \frac{4r}{\sqrt{3}}, 2r$

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

(i) $\kappa_{\text{metals}} \gg \kappa_{\text{insulators}} < \kappa_{\text{semiconductors}}$

(ii) $\kappa_{\text{metals}} \ll \kappa_{\text{insulators}} < \kappa_{\text{semiconductors}}$

(iii) $\kappa_{\text{metals}} < \kappa_{\text{semiconductors}} > \kappa_{\text{insulators}} = \text{zero}$

(iv) $\kappa_{\text{metals}} < \kappa_{\text{semiconductors}} > \kappa_{\text{insulators}} \neq \text{zero}$

Ans. (i) $\kappa_{\text{metals}} \gg \kappa_{\text{insulators}} < \kappa_{\text{semiconductors}}$

II. MULTIPLE CHOICE QUESTIONS (TYPE-II)

Note: In the following questions two or more options may be correct.

38. Which of the following is not true about the voids formed in 3 dimensional hexagonal close packed structure?

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

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

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

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

Ans. (iii) and (iv)

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

(i) get oriented in the direction of the applied magnetic field.

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

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

(iv) cancel out each other's magnetic moment.

Ans. (iii) and (iv)

Explanation: Anti ferromagnetic substances: The magnetic moments and domains are oppositely oriented and cancel out each others magnetic moment. Example MnO

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

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

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

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

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

Ans. (iii) and (iv)

Explanation: In impurity defect the ion (usually cation) is dislocated (moved) from its normal lattice site to an interstitial site. So it is also called dislocation defect. It does not change the density of the crystal. It only creates cationic vacancies. Frenkel defect causes vacancy defect at its original site and an interstitial defect at its new location. Thus, it does not change the density of the solid.

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

(i) Valence band overlaps with conduction band.

(ii) The gap between valence band and conduction band is negligible.

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

(iv) Valence band may remain partially filled.

Ans. (i), (ii) and (iv)

Explanation: Gap between valence band and conduction band determines the conductivity of the metal thus all the three options could be correct.

42. Under the influence of electric field, which of the following statements is true about the movement of electrons and holes in a *p*-type semi-conductor?

(i) Electron will move towards the positively charged plate through electron holes.

(ii) Holes will appear to be moving towards the negatively charged plate.

(iii) Both electrons and holes appear to move towards the positively charged plate.

(iv) Movement of electrons is not related to the movement of holes.

Ans. (i) and (ii)

Explanation: Silicon or Germanium (group – 14) doped with electron deficient impurity (group-13 element like B or Al or Ga) is called *p*-type

semiconductors. Here conductivity is due to positively charged electron holes.

43. Which of the following statements are true about semiconductors?

- (i) Silicon doped with electron rich impurity is a *p*-type semiconductor.
- (ii) Silicon doped with an electron rich impurity is an *n*-type semiconductor.
- (iii) Delocalised electrons increase the conductivity of doped silicon.
- (iv) An electron vacancy increases the conductivity of *n*-type semiconductor.

Ans. (ii) and (iii)

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

- (i) some of the anionic sites are occupied by an unpaired electron.
- (ii) some of the anionic sites are occupied by a pair of electrons.
- (iii) there are vacancies at some anionic sites.
- (iv) F-centres are created which impart colour to the crystals

Ans. (i) and (iv)

Explanation: The anionic vacancies occupied by unpaired electrons. F-centers impart colour to the crystals (E.g. yellow to NaCl and violet to KCl) due to excitation of these electrons by absorbing energy from the visible light falling on the crystals.

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

- (i) 4
- (ii) 8
- (iii) twice the number of octahedral voids.
- (iv) four times the number of tetrahedral voids.

Ans. (ii) and (iii)

Explanation: NaCl has *fcc* lattice. No. of atoms = 4

No. of octahedral void = 4. No. of tetrahedral void = $2 \times 4 = 8$

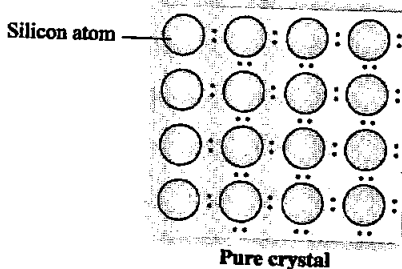
46. Amorphous solid can also be called _____.

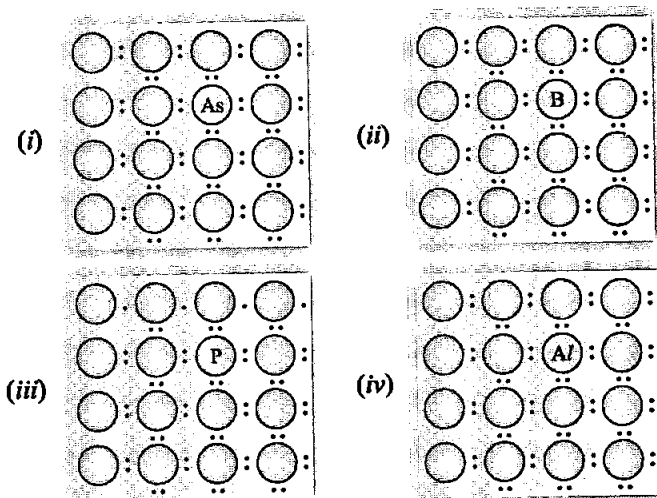
- (i) pseudo solids
- (ii) true solids
- (iii) super cooled liquids
- (iv) super cooled solids

Ans. (i) and (iii)

Explanation: It has tendency to flow like liquid.

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





Ans. (i) and (iii)

48. Which of the following statements are correct?

- (i) Ferrimagnetic substances lose ferrimagnetism on heating and become paramagnetic.
- (ii) Ferrimagnetic substances do not lose ferrimagnetism on heating and remain ferrimagnetic.
- (iii) Antiferromagnetic substances have domain structures similar to ferromagnetic substances and their magnetic moments are not cancelled by each other.
- (iv) In ferromagnetic substances all the domains get oriented in the direction of magnetic field and remain as such even after removing magnetic field.

Ans. (i) and (iv)

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

- (i) This is a crystalline solid.
- (ii) Refractive index is same in all the directions.
- (iii) This has definite heat of fusion.
- (iv) This is also called super cooled liquid.

Ans. (i) and (iii)

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

- (i) SiC (Silicon carbide) (ii) AlN
- (iii) Diamond (iv) I_2

Ans. (i), (ii) and (iii)

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

- (i) hcp (ii) bcc
- (iii) simple cubic (iv) fcc

Ans. (i) and (iv)

52. Frenkel defect is also known as _____.

- (i) stoichiometric defect (ii) dislocation defect
(iii) impurity defect (iv) non-stoichiometric defect

Ans. (i) and (ii)

53. Which of the following defects decrease the density?

- (i) Interstitial defect (ii) Vacancy defect
(iii) Frenkel defect (iv) Schottky defect

Ans. (ii) and (iv)

III. SHORT ANSWER TYPE

54. Why are liquids and gases categorised as fluids?

Ans. The liquids and gases have a property to flow i.e. the molecules can move past and tumble over one another freely. Hence, they have been categorised as fluids.

55. Why are solids incompressible?

Ans. The constituent particles (atoms, molecules or ions) have fixed positions and can only oscillate about their mean positions.

56. In spite of long range order in the arrangement of particles why are the crystals usually not perfect?

Ans. Crystals have long range order repeated pattern of arrangement of constituent particles but in the process of crystallisation some deviations from the ideal arrangement (i.e. defects) may be introduced, therefore, crystals are usually not perfect.

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

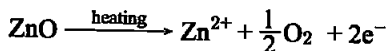
Ans. Yellow colour in sodium chloride is due to metal excess defect due to which unpaired electrons occupy anionic sites. These sites are called F-centres. These electrons absorb energy from the visible region for the excitation which makes crystal appear yellow.

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

Ans. In the crystals of FeO, some of the Fe²⁺ cations are replaced by Fe³⁺ ions. Three Fe²⁺ ions are replaced by two Fe³⁺ ions to make up for the loss of positive charge. Eventually there would be less amount of metal as compared to stoichiometric proportion

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

Ans. On heating ZnO loses oxygen according to the following reaction:



Zn²⁺ ions and electrons move to interstitial sites and F-centres are created which impart yellow colour to ZnO(s).

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

Ans. In case of semiconductors, with increase in temperature, more electrons can shift from valence band to conduction band. Hence conductivity increases.

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

Ans. On doping germanium with gallium some of the positions of lattice of germanium are occupied by gallium. Gallium atom has only three valence electrons. Therefore, fourth valency of nearby germanium atom is not satisfied. The place remains vacant. This place is deficient of electrons and is therefore called electron hole or electron vacancy. Electron from neighbouring atom comes and fills the gap, thereby creating a hole in its original position. Under the influence of electric field electron move towards positively charged plates through these holes and conduct electricity. The holes appear to move towards negatively charged plates.

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?

Ans. Let the number of N atom in ccp = x
 Number of tetrahedral voids = $2x$
 Number of M atoms = $1/3 \times 2x$
 $N : M = 3x : 2x = 3 : 2$
 Formula of the compound = M_2N_3

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

Ans. On heating amorphous substance change to crystalline form at some temperature. This is due to crystallization.

IV. MATCHING TYPE

Note: In the following questions match the items given in Column I with the items given in Column II. In some questions more than one item of Column I and Column II may match.

64. Match the defects given in Column I with the statements in given 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 he solid remains the same.

Ans. (i) → (c); (ii) → (a); (iii) → (d); (iv) → (b)

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

Column I	Column II
(i) Primitive cubic unit cell	(a) Each of the three perpendicular edges compulsorily have the different edge length i.e; $a \neq b \neq c$.
(ii) Body centred cubic unit cell	(b) Number of atoms per unit cell is one.
(iii) Face centred cubic unit cell	(c) Each of the three perpendicular edges compulsorily have the same edge length i.e; $a = b = c$
(iv) End centred orthorhombic unit cell	(d) In addition to the contribution from unit cell the corner atoms the number of atoms present in a unit cell is one.
	(e) In addition to the contribution from the corner atoms the number of atoms present in a unit cell is three.

Ans. (i) \rightarrow (b), (c); (ii) \rightarrow (c), (d); (iii) \rightarrow (c), (e); (iv) \rightarrow (a), (d)

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 with Fe^{3+}
(iii) Metal deficiency defect	(c) NaCl with Sr^{2+} and some cationic sites vacant

Ans. (i) \rightarrow (c); (ii) \rightarrow (a); (iii) \rightarrow (b)

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

Ans. (i) \rightarrow (d); (ii) \rightarrow (c); (iii) \rightarrow (b); (iv) \rightarrow (a)

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 alternate layers

Ans. (i) → (c); (ii) → (a); (iii) → (d); (iv) → (b)

V. ASSERTION AND REASON TYPE

Note: In the following questions a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

- (i) Assertion and reason both are correct statements and reason is correct explanation for assertion.
- (ii) Assertion and reason both are correct statements but reason is not correct explanation for assertion.
- (iii) Assertion is correct statement but reason is wrong statement.
- (iv) Assertion is wrong statement but reason is correct statement.

69. **Assertion:** The total number of atoms present in a simple cubic unit cell is one.

Reason: Simple cubic unit cell has atoms at its corners, each of which is shared between eight adjacent unit cells

Ans. (i)

Explanation: In simple cubic unit cell total no. of atoms = $8 \times 1/8 = 1$

70. **Assertion:** Graphite is a good conductor of electricity however diamond belongs to the category of insulators.

Reason: Graphite is soft in nature on the other hand diamond is very hard and brittle.

Ans. (ii)

Explanation: In graphite carbon atoms are arranged in different layers and each atom is covalently bonded to three of its neighbouring atoms in the same layer. The fourth valence electron of each atom is present between different layers and is free to move which makes graphite a good conductor of electricity. As different layers can slide over each other so it is soft.

In case of diamond C atom is bonded covalently. So it is hard and have very high melting point. It decomposes before melting so act as insulator.

71. **Assertion:** 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: Besides the body centre there is one octahedral void present at the centre of each of the six faces of the unit cell and each of which is shared between two adjacent unit cells.

Ans. (iii)

Explanation: In *ccp* structure atoms are present at the face centre as well as corner and create octahedral void at each body centre and all the 12 edges of the unit cell which is surrounded by 6 atoms. 4 atoms belong to the same unit cell and 2 belongs to the adjacent unit cell.

72. **Assertion:** The packing efficiency is maximum for the *fcc* structure.

Reason: The coordination number is 12 in *fcc* structures.

Ans. (ii)

Explanation: The correct explanation is, in *fcc* no. of atoms present = 4 and packing efficiency is 74%.

73. **Assertion:** Semiconductors are solids with conductivities in the intermediate range from $10^{-6} - 10^4 \text{ ohm}^{-1}\text{m}^{-1}$.

Reason: Intermediate conductivity in semiconductor is due to partially filled valence band.

Ans. (iii)

Explanation: Intermediate conductivity in semiconductor is due to small energy gap between valence band and conduction band.

VI. LONG ANSWER TYPE

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

Ans. As we know any atom surrounded by six atoms creates an octahedral void. In *fcc* body centre is surrounded by six atoms present at face centre. And hence one octahedral void is present at body centre of each unit cell.

No. of octahedral void at the centre of 12 edge = $\frac{1}{4} \times 12 = 3$

No. of octahedral void at body centre = 1

Total no. of octahedral void in *ccp* = $3 + 1 = 4$

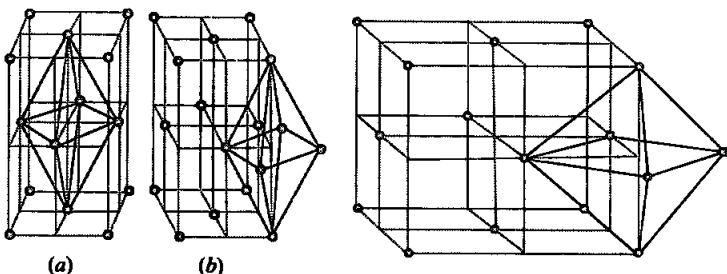


Fig. 1 Location of octahedral voids per unit cell of *ccp* or *fcc* lattice (a) at the body centre of the cube and (b) at the centre of each edge (only one such void is shown).

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

Ans. In ccp structure unit cell is divided into 8 small cubes. Each small cube has atoms at alternate corners. In all, each small cube has 4 atoms. When joined to one another, they make a regular tetrahedron. Thus there is one tetrahedral void in each small cube and 8 tetrahedral void in total.

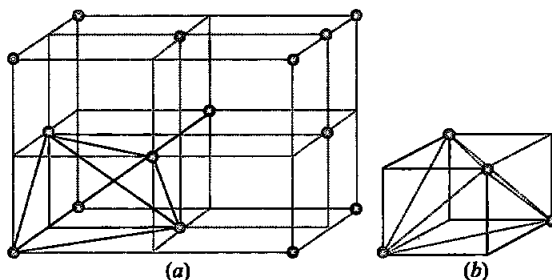


Fig. 2 (a) Eight tetrahedral voids per unit cell of ccp structure
(b) one tetrahedral void showing the geometry.

76. How does the doping increase the conductivity of semiconductors?

Ans. For practical use conductivity of a semiconductor is very low conductivity can be increased by adding small impurity, this process is called doping. Doping can be done with an impurity which is electron rich or electron deficient.

n-type semiconductors: Silicon or Germanium (group – 14) doped with electron rich impurity (group-15 element like P or As) is called n-type semiconductors. Here conductivity is due to the extra electron or delocalized electron.

p-type semiconductors: Silicon or Germanium (group – 14) doped with electron deficient impurity (group-13 element like B or Al or Ga) is called p-type semiconductors. Here conductivity is due to positively charged electron holes.

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 type of non-stoichiometric defect is present in this sample?

Ans. Let us consider out of 100 the no. of Fe^{2+} ion in the crystal = x
 $Fe^{3+} = 93 - x$

The positive charge on ferrous and ferric ions should balance the two units of negative charge on oxygen

$$2x + 3(93 - x) = 200$$

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

$$-x = -79 \text{ or } x = 79$$

Fraction of $Fe^{2+} = 79/93 = 0.849$

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

□□□