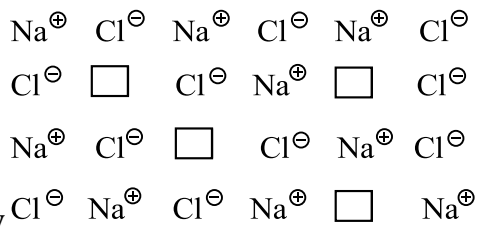
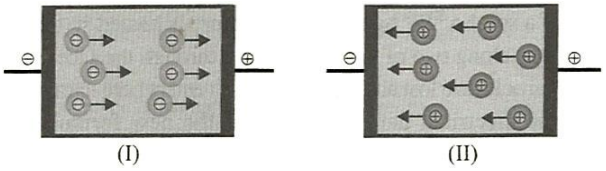
Single Correct Answer Type

1. In the crystals of which of the following ionic compounds would you expect maximum distance between the centers of the cations and anions?
   a) LiF b) CsF c) CsI d) LiI
2. The edge length of a face-centered cubic unit cell is 508 pin. If the radius of the cation is 110 pm, the radius of the anion is
   a) 144 pm b) 288 pm c) 618 pm d) 398 pm
3. A TV in fcc is formed by atoms at
   a) 3 corners + 1 face center
   b) 3 face centers + 1 corner
   c) 2 face centers + 2 corners
   d) 2 face centers + 1 corner + 1 body center
4. Analysis show that nickel oxide consists of nickel ion with 96% ions having d^8 configuration and 4% having d^7configuration. Which amongst the following best represents the formula of the oxide?
   a) $Ni_{1.02}O_{1.00}$ b) $Ni_{0.96}O_{1.00}$ c) $Ni_{0.98}O_{0.98}$ d) $Ni_{0.98}O_{1.00}$
5. The γ-form of iron has fcc-structure (edge length 386 pm) and β-form has bcc structure (edge length 290 pm). The ratio of density in γ-form and β-form is
   a) 0.9788 b) 1.02 c) 1.57 d) 0.6344
6. What is the maximum number of layers of atoms in close packed planes that will lie within two imaginary parallel planes having a distance between them of $13\sqrt{\frac{2}{3}}r$ (where $r$is the radius of atom) in the copper crystal (fcc)?
   (Consider the atoms to be within the parallel planes if their centers are on or with in the two parallel planes)
   a) 5 b) 6 c) 7 d) 8
7. The packing fraction for a body-centered cube is
   a) 0.42 b) 0.53 c) 0.68 d) 0.82
8. The coordination number of Al in the crystalline state of $AlCl_3$is
   a) 2 b) 4 c) 6 d) 8
9. When molten zinc is cooled to solid state, it assumes hcpstructure. Then the number of nearest neighbours of zinc atom will be
   a) 4 b) 6 c) 8 d) 12
10. A molecule A_2B ($Mw = 166.4$) occupies triclinic lattice with $a = 5$ Å, $b = 8$Åand $c = 4$ Å. If the density of AB_2 is 5.2 g cm^{-3}, the number of molecules present in one unit cell is
    a) 2 b) 3 c) 4 d) 5
11. 
    What type of crystal defect is indicated in the diagram given below
    a) Both Frenkel and Schottky defects b) Schottky defect
    c) Interstitial defect d) Frenkel defect
12. The number of hexagonal faces that are present in a truncated octahedron is
    a) 2 b) 4 c) 6 d) 8
13. What are types of following semiconductors I and II



a) I ⇒ p-type, II ⇒ n-type
b) I ⇒ n-type, II ⇒ p-type
c) Both n-type
d) Both p-type

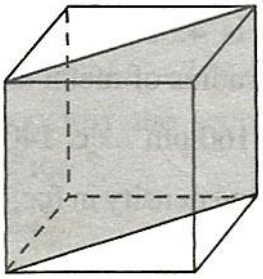
14. Which of the following is not a ferroelectric compound?
a) Rochelle salt b) $K_4[Fe(CN)_6]$ c) $BaTiO_3$ d) KH_2PO_4

15. The number of unit cells in 58.5 g of NaCl is nearly
a) 6×10^{20} b) 3×10^{22} c) 1.5×10^{23} d) 0.5×10^{24}

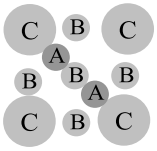
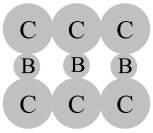
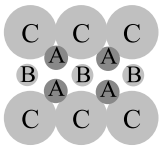
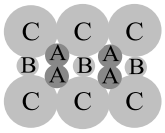
16. In the closest packing of atoms
a) The size of TV is greater than that of OV
b) The size of TV is smaller than that of OV
c) The size of TV is equal to that of OV
d) The size of TV may be greater or smaller or equal to that of OV depending upon the size of atoms

17. The density of an ionic compound ($Mw = 58.5$) is 2.165 kg m^{-3} and the edge length of unit cell is 562 pm, then the closest distance between $A^{\oplus}B^{\ominus}$ and Z_{eff} of unit cell is
a) 281 pm,4 b) 562 pm,2 c) 562 pm,4 d) 281 pm,4

18. In a hypothetical solid, C atoms are found to form cubical close-packed lattice. A atoms occupy all tetrahedral voids and B atoms occupy all octahedral voids



A and B atoms are of appropriate size, so that there is no distortion in the ccp lattice of C atoms. Now if a plane as shown in the following figure is cut, then the cross section of this plane will look like

a) 
b) 
c) 
d) 

19. The interionic distance for cesium chloride crystal will be
a) a b) $a/2$ c) $\sqrt{3}a/2$ d) $2a/\sqrt{3}$

20. The number of nearest neighbours and next nearest neighbours of an $Na^{\oplus}$ ion in a crystal of NaCl are, respectively,
a) $6Na^{\oplus}, 12Cl^{\ominus}$ b) $6Cl^{\ominus}, 12Na^{\oplus}$ c) $12Cl^{\ominus}, 12Na^{\oplus}$ d) $6Cl^{\ominus}, 6Na^{\oplus}$

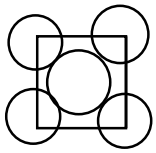
21. A metal of density 7.5×10^3 kg m^{-3} has an fcc crystal structure with lattice parameter $a = 400$ pm. Calculate the number of unit cells present in 0.015 kg of the metal
a) 6.250×10^{22} b) 3.125×10^{23} c) 3.125×10^{22} d) 1.563×10^{22}

22. Superconductors are derived from the compounds of
a) p-block elements b) Lanthanides c) Actinides d) Transition elements

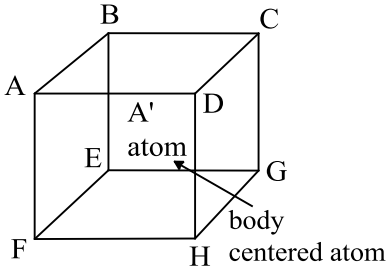
23. If $R$is the radius of the octahedral voids and $r$is the radius of the atom in close packing, then $r/R$is equal to
a) 2.41 b) 4.76 c) 3.22 d) 9.1

24. An ionic solid $A^{\oplus}B^{\ominus}$ crystallizes as a bcc structure. The distance between cation and anion in the lattice is 338 pm. The edge length of cell is
a) 338 pm b) 390.3 pm c) 292.7 pm d) 507 pm

25. Every atom or ion that forms an fcc unit cell is surrounded by
    a) Six OVs and eight TVs b) Eight OVs and six TVs
    c) Six OVs and six TVs d) Eight OVs and four TVs
26. How many kinds of space lattices are possible in a crystal?
    a) 23 b) 7 c) 230 d) 14
27. In cubic ZnS (II-VI) compounds, if the radii of Zn and S atoms are 0.74 Å and 1.70 Å, the lattice parameter of cubic ZnS is
    a) 11.87 Å b) 5.634 Å c) 5.14 Å d) 2.97 Å
28. A metal crystallizes in bcc lattice. The percent fraction of edge length not covered by atom is
    a) 10.4% b) 13.4% c) 12.4% d) 11.4%
29. Which of the following is a ferroelectric compound?
    a) $BaTiO_3$ b) $K_4[Fe(CN)_6]$ c) Pb_2O_3 d) None of these
30. Silver (atomic weight $= 108$ g mol^{-1}) has a density of 10.5 g cm^{-3}. The number of silver atoms on a surface of area 10^{-12}m^2 can be expressed in scientific notation as $y \times 10^x$. The value of x is
    a) 3 b) 5 c) 7 d) 9
31. The lattice parameter of GaAs (radius of Ga $= 1.22$ Å, As $= 1.25$ Å) is
    a) 5.635 Å b) 2.852 Å c) 5.774 Å d) 4.94 Å
32. An ionic solid $A^{\oplus}B^{\ominus}$ crystallizes as an fcc structure. If the edge length of cell is 508 pm and the radius of anion is 144 pm, the radius of cation is
    a) 110 pm b) 364 pm c) 220 pm d) 288 pm
33. The coordination number of a metal crystallizing in a hexagonal close-packed structure is
    a) 12 b) 4 c) 8 d) 6
34. The range of radius ratio (cationic to anionic) for an octahedral arrangement of ions in an ionic solid is
    a) $0.155 - 0.225$ b) $0.225 - 0.414$ c) $0.414 - 0.732$ d) $0.732 - 1.000$
35. A semiconductor of Ge can be made p-type by adding
    a) Trivalent impurity b) Tetravalent impurity
    c) Pentavalent impurity d) Divalent impurity
36. The material used in solar cells contains
    a) Cs b) Si c) Sn d) Ti
37. CsBrhas bcc structure with edge length of 43 pm. The shortest interionic distance between cation and anion is
    a) 3.72 pm b) 1.86 pm c) 7.44 pm d) 4.3 m
38. The packing efficiency of the two dimensional square unit cell shown below is



    a) 39.27% b) 68.02% c) 74.05% d) 78.54%
39. In body-centered cubic lattice given below, the three distances AB, AC, and AA'' are



    a) $a, \sqrt{2}a, \frac{\sqrt{3}a}{2}$ b) $a, \frac{\sqrt{3}a}{2}, \sqrt{2}a$ c) $\frac{\sqrt{3}a}{2}, \sqrt{2}a, a$ d) $a, \frac{a}{\sqrt{2}}, \frac{\sqrt{3}a}{2}$
40. How many unit cells are present in a cubic shaped ideal crystal of NaCl of mass 1.0 g?
    a) 1.28×10^{21} b) 1.71×10^{21} c) 2.57×10^{21} d) 5.14×10^{21}

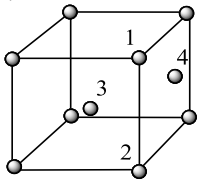
41. Silicon dopped with group 13 and group 15 member elements is, respectively, called……semiconductor
a) p-type, n-type b) n-type, p-type c) p-type d) n-type

42. A solid has a structure in which W atoms are located at the corners of a cubic lattice, Oatoms at the center of edges, and Na atom at the center of the cube. The formula of thecompound is
a) $NaWO_2$ b) $NaWO_3$ c) Na_2WO_3 d) $NaWO_4$

43. In which of the following crystals alternate tetrahedral voids are occupied?
a) NaCl b) Zns c) CaF_2 d) Na_2O

44. Two ionic solids AB and CB crystallize in the same lattice. If $r_{A^{\oplus}}/r_{B^{\ominus}}$ and $r_{C^{\oplus}}/r_{B^{\ominus}}$ are 0.50 and 0.70, respectively, then the ratio of edge length of AB and CD is
a) 0.68 b) 0.78 c) 0.88 d) 0.98

45. In an fcc unit cell, atoms are numbered as shown below. The atoms not touching each other are (Atom numbered 3 is face center of front face)



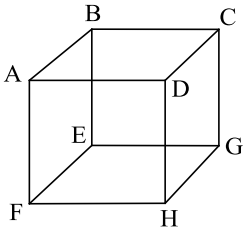
a) 3 and 4 b) 1 and 3 c) 1 and 2 d) 2 and 4

46. What is the density of Na_2O having antifluorite-type crystal structure, if the edge length of cube is 100 pm and what is the effect on density by 0.05% Frenkel defect?
a) 823.5 g cm^{-3}, density decrease b) 414.16 g cm^{-3}, density decreases
c) 823.5 g cm^{-3}, density remains same d) 414.16 g cm^{-3}, density remains same

47. An fcc lattice has a lattice parameter $a =$ 400 pm. Calculate the molar volume of the lattice including all the empty space
a) 10.8 mL b) 96 mL c) 8.6 mL d) 9.6 mL

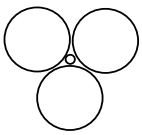
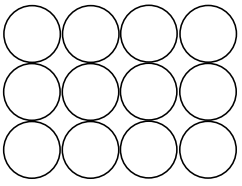
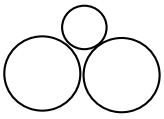
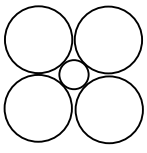
48. Which of the following metal oxides is anti-ferromagnetic in nature?
a) MnO_2 b) TiO_2 c) VO_2 d) CrO_2

49. In the cubic lattice given below, the three distances between the atoms $A-B, A-C$, and $A-G$are, respectively,



a) $a, \sqrt{2}a, \sqrt{3}a$ b) $a, \sqrt{3}a, \sqrt{2}a$ c) $\frac{a}{2}, \frac{a}{\sqrt{2}}, \frac{\sqrt{3}a}{2}$ d) $a, \frac{\sqrt{3}a}{2}, \sqrt{2}a$

50. Which of the following figures represents the cross-section of an OV?

a)  b)  c)  d) 

51. Schottky defect to crystals is observed when
a) Unequal number of cations and anions are missing from the lattice
b) Equal number of cations and anions are missing from the lattice
c) An ion leaves its normal site and occupies an interstitial site
d) Density of the crystal is increased

52. A crystal is made up of particles X, Y, and Z. X forms fccpacking. Y occupies all octahedral voids of X and Z occupies all tetrahedral voids of X. It all the particles alongone body diagonal are removed, then the

formula of crystal would be

a) XYZ_2 b) X_2YZ_2 c) $X_8Y_4Z_5$ d) $X_5Y_4Z_8$

53. An elemental crystal has a density of 8570 kg m^{-3}. The packing efficiency is 0.68. If the closest distance between neighbouring atoms is 2.86 Å, the mass of one atom is (1 amu $= 1.66 \times 10^{-27}$kg)

a) 186 amu b) 93 amu c) 46.5 amu d) 43 amu

54. A compound formed by elements A and B crystallizes in the cubic structure where A atoms are at the face-centers. The formula of the compound is

a) AB_3 b) AB c) A_3B d) A_2B_2

55. In a tetragonal crystal

a) $a = b = c, \alpha = \beta = 90° \neq \gamma$ b) $\alpha = \beta = \gamma = 90°, a = b \neq c$

c) $\alpha = \beta = \gamma = 90°, a \neq b \neq c$ d) $\alpha = \beta = 90°, \gamma = 120°, a = b \neq c$

56. Pure silicon and germanium are

a) Conductors b) Insulators

c) Semiconductors d) May be any one of the above

57. Which of the following has Frenkel defect?

a) Sodium chloride b) Graphite c) Silver bromide d) Diamond

58. In the calcium fluoride structure, the coordination number of the cations and the anions are, respectively,

a) 6 and 6 b) 8 and 4 c) 4 and 4 d) 4 and 8

59. In a solid AB having the NaCl structure, A atom occupies the corners of the cubic unit cell. If all the face-centered atoms along one of the axes are removed, then the resultant stoichiometry of the solid is

a) AB_2 b) A_2B c) A_4B_3 d) A_3B_4

60. Na and Mg crystallize in bcc- and fcc-type crystals, the ratio of number of atoms present in the unit cell of their respective crystal is

a) 1 b) 0.5 c) 3 d) 4

61. The volume of atoms present in a face-centered cubic unit cell of a metal (r is atomic radius) is

a) $\frac{20}{3}\pi r^3$ b) $8\pi r^3$ c) $4\pi r^3$ d) $\frac{16}{3}\pi r^3$

62. The edge length of unit cell of a metal ($Mw = 24$) having cubic structure is 4.53 Å. Ifthe density of metal is 1.74 g cm^{-3}, the radius of metal is ($N_A = 6 \times 10^{23}$)

a) 180 pm b) 160 pm c) 140 pm d) 190 pm

63. To get n-type doped semiconductor, impurity to be added to silicon should have the following number of valence electrons

a) 2 b) 5 c) 3 d) 1

64. The number of atoms in 100 g of an fcc crystal with density $= 10.0$ g cm^{-3} and cell edge equal to 200 pm is equal to

a) 5×10^{24} b) 5×10^{25} c) 6×10^{23} d) 2×10^{25}

65. The electrical conductivity of semiconductor is

a) 10^8 $ohm^{-1}cm^{-1}$ b) $10^{-22} ohm^{-1}cm^{-1}$

c) In the range of $10^{-9}$to$10^2 ohm^{-1}cm^{-1}$ d) None of the above

66. The ratio of the volume of a tetragonal lattice unit cell to that of a hexagonal lattice unit cell is(both having same respective lengths)

a) $\frac{\sqrt{3}}{2}abc$ b) $\frac{2}{3\sqrt{3}}$ c) $\frac{2}{\sqrt{3}}\frac{a^2c}{b}$ d) 1

67. The number of octahedral sites per sphere in fcc structure is

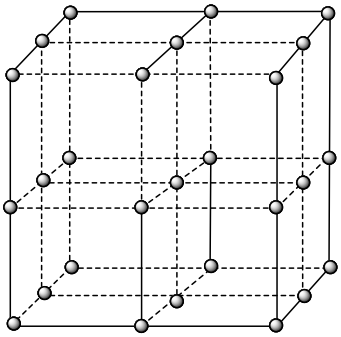
a) 8 b) 4 c) 2 d) 1

68. Consider the structure of CsCl (8:8 co-ordination). How many $Cs^{\oplus}$ ions occupy the second nearest neighbour locations of a $Cs^{\oplus}$ ion?

a) 8 b) 24 c) 6 d) 16

69. The following diagram shows the arrangement of lattice points with $a = b = c$and $\alpha = \beta = \gamma = 90°$.

Choose the correct options



a) The arrangement is sc with each lattice point surrounded by 6 nearest neighbours
b) The arrangement is sc with each lattice point surrounded by 8 nearest neighbours
c) The arrangement is fcc with each lattice point surrounded by 12 nearest neighbours
d) The arrangement is bcc with each lattice point surrounded by 8 nearest neighbours

70. In a closed packed structure of mixed oxides, the lattice is composed of mixed oxides ions. One-eighth of tetrahedral voids are occupied by divalent cations (A^{2+}) while one-half of octahedral voids are occupied by trivalent cations(B^{3+}). The formula of mixed oxide is
a) A_2BO_3 b) AB_2O_3 c) A_2BO_4 d) AB_2O_4
71. Na and Mg crystallize in bcc- and fcc-type crystals, respectively, then the number of atoms of Na and Mgpresent in the unit cell of their respective crystal is
a) 4 and 2 b) 9 and 14 c) 14 and 9 d) 2 and 4
72. Potassium crystallizes with a
a) Face-centered cubic lattice b) Body-centered cubic lattice
c) Simple cubic lattice d) Orthorhombic lattice
73. The intermetallic compound LiAg crystallizes in cubic lattice in which both lithium and silver have co-ordination number of 8. The crystal class is
a) Simple cubic b) Body-centered cubic c) Face-centered cubic d) None of these
74. The atomic fraction (d) of tin in bronze (fcc) with a density of 7717 kg m^{-3} and a lattice parameter of 3.903 Å is (Aw Cu = 63.54, Sn = 118.7, 1 amu = 1.66×10^{-27}kg)
a) 0.01 b) 0.05 c) 0.10 d) 3.8
75. The ratio of packing density in fcc, bcc, and cubic structure is, respectively,
a) 1:0.92:0.70 b) 0.70:0.92:1 c) 1:0.70:0.92 d) 0.92:0.70:1
76. A metallic crystal crystallizes into a lattice containing a sequence of layers ABABAB... ...any packing of spheres leaves out voids in the lattice. What percentage by volume of this lattice is empty space?
a) 74% b) 26% c) 50% d) None of these
77. In NaCl, the chloride ions occupy the space in a fashion of
a) fcc b) bcc c) Both d) None
78. If the lattice parameter of Si = 5.43 Å and the mass of Siatom is $28.08 \times 1.66 \times 10^{-27}$ kg, the density of silicon in kg m^{-3} is (Given: Silicon has diamond cubic structure)
a) 2330 b) 1115 c) 3445 d) 1673
79. Due to Frenkel defect, the density of the ionic solids
a) Increases b) Decreases c) Does not change d) changes
80. In the structure of diamond, carbon atoms appears at
a) 0,0,0, and $\frac{1}{2},\frac{1}{2},\frac{1}{2}$ b) $\frac{1}{4},\frac{1}{4},\frac{1}{4}$, and $\frac{1}{2},\frac{1}{2},\frac{1}{2}$ c) 0,0,0, and $\frac{1}{4},\frac{1}{4},\frac{1}{4}$ d) 0,0,0, and $\frac{3}{4},\frac{3}{4},\frac{3}{4}$

Multiple Correct Answers Type

81. For the spinet structure ($MgAl_2O_4$), the correct statement is/are
a) 50% OVs are occupied by ions b) Al^{3+} is equally distributed in TVs and OVs

c) Oxide ions occupy ccp lattice d) 12.5% TVs are occupied by ions

82. Which of the following statements is/are correct about TVs in an fcc unit cell?
Given: Edge length $= a$
Body diagonal $= b$
a) Each TV lies at a distance $b/4$ from the nearest corner
b) Each TV lies at a distance $3b/4$ from the farthest corner
c) Each TV lies at a distance of $\sqrt{3}a/4$from the nearest corner
d) The distance between two TVs is $b/2$

83. Which of the following statements is/are correct about TVs in an fcc unit cell?
a) Number of TVs per atom in fcc unit cell is 2
b) Number of TVs per unit cell is 8
c) Number of TVs is twice the number of atoms in the fccunit cell
d) Number of TVs is equal to the number of atoms in the fcc unit cell

84. The elements of symmetry in a crystal is/are :
a) Plane of symmetry b) Axis of symmetry c) Centre of symmetry d) None of these

85. Bragg's law is given by the equation :
a) $n\lambda = 2\theta \sin\theta$ b) $n\lambda = 2d \sin\theta$ c) $2n\lambda = d \sin\theta$ d) $\lambda = (2d/n) \sin\theta$

86. Select the correct statement(s)
a) The non-stoichiometric form of NaCl is yellow and that of KCl is blue-lilac
b) Solids containing F-centers (Farbe) are paramagnetic
c) Non-stoichiometric compounds are called Berthollidecompounds
d) Conduction by electrons is called n-type semiconductors

87. In the fluorite structure if the radius ratio is $\left(\sqrt{\frac{3}{2}} - 1\right)$, how many ions does each cation touch?
a) 4 anions b) 12 cations c) 8 anions d) No cations

88. Recently discovered superconductivity materials are
a) M_3C_{60} b) $YBa_2Cu_3O_7$ c) SiC d) $Hg_2Ba_2YCaCu_2O_7$

89. What is true about a bcc unit cell?
a) The number of atoms in the unit cell is 2
b) In addition to an atom at the center of the body, in a unitcell there are 8 atoms at 8 different corners
c) One-eighth of an atom at a corner of the unit cell
d) None of the above

90. The space in which atoms are not present in unit cell is
a) In sc 48% b) In fcc 26% c) In bcc 32% d) In hexagonal 26%

91. Diamond is
a) A covalent solid b) A non-conductor c) A lubricant d) sp^3 hybridized

92. In which of the following systems primitives $a \neq b \neq c$?
a) Orthorhombic b) Monoclinic c) Triclinic d) Hexagonal

93. Graphite is
a) A good conductor b) sp^2 hybridised c) An amorphous solid d) A covalent crystal

94. If a mixture of LiCl and NaCl is melted and then cooled,
a) A solid solution is formed
b) Mixture formed is called eutectic mixture
c) $TiO_{1.8}$is non-stochiometric solid solution of Ti_2O_3 and TiO_2
d) Neither LiCl nor NaCl seperates

95. Which is/are not amorphous solid(s)?
a) Rubber b) Graphite c) Glass d) Plastics

96. Select the correct statement(s) about three-dimensional hcpsystem
a) The number of atoms in hcp unit cell is six
b) The volume of hcp unit cell is $24\sqrt{2}r^3$

c) The empty space in hcp unit cell is 26%
d) The base area of hcp unit cell is $6\sqrt{3}r^2$

97. Which of the following statements is/are correct?
a) The coordination number of each type of ion in CsCl crystal is 8
b) A metal that crystallizes in bcc structure has a coordination number of 12
c) A unit cell of an ionic crystal shares some of its ions with other unit cells
d) The length of the unit cell in NaCl is 522 pm ($r_{Na^{\oplus}} = 95$ pm, $r_{Cl^{\ominus}} = 181$ pm)

98. Select the correct statement(s)
a) The conductance through electrons is called p-type conduction
b) The conductance through positive holes is called p-type conduction
c) The conductance through electrons is called n-type conduction
d) The band gap in germanium is small

99. Which of the following having their radius ratio between 0.414 and 0.732, i.e., for NaCl structure, have their radius ratio not in this range but possess NaCl-type structure?
a) LiBr b) KCl c) RbCl d) BaO

100. Which of the following statements is/are correct?
a) Dislocation of ion from lattice site to interstitial site is called Frenkel defect
b) Missing of +ve and −ve ions from their respective position producing a pair of holes is called Schottkydefect
c) The presence of ions in the vacant interstital sites along with lattice point is called interstital defect
d) Non-stoichiometric NaCl is yellow solid

101. Which of the following is/are covalent solids?
a) Fe b) Diamond c) NaCl d) Graphite

102. Which of the following statements is/are correct?
a) If threeFe^{2+} ions are missing from their lattice in FeO,then there must be two Fe^{3+}ions somewhere in the lattice
b) Crystals with metal deficiency defects are called super conductors
c) Crystals with metal deficiency are called semiconductors
d) 1 Bohr Magneton $= 9.27 \times 10^{-24}$ A m^2

103. What is true about simple cubic type of unit cells?
a) Eight constituents are at different corners of the cube
b) $Z_{\text{eff}} = 1$
c) Contribution by one corner is 1/8 th of an atom
d) None of the above

104. Which of the following statements is/are correct for bothfluorite and antifluorite structures?
a) Cation is present in alternate TVs
b) Anion constitutes lattice
c) Number of formula unit in one unit cell is 4
d) 100% tetrahedral voids are occupied

105. A mineral having the formula AB_2 crystallizes in the ccp lattice, with A atoms occupying the lattice points. Select the correct statement(s)
a) The coordination number (CN) for A atoms = 8
b) The CN for B atom = 4
c) 100% of TVs are occupied by B atoms
d) 50% of TVs are occupied by B atoms

106. Identical spheres are undergoing two-dimensional packing in square close packing and hexagonal close packing. Which is correct regarding the spheres?
a) The ratio of coordination number for a sphere in first case to that in second case is 2:3
b) Packing in second case is more effective
c) Packing in first case is more effective
d) The stacking of layer on first type packing produces simple cubic structure

107. Position of OVs in an fcc structure are
a) Corners of unit cell
b) Edge center of unit cell
c) Body center of unit cell
d) Face center of unit cell

108. The density of KBr is 2.75 gcm^{-3}. The length of the unit cell is 654 pm. Atomic mass of $K = 39, Br = 80$ Then what is true about the predicted nature of the solid?
a) The unit cell is fcc
b) $Z = 4$
c) There are four constituents/unit cells
d) There are 8 ions at corners and 6 at the centers of the faces

109. If the radius of anion is 0.20 nm, the maximum radius of cations which can be filled in respective voids is correctly matched in
a) $r_{\oplus} = 0.0828$ nm for tetrahedral void
b) $r_{\oplus} = 0.045$ nm for triangular void
c) $r_{\oplus} = 0.1464$ nm for octahedral void
d) None of the above

110. For which of the following cases, answer is 4?
a) Coordination number of Zn^{2+} in Zinc blende
b) Number of body diagonal planes in a cube
c) Formula units in rock salt structure
d) Formula units in CsCl structure

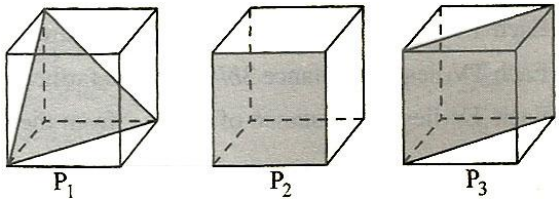
111. The correct statement (s) regarding defects in solids is (are):
a) Frenkel defect is usually favoured by a very small difference in the sizes of cation and anion
b) Frenkel defect is a dislocation defect
c) Trapping of an electron in the lattice leads to the formation of F-centre
d) Schottky defects have no effect on the physical properties of solids.

112. Which is/are amorphous solid(s)?
a) NaCl
b) CaF_2
c) Glass
d) Plastics

113. Molecular crystals exist in :
a) Crystalline state
b) Amorphous state
c) Non-crystalline state
d) None of these

114. Select the correct statement(s)
a) Solids with F-centers are paramagnetic
b) Ferrimagnetic character of Fe_3O_4 at room temperature changes to paramagnetic character at 850 K
c) Anti-ferrimagneticV_2O_3 changes to paramagnetic at 150 K
d) Non-stoichiometric Cu_2O is a p-type semiconductor

115. Following three planes (P_1, P_2, P_3) in an fcc unit cell are shown in the figure below. Consider the following statements and choose the correct option/options that follow:



a) P_1 contains no three dimensional voids
b) P_2 contains only octahedral voids
c) P_3contains both octahedral and tetrahedral voids
d) All of these

116. Aluminium metal has a density of 2.72 g cm^{-3} and crystallizes in a cubic lattice with an edge of 404 pm. Which is/are correct?
a) It forms an fcc unit cell
b) It forms a bcc unit cell
c) Its coordination number is 8
d) Its coordination number is 12

117. Non-stoichiometric compounds are
a) Cu_2O
b) Cu_2S
c) FeO
d) $Hg_2Ba_2YCaCu_2O_7$

118. An octahedron has
a) 8 corners
b) 8 faces
c) 8 edges
d) 12 edges

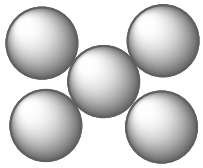
119. If the radius of $Cs^{\oplus} = 1.69$ Å and $Br^{\ominus} = 1.95$ Å, then which of the following is/are correct statement?

a) The edge length of unit cell is 4.2 Å
b) The coordination number for $Cs^{\oplus}$ is 6
c) CsBr has bcc-type structure
d) $Br^{\ominus}$ ions touch each other along the edge

120. Position of octahedral voids in fcc structure is/are
a) Edge center of unit cell
b) Body center of unit cell
c) Corners of unit cell
d) Face center of unit cell

121. In which of the following systems interfacial angles $\alpha = \gamma = 90°$ but $\beta \neq 90°$?
a) Monoclinic b) Rhombohedral c) Triclinic d) Hexagonal

122. Given is the arrangement of atoms in a crystllographic plane. Which plane correctly represent(s) the adjacent drawn structure?



a) Face plane in fcc
b) Body diagonal plane in fcc
c) Face plane in bcc
d) Body diagonal plane in bcc

123. An hcp and a ccp structure for a given element would be expected to have
a) The same co-ordination number
b) The same density
c) The same packing fraction
d) All of these

124. Ions of NaCl which are touched by 1 body diagonal are
a) $Cl^{\ominus}$ ions present at the corner of cube
b) $Cl^{\ominus}$ ions present at the face center of cube
c) $Na^{\oplus}$ ions present at the edge center of cube
d) $Na^{\oplus}$ present at body center of cube

125. Position of TVs in closest packed structure is/are
a) Edge center of unit cell
b) Two TVs on each body diagonal
c) Position of each TV from corner is $\sqrt{3}a/4$
d) Face center of unit cell

Assertion - Reasoning Type

This section contain(s) 0 questions numbered 126 to 125. Each question contains STATEMENT 1(Assertion) and STATEMENT 2(Reason). Each question has the 4 choices (a), (b), (c) and (d) out of which **ONLY ONE** is correct.

a) Statement 1 is True, Statement 2 is True; Statement 2 **is** correct explanation for Statement 1

b) Statement 1 is True, Statement 2 is True; Statement 2 **is not** correct explanation for Statement 1

c) Statement 1 is True, Statement 2 is False

d) Statement 1 is False, Statement 2 is True

126

Statement 1: The conductance through electrons is called n-type conduction and if through positive holes it is called p-type conduction.

Statement 2: Doping involves preparation of semiconductors by the presence of impurities in the intrinsic semiconductor.

127

Statement 1: Ferromagnetic substances are strongly attracted by magnetic field.

Statement 2: Ferromagnetism arises due to spontaneous alignment magnetic moments of ions or

atoms in the same direction.

128

Statement 1: In any ionic solid [MX] with Schottky defect, the number of positive and negative ions are same

Statement 2: An equal number of cation and anion vacancies is present

129

Statement 1: In CsCl crystal, $Cs^{\oplus}$ ions adopt bcc arrangement

Statement 2: For N atoms adopting bcc arrangement, there are $2N$ TVs

130

Statement 1: Diamond and graphite are polymorphic forms.

Statement 2: Carbon adopts different structural arrangements under different conditions to give there two forms.

131

Statement 1: Triclinic system is the most unsymmetrical system

Statement 2: No axial angle is equal to 90° in triclinic system

132

Statement 1: Covalent crystals have higher melting point

Statement 2: Covalent bonds are stronger than ionic bonds

133

Statement 1: Co-ordination number of CsCl changes from 8 : 8 to 6 : 6 on heating.

Statement 2: The crystal structure of CsCl changes to NaCl on heating.

134

Statement 1: Solids containing F centers are paramagnetic

Statement 2: Solids containing F centers conduct electricity and it is n-type semiconduction

135

Statement 1: Graphite is an example of tetragonal crystal system.

Statement 2: For a tetragonal system a=b≠ $c, \alpha = \beta = 90°, y = 120°$

136

Statement 1: Group-15-doped crystals of Si are called n-type semi conductors

Statement 2: Neutrons are responsible for the semi-conducting properties

137

Statement 1: The electrical conductivity of a semiconductor increases with increase in temperature

Statement 2: With increase in temperature, large number of electrons from the valence band can jump to the conduction band

138

Statement 1: Group-13-doped crystals of Si are called a p-type semiconductors

Statement 2: Positive holes are responsible for the semiconducting properties

139

Statement 1: Graphite is an example of tetragonal crystal system

Statement 2: For a tetragonal system, $a = b \neq c$ and $\alpha = \beta = 90°, \gamma = 120°$

140

Statement 1: In sodium chloride crystal, $Na^{\oplus}$ ions occupy OVs while $Cl^{\ominus}$ ions occupy vertices of octahedron

Statement 2: The radius ratio of $Na^{\oplus}$: $Cl^{\ominus}$ lies between 0.4 and 0.7

141

Statement 1: Glasses can be moulded and blows into various shapes.

Statement 2: Glasses have a low melting point.

142

Statement 1: For ionic solids exhibiting Frenkel defects, the density remains unaltered.

Statement 2: Doping of group 14 elements with suitable elements of group 13 produces p-type of semiconductors.

143

Statement 1: In CsCl crystal, the coordination number of $Cs^{\oplus}$ ion is 8

Statement 2: $Cl^{\ominus}$ions in CsCl adopt bcc type of packing

144

Statement 1: In the rock salt type structure, all the OVs are occupied by $Na^{\oplus}$ ions

Statement 2: Number of OVs = Number of $Cl^{\ominus}$ ions in the packing

145

Statement 1: Equivalent conducting power of H^{+} and OH^{-} ion is maximum and abnormally high among all the ions.

Statement 2: There occurs a proton jump from one water molecule to other leading to grothus type conductance.

146

Statement 1: Frenkel defects are found in silver halides.

Statement 2: Frenkel defects are commonly found in ionic solids.

147

Statement 1: In sodium chloride crystal, the coordination number of $Na^{\oplus}$ is 6

Statement 2: The sodium atom is smaller than chlorine atom

148

Statement 1: In any ionic solid (*MX)* with Schottky defects, number of positive and negative ions are same.

Statement 2: Equal number of cation and anion vacancies are present.

149

Statement 1: Space or crystal lattice have symmetry of the arrangement of points.

Statement 2: nλ=2dSin θ; is known as Bragg's equation.

150

Statement 1: Initially term pseudo solid was given for solids which were easily distorted by bending and compressing forces. They even tend to flow slowly under of own weight and lose shape.

Statement 2: These characteristics are shown by pseudo solids as in pinch. Glass and thus the name pseudo solid was replaced by super cooled liquids.

151

Statement 1: Frenkel defects are shown by AgX

Statement 2: $Ag^{\oplus}$ ions have small size

152

Statement 1: In hexagonal close packing voids are between three touching spheres whose centres lie at the corners of an equilateral triangle.

Statement 2: In hexagonal close packing voids are called square voids.

153

Statement 1: Band gap in germanium is small.

Statement 2: The energy spread of each germanium atomic energy level is infinitesimally small.

154

Statement 1: Bragg's equation has no solution if $n = 2$ and $\lambda = d$.

Statement 2: Bragg's equation is : $n\lambda = 2d \sin\theta$

155

Statement 1: 6 : 6 co-ordination at normal temperature and pressure changes to 8 : 8 co-ordinations at high pressure.

Statement 2: Pressure influences the structure of solids.

156

Statement 1: The density of crystal having Schottky defect is lowered

Statement 2: The crystals suffering from Schottkydefect have same number of cations and anions missing from their normal lattice sites

157

Statement 1: Solids having more F-centres possess intense colours.

Statement 2: Excess of Na^+ in NaCl solid having F-centres makes it appear to pink.

158

Statement 1: The size of a cation is larger in TV than in OV

Statement 2: Cations occupy more space than anions is crystal packing

159

Statement 1: The close packing of atoms in cubic structure is in the order, fcc $>$ bcc $>$ sc.

Statement 2: Packing density $= \frac{\text{volumes of unit cell}}{a^3}$

160

Statement 1: Antiferromagnetic substances on heating to high temperature become paramagnetic

Statement 2: On heating, the randomization of spins occurs

161

Statement 1: Zinc blende and wurtzite both have fcc arrangement of S^{2-} ions

Statement 2: A unit cell of both has four formula units of ZnS

162

Statement 1: Non-stoichiometric compounds are called Bertholide compounds. NaCl and KCl crystal, when heated in an atmosphere of Na and K vapours, respectively, they impart violet and yellow colours to NaCl and KCl, respectively

Statement 2: Metal excess defect is due to the presence of extra cations at the interstitial sites. The excess metal ions move to the interstitial sites and the electrons to the neighbouring sites. The colour results by the excitation of these electrons by absorbing suitable energy from visible light. When the excited electron comes back to the ground state, there is emission of radiation in the visible region and gives complimentary colour

163

Statement 1: hcp is more closely packed than ccp

Statement 2: hcp has a CN of 12, whereas ccp has a CN of 8

164

Statement 1: Solids containing F-centres are paramagnetic.

Statement 2: F-centres solids possess holes occupied by unpaired electrons.

165

Statement 1: bcc arrangement is less closely packed than ccp arrangement.

Statement 2: In ccp 74% of the available space is occupied by spheres bcc in bcc only 68% of the space is occupied by spheres.

166

Statement 1: In NaCl crystal each Na^+ ion is touching $6Cl^-$ ions but these Cl^- ions do not touch each other.

Statement 2: The radius ratio r_{Na}/r_{Cl^-} is greater than 0.414 required for exact fitting.

167

Statement 1: 8 : 8 co-ordination of CsCl at low temperature changes to 6:6 co-ordination at 760K.

Statement 2: Temperature also influence the structure of solids.

168

Statement 1: A crystal having fcc structure is more closely packed than a crystal having bcc structure.

Statement 2: Packing fraction for fcc structure is double that of bcc structure.

169

Statement 1: In rock salt structure, all the octahedral voids in the close packing of anions are occupied by cations.

Statement 2: In rock salt structure, the distance of closest approach between two anions equal to half the face diagonal of unit cell.

Matrix-Match Type

This section contain(s) 0 question(s). Each question contains Statements given in 2 columns which have to be matched. Statements (A, B, C, D) in **columns I** have to be matched with Statements (p, q, r, s) in **columns II**.

170.

Column-I	Column- II
(A) Hcp	(p) 0.38
(B) Ccp	(q) 0.48
(C) Bcc	(r) 0.22
(D) Sc	(s) 0.66
(E) Dc(diamond cubic)	(t)

CODES :

	A	B	C	D
a)	r	p	q	s
b)	p	r	s	q
c)	s	q	p	r
d)	p	s	q	s

171.

	Column-I		Column- II
(A)	Depature from regularity in the arrangement of constitutent particles in a crystal	(p)	Zinc blende
(B)	Cubic	(q)	Defect or imperfection
(C)	Glass and fused silica	(r)	SiO_4
(D)	Tetrahedral	(s)	Amorphous solid

CODES :

	A	**B**	**C**	**D**
a)	p	r	q	s
b)	q	p	s	r
c)	s	q	r	p
d)	r	s	p	q

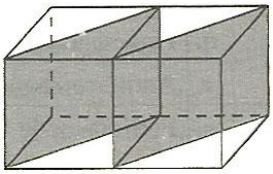
172.

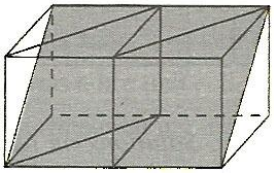
	Column-I		Column- II
(A)	Simple cubic and face-centred cubic parameters	(1)	have these cell
(B)	Cubic and rhombohedral	(2)	Are two crystal system
(C)	Cubic and tetragonal	(3)	Have only two crystallo-graphic angles of 90^0
(D)	Hexagonal and monoclinic	(4)	Belong to same crystal system

CODES :

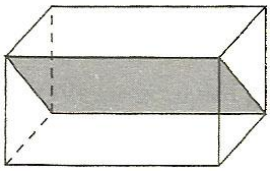
	A	**B**	**C**	**D**
a)	1,4	1,2	2	2,3
b)	3,2	3	4,2	1,2
c)	2	2,3	1,4	4,2
d)	1,2	4,1	3	2,3

173.

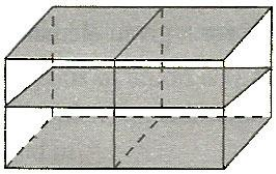
	Column-I		Column- II
(A)		(p)	101

(B) 

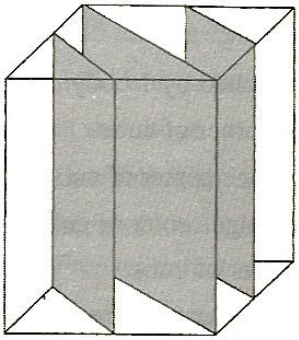
(q) 110

(C) 

(r) 022

(D) 

(s) $\overline{1}01$

(E) 

(t) 220

CODES :

	A	B	C	D	E
a)	q	p	s	r	t
b)	s	r	t	q	t
c)	t	q	r	s	t
d)	p	t	q	r	t

174.

Column-I	Column- II
(A) Body diagonal	(p) Only 2 face center ions
(B) C_4 axis (tetrad axis)	(q) Only 2 corners ions
(C) Rectangular plane	(r) Body center ion
	(s) Only one octahedral void

CODES :

	A	B	C	D
a)	Q,r,s	p,r,s	r	
b)	p,r,s	q,r,s	q	
c)	r	p,r	q,s	

d) p,r r q,r,s

175.

Column-I	Column- II
(A) F –centers	(p) Extra cations present in interstitial sites
(B) Metal excess defect	(q) Some cations are replaced by one of higher valence
(C) Metal deficinecy defect	(r) Both cations and anions are missing from lattices
(D) Schottky defects	(s) Electrons trapped in anionic vacancies

CODES :

	A	**B**	**C**	**D**
a)	p	q	r	s
b)	s	r	p	q
c)	r	s	q	p
d)	s	p	q	r

176.

Column-I	Column- II
(A) Rochelle salt	(p) Ferroelectric
(B) Ferrites	(q) Paramagnetic
(C) Nitric oxide (NO)	(r) Antiferromagnetic
(D) Manganese dioxide (MnO_2)	(s) Ferrimagnetic
(E) $BaTiO_3$ (barium titnate)	(t)

CODES :

	A	**B**	**C**	**D**	**E**
a)	p	q	r	t	p,q
b)	p,q	s	q	r	p,q
c)	s	p,q	r	s	p,q
d)	r	q	s	p,q	p,q

177.

Column-I	Column- II
(A) $Fe^{III}(Fe^{II}\ Fe^{III})O_4$	(p) Rutile structure
(B) $Mg^{II}Al_2^{III}O_4$ and $CO^{II}(CO^{III})_2O_4$	(q) Inverse 2:3 spinel structure

(C) $MnO_2$and SnO_2 (r) Normal 2:3 spinel structure

(D) $BaTiO_3$ (s) Perovskite structure

(E) CaF_2 and $SrCl_2$ (t) Fluorite-type structure

CODES :

	A	**B**	**C**	**D**	**E**
a)	q	r	p	s	t
b)	r	s	t	q	t
c)	p	q	r	t	t
d)	t	p	q	r	t

178.

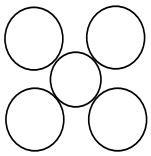
Column-I	**Column- II**
(A) For spinel structure, $(TV/OV)_{occupied}$	(p) 2:1
(B) For spinel structure $(TV/OV)_{unoccupied}$	(q) 1:2
(C) For inverse spinel structure $(TV/OV)_{occupied}$	(r) 7:2
(D) For inverse spinel structure $(TV/OV)_{unoccupied}$	(s) 2:7

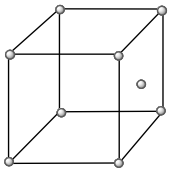
CODES :

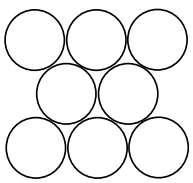
	A	**B**	**C**	**D**
a)	r	s	q	p
b)	q	r	p	p
c)	p	q	r	s
d)	s	p	s	r

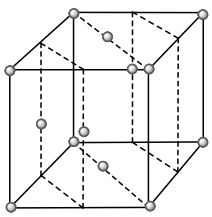
179.

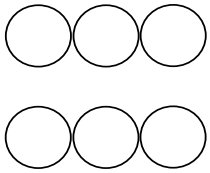
Column-I **Column- II**

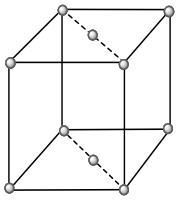
(A) 

(p) 

(B) 

(q) 

(C) 

(r) 

CODES :

	A	B	C	D
a)	q	r	p	
b)	s	p	q	
c)	p	q	r	
d)	r	s	p	

Linked Comprehension Type

This section contain(s) 14 paragraph(s) and based upon each paragraph, multiple choice questions have to be answered. Each question has atleast 4 choices (a), (b), (c) and (d) out of which **ONLY ONE** is correct.

Paragraph for Question Nos. 180 to -180

The "OLIVINE" series of minerals consists ofcrystals in which Fe^{2+} and Mg^{2+}ions may substitute for each other causing substitutional impurity defects without changing the volume of unit cell. In "OLIVINE" series of minerals,O^{2-}ions exist as fcc with Si^{4+} occupying one-fourth of OVs and divalent metal ions occupying one-fourth of TVs. The density of "forsterite" (magnesium silicate) is 3.21 g cm^{-3} and that of "fayalite" (ferrous silicate) is 4.34 g cm^{-3}

180. The formula of "fayalite mineral" is:

a) Fe_2SiO_4 b) $FeSiO_4$ c) Fe_2SiO_6 d) $FeSiO_3$

Paragraph for Question Nos. 181 to - 182

AX, AY, BX, and BY have rock salt type structure with following internuclear distances:

Salt	Anion-anion distance in	Cation-anion distance in Å
AX	2.40	1.70
AY	1.63	1.15
BX	2.66	1.88
BY	2.09	1.48

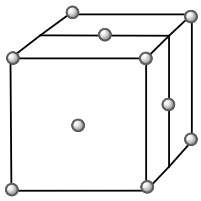
181. Ionic radii of $A^{\oplus}$ and $B^{\oplus}$, respectively, are

a) 0.35 and 0.68 Å b) 0.68 and 0.35 Å c) 1.20 and 0.80 Å d) 0.80 and 1.20 Å

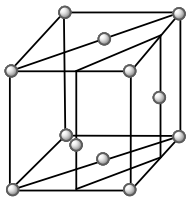
Paragraph for Question Nos. 182 to - 183

The length of a unit (a) in the Ni crystal is 0.352 nm. The diffraction of X-rays of 0.154 nm wavelength (λ) from a Ni crystal occurs at 22.2°, 25.9°, and 38.2°. By using Bragg's law, $n\lambda = 2d \sin\theta$), and assuming that the diffractions are first order ($n = 1$), the distances are calculated to be 0.204 nm, 0.176 nm, and 0.124 nm

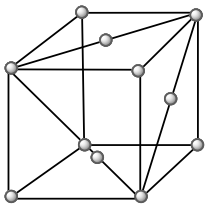
The various structures for the Ni crystal are represented as:



(I)



(II)



(III)

182. The distance (d) of 0.204 nm represent which structure?

a) I b) II c) III d) All

Paragraph for Question Nos. 183 to - 183

In crystalline solids atoms or molecules are arranged in a regular and long range order fashion in a three dimensional pattern. These have sharp melting point, flat faces, sharp edges, bounded by well defined planes. A large number of unit cells, each of which possess a definite geometry bounded by plane faces give rise to the formation of a crystal. A point at the corner of unit cell contributes for 1/8 of each such point to unit cell. A point along an edge contributes for 1/4 of each such point to unit cell. A body centred point contributes for 1 each such points to unit cell. Coordination number is the number of nearest neighbours that each ion is surrounded by an oppositely charged ions. Radius of unit cell in sc, fcc and bcc is $\frac{a}{2}, \frac{a}{2\sqrt{2}}$ and $\frac{\sqrt{3}a}{4}$ where a is edge length of cell.

183. A mineral having the formula AB_2 crystallises in the cubic closed packed lattice, with A^{2+} atoms occupying the lattice points and B^- tetrahedral voids. The co-ordination number of A, B and fraction of the tetrahedral sites occupied by B atom respectively are:

a) 8, 4, 100% b) 4, 8, 100% c) 8, 6, 57% d) 6, 8, 57%

Paragraph for Question Nos. 184 to - 184

In hexagonal systems of crystals, a frequently encountered arrangement of atoms is described as a hexagonal prism. Here, the top and bottom of the cell are regular hexagons and three atoms are sandwiched in between them. A space-filling model of this structure, called hexagonal closepacked (HCP), is constituted of a sphere on a flat surface surrounded in the same plane by six identical spheres as closely as possible. Three spheres are then placed over the first layer so that they touch each other and represent the second layer. Each one of these spheres touches three spheres of the bottom layer. Finally, the second layer is covered with a third layer that is identical to the bottom layer in relative position. Assume radius of every sphere to be $'r'$.

184. The number of atoms in this HCP unit cell is :

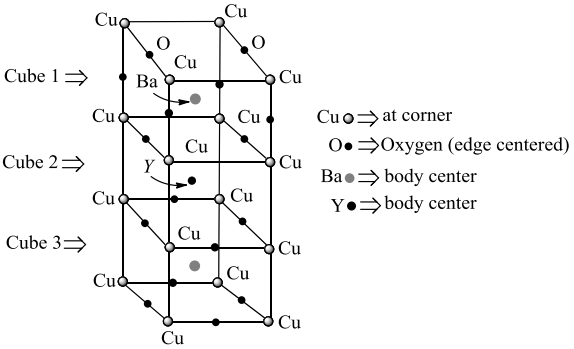
a) 4 b) 6 c) 12 d) 17

Integer Answer Type

185. Number of Al atoms per unit cell of Al in its crystal lattice is ….
186. Give the total score of the correct statements of the following

	Statements	Score
a.	First two nearest neighbour distances for sc lattice are, respectively, a and $\sqrt{2}a$	4
b.	First two nearest neighbour distances for bcc lattice are, respectively, $\frac{\sqrt{3}a}{2}$ and a	3
c.	In ZnS (wurtzite), Zn^{2+} ions occupy lattice point while in ZnS (zinc blende), Zn^{2+} ions occupy alternate TVs	2
d.	In point defects, volume and geometry of the crystal do not change	1

187. FeO crystallises in NaCl type lattice. The crystal is however non-stoichiometric as $Fe_{0.96}O$ and deficient in iron. Some cation sites are vacant and some contain Fe^{3+} so that it becomes electrically neutral. The % of cation sites vacant are ….
188. Number of hexagonal faces that are present in a truncated octahedran.
189. If the distance between $Cs^+ - Cl^-$ in CsCl lattice is $2\sqrt{3}$ Å, the edge length of cube is …..
190. A solid has a structure in which X atoms are located at cubic corners of unit cell, O atom are at the edge centers and Y atoms at cube center
    Then the formula of compound is $X_aY_bO_c$
    If two atoms of O are missing from any of two edge centers per unit cell, then the molecular formula is $X_xY_yO_z$.
    Then, find the value of $(x + y + z) - (a + b + c)$
191. In HCP arrangement of atoms, coordination no. of atoms in the middle layer is …
192. If a solid $A^{\oplus}B^{\ominus}$ having ZnS structure is heated so that the ions along two of the axis passing through the face center particles are lost and bivalent ion (Z) enters here to maintain the electrical neutrality, so that the new formula unit becomes $A_xB_yZ_c$, Report the value of $x + y + c$
193. The number of tetrahedral voids present in bcc lattice is ……
194. The following figure shows the unit cell of a compound, i.e., a mixed oxide of yttrium, barium, and copper. The formula of mixed oxide is $Y_aBa_bCu_cO_d$. Find the value of $(a + b + c + d)$



Note: For Q. 10, the integer value is between 10 and 20

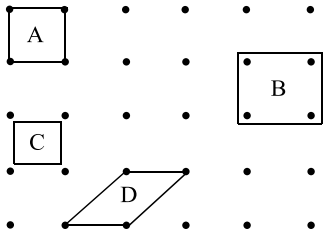
195. The no. of octahedral sites per square are in a ccp (fcc) structure …..
196. If edge length of a bcc crystallized Fe is $8\sqrt{3}$, the atomic radius is ….
197. A bcc lattice is made up of hollow spheres of B. Spheres of solidsA are present in hollow spheres of B. The

radius of A is half of the radius of B. The ratio of total volume of spheres of B unoccupied by A in a unit cell and volume of unit cell is A $\times \frac{\pi\sqrt{3}}{64}$. Find the value of A

198. Caesium atoms are the largest naturally occurring atoms. The radius of Cs atom is 2.6 Å. The number of moles of Cs atoms to be laid side by side to give a row of Cs atoms 2.50 cm long is $x \times 10^{-17}$. Find the value of x
199. Find the coordination number of $Na^{\oplus}$ in Na_2O
200. O^{2-}ions are arranged in ccp in a spinel structure. A^{2+}ions occupy 1/8 of TVs and $B^{\oplus}$ ions occupy half of OV. The void volume of unit cell = 0.11 A. Find the value of A
201. Silver (at. wt. = 108 g mol^{-1}) has a density of 10.5 g/cm^3. The number of silver atoms on a surface area of 10^{-12} m^2 can be expressed in scientific notations as Y x 10^X. The value of X is :
202. Given the total score of the correct statements of the following

	Statements	Score
a.	In an antifluorite structure, cations are present in all TVs	1
b.	If the radius of cation is 0.35 pm and that of anion is 0.95 pm, then the CN of the crystal is 4	2
c.	An atom or ion is transfered from a lattice site to an interstitial position in Frenkel defect	3
d.	The density of a crystal always decreases in point defects	4

203. Lattice energy of NaCl is $-$ 186 kcal/mol and solution enthalpies of cation and anion respectively are -97 and -85 kcal/mol. The enthalpy of solution of NaCl in kcal is …
204. Metal M of radius 50 nm is crystallized in fcc type and made cubical crystal such that face of unit cells aligned with face of cubical crystal. If the total number of metal atoms of M at all faces of cubical crystal is 6×10^{30}, then the area of one face of cubical crystal is A $\times 10^{16} m^2$. Find the value of A
205. A mineral having the formula AB_2 crystallises in cubic close packed lattice, with A atoms occupying the lattice point. The radio of coordination no. of A and B is ….
206. A crystal of sodium hydride has fcc unit cell of H^-ions with Na^+ ions at the body centres of unit cell and in the centre of edges. The no. of H^- that touch each Na^+ is …..
207. The ratio of coordination no. of Al and no. of Al atoms per unit cell in fcc lattice is…
208. Co-ordination number of Al in the crystalline state of $AlCl_3$ is :
209. In the figure given below, four parallelogram are shown. How many parallelograms are unit cells?



: ANSWER KEY :

1)	c	2)	a	3)	b	4)	d
5)	a	6)	c	7)	c	8)	c
9)	d	10)	b	11)	b	12)	d
13)	b	14)	b	15)	c	16)	b
17)	a	18)	c	19)	c	20)	b
21)	c	22)	a	23)	a	24)	b
25)	a	26)	d	27)	b	28)	b
29)	a	30)	c	31)	b	32)	a
33)	a	34)	c	35)	a	36)	b
37)	a	38)	d	39)	a	40)	c
41)	a	42)	b	43)	b	44)	c
45)	c	46)	d	47)	d	48)	a
49)	a	50)	a	51)	b	52)	d
53)	b	54)	a	55)	b	56)	b
57)	c	58)	b	59)	d	60)	b
61)	d	62)	b	63)	b	64)	a
65)	c	66)	b	67)	d	68)	c
69)	a	70)	d	71)	d	72)	b
73)	b	74)	b	75)	a	76)	b
77)	a	78)	a	79)	c	80)	a

1)	a,c,d	2)	a,b,c,d	3)	a,b,c	4)	a, b, c
5)	b, d	6)	a,b,c,d	7)	b,c	8)	a,b,d
9)	a,b,c	10)	a,b,c,d	11)	a,b,d	12)	a,b,c
13)	a,b,d	14)	a,b,c,d	15)	b	16)	a,b,c,d
17)	a,c,d	18)	b,c,d	19)	a,b,c,d	20)	a,b,c,d
21)	b,d	22)	a,c,d	23)	a,b,c	24)	c,d
25)	a,b,c	26)	a,b,d	27)	b,c	28)	a,b,c,d
29)	a,b,c	30)	a,c	31)	b, c	32)	c, d
33)	a, b, c	34)	a,b,c,d	35)	a,b,c,d	36)	a,d
37)	a,b,c,d	38)	b,d	39)	a,c	40)	a,b
41)	a,b	42)	a,d	43)	a,c	44)	a,d
45)	b,c	1)	d	2)	c	3)	a
	4)	c					
5)	a	6)	b	7)	c	8)	c
9)	b	10)	d	11)	c	12)	a
13)	a	14)	e	15)	d	16)	a

17)	d	18)	a	19)	b	20)	c
21)	b	22)	b	23)	c	24)	b
25)	d	26)	a	27)	a	28)	a
29)	c	30)	c	31)	a	32)	a
33)	e	34)	c	35)	a	36)	e
37)	d	38)	e	39)	c	40)	d
41)	a	42)	c	43)	a	44)	d
1)	a	2)	b	3)	a	4)	a
5)	a	6)	d	7)	b	8)	a
9)	b	10)	c	1)	a	2)	a
	3)	c	4)	a			
5)	a	1)	4	2)	8	3)	4
	4)	8					
5)	4	6)	4	7)	6	8)	7
9)	4	10)	13	11)	1	12)	6
13)	7	14)	8	15)	4	16)	2
17)	7	18)	6	19)	4	20)	2
21)	2	22)	6	23)	3	24)	4
25)	2						

: HINTS AND SOLUTIONS :

1 **(c)**

$Cs^{\oplus}$ and$I^{\ominus}$ions have largest sizes

2 **(a)**

For face-centered cubic unit cell (e.g., that of NaCl), edge length = 2 ×Distance between cation and anion = $2(r_c + r_a) = 508$ pm (given). Putting r_c =110 pm, we get $r_a = 144$ pm

3 **(b)**

A TV in fcc is formed by 3 face center atoms and one corner atom. In total, 8 such tetrahedrons are possible

4 **(d)**

$Ni = 3d^8\ 4s^2$(At no.=28)

$\therefore Ni^{2+} = 3d^8$and $Ni^{3+} = 3d^7$

Hence, 96% ion of Ni^{2+} and 4% ions of Ni^{3+} are present

Let number of O^{2-} ion present in the crystal $=x$

Applying electroneutrality rule,

Total positive charge = Total negative charge

96×2 (+ve charge) $+ 4 \times 3$ (+ve charge)

$= x \times 2$ (−ve charge)

$\therefore 96 \times 2 + 4 \times 3 - 2x = 0$

$\therefore x = 1.02$

So formula of crystal$Ni_{1.00}O_{1.02}$or $Ni_{0.98}O_{1.00}$

5 **(a)**

Z_{eff} for fcc = 4 and for bcc = 2/unit cell

$$\frac{\rho_\gamma}{\rho_\beta} = \frac{\rho_{fcc}}{\rho_{bcc}} = \frac{Z_{eff(fcc)}}{Z_{eff(bcc)}} \times \left(\frac{a_{bcc}}{a_{fcc}}\right)^3$$

$$= \frac{4}{2} \times \left(\frac{290}{386}\right)^3 = 0.9788$$

6 **(c)**

Distance between two layer (A and B)

$$= \frac{c}{2} = \sqrt{\frac{8}{3}}(r)$$

$$= \sqrt{\frac{2}{3}}\ (2r)$$

[Given distance between two imaginary Plane $= 13\frac{\sqrt{2}}{\sqrt{3}}(r)$]

Let K is the number of imaginary planes

Hence,

$$K \times \frac{\sqrt{2}}{\sqrt{3}}(2r) = 13\frac{\sqrt{2}}{\sqrt{3}}(r) \Rightarrow K = \frac{13}{2} = 6.5 \approx 7$$

Thus, maximum number of layers = 7 (see figures below)

1 [Imaginary plane (a)]
2
3
4
5
6
7 [Imaginary plane (b)]

7 **(c)**

Factual statement

8 **(c)**

Coordination number of Al in $AlCl_3$ in (solid) crystalline state is 6.

9 **(d)**

hcp has 12 nearest neighbours

10 **(b)**

Volume of unit cell

$= a \times b \times c = 5 \times 10^{-8} \times 8 \times 10^{-8} \times 4 \times 10^{-8}$

$= 1.6 \times 10^{-22}cm^3$

Mass of unit cell $= 1.6 \times 10^{-22} \times 5.2 = 8.32 \times 10^{-22}$g

Number of molecules in one unit cell $= \frac{8.32 \times 10^{-22}\ g}{166.4\ g\ mol^{-1}}$

$= 3$

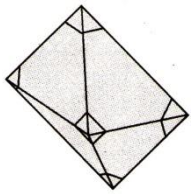
11 **(b)**

Since equal number of cations(2 $Na^{\oplus}$ ions) and anions (2 $Cl^{\ominus}$ ions) are missing in the figure given, so it Schottky defect

12 **(d)**

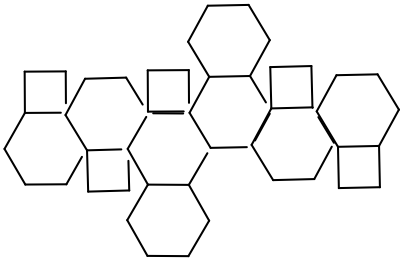
The truncated octahedron is the 14-faced Archimedean solid, with 14 total faces : 6 squares and 8 regular hexagons.

The truncated octahedron is formed by removing the six right square pyramids one from each point of a regular octahedron as :



Truncated octahedron

Truncated Octachedron



Truncated octahedron unfolded in two dimensions

14 **(b)**

Factual statement

15 **(c)**

58.5 g NaCl = 1 mol

$= 6.02 \times 10^{23} \mathrm{Na}^{\oplus}\mathrm{Cl}^{\ominus}$ units

One unit cell contains 4 $\mathrm{Na}^{\oplus}\mathrm{Cl}^{\ominus}$ units. Hence, number of the unit cell present $= 6.02 \times 10^{23}/4 = 1.5 \times 10^{23}$

16 **(b)**

For a given radius of anion ($r_{\ominus}$)

Radius ratio for OV and TV is as follows:

$$\left(\frac{r_{\oplus}}{r_{\ominus}}\right)_{\mathrm{OV}} > \left(\frac{r_{\oplus}}{r_{\ominus}}\right)_{\mathrm{TV}}$$

$$\begin{pmatrix} \text{For OV}, \dfrac{r_{\oplus}}{r_{\ominus}} = 0.414 - 0.732 \\ \text{For TV}, \dfrac{r_{\oplus}}{r_{\ominus}} = 0.225 - 0.414 \end{pmatrix}$$

Hence, size of OV is larger than that of TV

17 **(a)**

$$\rho = \frac{Z_{\mathrm{eff}} \times Mw}{a^3 \times N_{\mathrm{A}}}$$

$2.165\ \mathrm{kg\ m^{-3}}$

$$= \frac{Z_{\mathrm{eff}} \times 58.5 \times 10^{-3}\mathrm{kg\ mol^{-1}}}{(562 \times 10^{-12})^3 \mathrm{m^3} \times 6 \times 10^{23}\mathrm{atoms}}$$

$\therefore Z_{\mathrm{eff}} = 4$ (fcc-type structure)

∴For fcc,

$$d_{\mathrm{A}^{\oplus}-\mathrm{B}^{\ominus}} = \frac{a}{2} = \frac{562}{2} = 281\ \mathrm{pm}$$

18 **(c)**

From figure, it is clear 4 corners and 2 face centers lie on the shaded plane. Therefore, there will be six C atoms, and atoms (marked A) in TVs do not touch other.

Fig. (a) is not possible; four atom marked C

Fig. (b) is not possible, atoms A in TVs are not shown in figure

Fig. (c) is possible, since atoms A in TVs are not touching each other

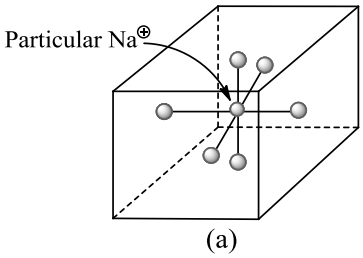
Fig. (d) is not possible, since atoms A in TVs are touching each other

19 **(c)**

As CsCl is body-centered, $d = \sqrt{3}a/2$

20 **(b)**

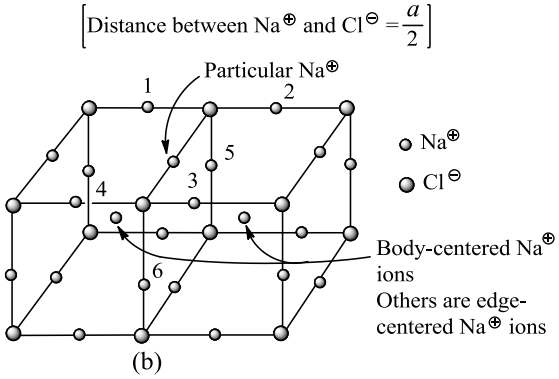
$\mathrm{Na}^{\oplus}$ lies in OVs formed by $\mathrm{Cl}^{\ominus}$ ($\mathrm{Na}^{\oplus}$ touches six $\mathrm{Cl}^{\ominus}$ ions)



(a)

$\mathrm{Na}^{\oplus}$ and $\mathrm{Cl}^{\ominus}$ are not shown touching in the figure. Each atom shown is present at the face center of each cube

$\left[\text{Distance between two } \mathrm{Na}^{\oplus} \text{ and } \mathrm{Cl}^{\ominus} = \frac{a}{2}\right]$



(b)

Try to visualize two cubes exactly above these two cubes.Each atom shown is present at the edge center and body center of each cube

Distance between two nearest $\mathrm{Na}^{\oplus} = \frac{a}{\sqrt{2}}$

1. Thus, the number of nearest neighbours of $\mathrm{Na}^{\oplus}$ ion = 6 $\mathrm{Cl}^{\ominus}$ ions

2. The number of next nearest neighbours of $\mathrm{Na}^{\oplus}$ ion = 12 $\mathrm{Na}^{\oplus}$ ions

Note: *Next nearest neighbours are shown by number* $1, 2, 3, \ldots 6$ *in Fig.* (b)*. Likeswise* 6 *next nearest neighbours of* $Na^{\oplus}$ *ions will be in the above two cube. Hence, total number of next nearest neightbours of* $Na^{\oplus}$ *ions* $= 12\ Na^{\oplus}$ *ions*

21 **(c)**

The volume available $= \frac{0.015}{7.5 \times 10^3}$

(Number of unit cells)$\times (400 \times 10^{-12})^3 = \frac{0.015}{7.5 \times 10^3}$

$\Rightarrow$ Number of unit cell $= 3.125 \times 10^{22}$

22 **(a)**
Factual statement

23 **(a)**
For OV,
$\frac{R}{r}\left(\text{i.e.,}\frac{r_{\oplus}}{r_{\ominus}}\text{or }\frac{r_{\text{void}}}{r_{\ominus}}\right) = 0.414$
$\therefore \frac{r}{R} = \frac{1}{0.414} = 2.41$

24 **(b)**
For bcc,
$(r_{\oplus} + r_{\ominus}) = \frac{\sqrt{3}}{2}a$
$338 \text{ pm} = \frac{\sqrt{3}}{2}a \Rightarrow a = 390.3 \text{ pm}$

25 **(a)**
Look at corner atom of fcc unit cell. A corner atom can support 8 unit cell. In each cube, at a distance of $\sqrt{3}a/4$ from corner atom, there is a tetrahedral void; it implies each atom is surrounded by eight tetrahedral voids. At the center of edge, there is an octahedral void. Each corner can support six edges and hence it is surrounded by six octahedral voids

26 **(d)**
All factual statements

27 **(b)**
$\frac{r_{\oplus}}{r_{\ominus}}\left(\text{i.e.,}\frac{r_{Zn^{\oplus}}}{r_{S^{2-}}}\right) = \frac{0.74 \text{ Å}}{1.70 \text{ Å}} = 0.44$
From radius ratio, it is expected that Zn^{2+} ion occupy OVs; however, the value of 0.44 is only slightly larger than $r_{\text{void}}/r_{\ominus} = 0.414$ for OV. There is also some covalent character in the $Zn^{2+} - S^{2-}$ interaction, which tends to shorten the interaction distance
Note: *Experimentally, it was found that Zn^{2+} ions occupy TVs*
$\therefore (r_{Zn^{2+}} + r_{S^{2-}}) = \frac{\sqrt{3}}{4}a$
$(0.74 + 1.70)\text{Å} = \frac{\sqrt{3}}{4}a \Rightarrow a = 5.634 \text{ Å}$

28 **(b)**
For bcc, $r = \frac{\sqrt{3}}{4}a$
Edge length not covered by atom $= a - 2\text{r}$
$= a - 2 \times \frac{\sqrt{3}}{4}a$
$= a\left[\frac{2-\sqrt{3}}{2}\right]$
$\therefore$ % of fraction not covered $= \frac{a\left[\frac{2-\sqrt{3}}{2}\right]}{a} \times 100$
$= 0.134 \times 100 = 13.4\%$

29 **(a)**
Factual statement

30 **(c)**
Volume of one mole of silver atoms $= \frac{108}{10.5}\text{cm}^3/\text{mol}$
Volume of one silver atom $= \frac{108}{10.5} \times \frac{1}{6.022 \times 10^{23}} \text{ cm}^3$
So, $\frac{4}{3}\pi r^3 = \frac{108}{10.5} \times \frac{1}{6.022 \times 10^{23}} = 1.708 \times 10^{-23}$
$r^3 = 0.407 \times 10^{-23}\text{cm}^3 = 0.407 \times 10^{-29}\text{m}^3$
Area of each silver atom,
$\pi r^2 = \pi(0.407 \times 10^{-29} \text{ m}^3)^{2/3}$
So, number of silver atoms in given area
$= \frac{10^{-12}}{(0.407 \times 10^{-29} \text{ m}^3)^{2/3}} = \frac{10^8}{\pi \times 2}$
$= 1.6 \times 10^7 = y \times 10^x$
So, $x = 7$

31 **(b)**
$\frac{r_{\oplus}}{r_{\ominus}}\left(\text{i.e.,}\frac{r_{Ga^{\oplus}}}{r_{As^{3-}}}\right) = \frac{1.22 \text{ Å}}{1.25 \text{ Å}} = 0.976$
From radius ratio, it is clear that cation(Ga^{3+} ion) lies in body centered or cubic void, where
$2(r_{\oplus} + r_{\ominus}) = \sqrt{3}a$
$2(1.22 + 1.25)\text{Å} = \sqrt{3}a \Rightarrow a = 2.852$

32 **(a)**
For fcc,
$(r_{\oplus} + r_{\ominus}) = \frac{a}{2}$
$r_{\oplus} + 144 \text{ pm} = \frac{508 \text{ pm}}{2}$
$\therefore r_{\oplus} = 110 \text{ pm}$

33 **(a)**
In hcp, a particle as shown here is surrounded by 12 particles, six in its own plane and three each above and below the plane

34 **(c)**
Factual statement

35 **(a)**
Ge is Group 14 elements. Positive holes can be created by adding Group 13 element, i.e., trivalent impurity

36 **(b)**
SiO_2 is used in solar cells

37 **(a)**
Body diagonal $= \sqrt{3}a$
Distance between $Cs^{\oplus}$ and $Br^{\ominus}$ is
$\frac{\text{Body diagonal}}{2} = \frac{\sqrt{3}a}{2} = \frac{\sqrt{3} \times 43}{2} = 3.724$

38 **(d)**

$a = \left(\sqrt[2]{2r}\right)$ Packing fraction

$$= \frac{2 \times \pi r^2}{\left(\sqrt[2]{2r}\right)^2} = \frac{2\pi r^2}{8r^2}$$

$$= \frac{\pi}{4} = \frac{3.14}{4} = 0.78\ 54$$

$$= 78.54\%$$

39 **(a)**

1. Edge length= $AB = AD = BC = CD = a$
2. $AC = \sqrt{2}a$
3. AG (body diagonal)= $\sqrt{3}a$

Therefore $AA' = AG/2 = \frac{\sqrt{3}}{2}a$

40 **(c)**

For fcc, $Z_{eff} = 4$/unit cell

Mw of NaCl = 58.5 g mol^{-1}

Number of atoms in 1.0 g NaCl = $\frac{6\times10^{23}}{58.5}$

Number of unit cells in 1.0 g NaCl

$$= \frac{6 \times 10^{23}}{58.5 \times 4} = 2.57 \times 10^{21} \text{ unit cells}$$

41 **(a)**

p-type (factual statement)

42 **(b)**

W atoms/unit cell $= 8 \times \frac{1}{8} = 1$

O atoms/unit cell $= 12 \times \frac{1}{4} = 3$

Na atoms/unit cell $=1$

Hence, formula is $NaWO_3$

43 **(b)**

In ZnS structure, sulphide ions occupy all (fcc) lattice points while Zn^{2+} ions are present in alternate tetrahedral sites.

Therefore, there is one Zn^{2+} ion for every S^{2-} ion.

44 **(c)**

$\frac{r_{A^\oplus}}{r_{B^\ominus}} = 0.50$ and $\frac{r_{C^\oplus}}{r_{B^\ominus}} = 0.70$

$$\Rightarrow \frac{r_{A^\oplus} + r_{B^\oplus}}{r_{B^\ominus}} = 1 + 0.5 = 1.5$$

Similarly, $\frac{r_{C^\oplus} + r_{B^\ominus}}{r_{B^\ominus}} = 1.70$

$$\therefore \frac{r_{A^\oplus} + r_{B^\ominus}}{r_{C^\oplus} + r_{B^\ominus}} = \frac{1.5}{1.7} = 0.88$$

Also, $a_{AB} = 2\left(r_{A^\oplus} + r_{B^\ominus}\right)$ and $a_{CB} = 2\left(r_{C^\oplus} + r_{B^\ominus}\right)$

$$\therefore \frac{a_{AB}}{a_{CB}} = \frac{1.5}{1.7} = 0.88$$

45 **(c)**

In fcc structure, corner atoms do not touch each other (atoms 1 and 2), but every face center atom touches corners. Moreover, every face center atom touched every other face center atom provided it is not the opposite face center atom in an fcc unit cell

1. Atoms 3 and 4 are touching each other where center-to-center distance = $\frac{a}{\sqrt{2}}$
2. Atoms 1 and 2 are not touching each other
3. Atoms 2 and 4 are touching each other where center-to-center distance = $\frac{a}{\sqrt{2}}$

46 **(d)**

Density $(\rho) = \frac{Z_{eff} \times Mw}{N_A \times a^3}$

(For antifluorite, $Z_{eff} = 4$/unit cell)

$$(\rho) = \frac{4 \times [23 \times 2 + 16]}{6 \times 10^{23} \times (100 \text{ pm} \times 10^{-10}\text{cm})^3}$$

$$\left[\begin{array}{l} 1 \text{ pm} = 10^{-12}\text{m} \\ \quad = 10^{-10} \text{ cm} \end{array}\right]$$

$= 414.16$ g cm^{-3}

Note: *Frenkel defect does not change the density of the crystal*

47 **(d)**

Number of atoms $= N_A$

$\Rightarrow$ Number of unit cells $= \frac{N_A}{4}$

[$\because$ 4 atoms in each unit cell]

Volume of 1 mol lattice $= \frac{N_A}{4} \times$Volume of unit cell

$$= \frac{6.023 \times 10^{23}}{4} \times (400 \times 10^{-12})^3 \text{m}^3 = 9.64 \text{ mL}$$

48 **(a)**

Factual statement

49 **(a)**

1. Edge length= $AB = AD = BC = CD = a$
2. $AC = \sqrt{(AB^2) + (BC)^2} = \sqrt{a^2 + a^2} = \sqrt{2}a$
3. $AG = \sqrt{(AC^2) + (CG)^2} = \sqrt{2a^2 + a^2} = \sqrt{3}a$

51 **(b)**

All factual statements

52 **(d)**

For fcc, number of X atoms $= 4$/unit cell

Number of TVs $= 8Z$

Number of OVs $= 4Y$

Number of atoms removed along one body diagonal = 2X (corner) and 2Z (TVs) and 1Y

(OV at body center)

$\therefore$Number of X atoms left $= 4 - \left(2 \times \frac{1}{8}\right) = \frac{15}{4}$

Number of Y atom left $= 4 - (1 \times 1) = 3$
Number of Z atom left $= 8 - (2 \times 1) = 6$

The simplest formula $= X_{\frac{15}{4}}Y_3Z_6 \Rightarrow X_{15}Y_{12}Z_{24}$

$\Rightarrow X_5Y_4Z_8$

53 **(b)**
Let the volume of unit cell $= V$

Volume occupied by atoms $= 0.68\ V$

Thus,

$Z_{\text{eff}}\left(\frac{4}{3}\pi r^3\right) = 0.68\ V$

Also, $2r = 2.86$ Å $\Rightarrow r = 1.43$ Å

$\rho = \frac{Z_{\text{eff}} \times Aw}{a^3 \times N_A}\left(\frac{Aw}{N_A} = m\text{ass of an atom in amu}\right)$

Applying another formula of ρ

$\rho = \frac{Z_{\text{eff}} \times \text{Mass in amu} \times 1.66 \times 10^{-27}\text{kg}}{V}$

$8570\ \text{kg m}^{-3} = \frac{0.68 \times m \times 1.66 \times 10^{-27}\text{kg}}{\frac{4}{3}\pi(1.43)^3 \times 10^{-30}}$

$\therefore m \Rightarrow 93$ amu

54 **(a)**
Number of A atoms $= 8 \times \frac{1}{8} = 1$
Number of B atoms $= 6 \times \frac{1}{2} = 3$
Formula $= AB_3$

55 **(b)**
Factual statement

56 **(b)**
Factual statement

57 **(c)**
AgBr has frenkel defects due to large difference in the size of $Ag^{\oplus}$ and $Br^{\oplus}$ions

58 **(b)**
In fluorite-type structure, CN $= 8:4$ (factual statement)

59 **(d)**
AB has NaCl-type structure (fcc system)
$\therefore$ Number of A atoms
$= 8$ (corner)$\times \frac{1}{8}$(per corner share)$+ 6$(faces) $\times \frac{1}{2}$(per face center share)
$= 1 + 3 = 4$/unit cell
Number of B atoms
$= 12$ (corner)$\times \frac{1}{4}$(per edge corner share)$+1$(body center)
$= 1 + 3 = 4$/unit cell
Number of A atoms removed (face centered atom of one axis)
$= 2$ (faces) $\times \frac{1}{2}$ (per face center share)
$= 1$/unit cell
Number of A atoms left $= 4 - 1 = 3$/unit cell
Formula $= A_3B_4$

60 **(b)**
For bcc, $Z_{\text{eff}} = 2$/unit cell
For fcc, $Z_{\text{eff}} = 4$/unit cell
$\therefore$ Ration $= \frac{2}{4} = 0.5$

61 **(d)**
For fcc, $Z_{\text{eff}} = 4$/unit cell
Volume of atoms in the unit cell $= \frac{4}{3}\pi r^3 \times Z_{\text{eff}}$
$= \frac{4}{3}\pi r^3 \times 4$
$= \frac{16}{3}\pi r^3$

62 **(b)**
$\rho = \frac{Z_{\text{eff}} \times Mw}{a^3 \times N_A}$
$1.74\ \text{g cm}^{-3} = \frac{Z_{\text{eff}} \times 24}{(4.53 \times 10^{-8})^3\ \text{cm}^3 \times 6 \times 10^{23}\text{atoms}}$
$\therefore Z_{\text{eff}} = 4$ (fcc structure)
For fcc, the radius of atom is:
$r = \frac{a}{2\sqrt{2}} = \frac{4.53\ \text{Å}}{2\sqrt{2}} = 1.60\text{Å} = 160$ pm

63 **(b)**
For n-type, impurity added to silicon should have more than 4 valence electrons

64 **(a)**
$\rho = \frac{Z_{\text{eff}} \times Mw}{a^3 \times 10^{-30} \times N_A}$ [For fcc, $Z_{\text{eff}} = 4$/unit cell]
$\therefore Mw = \frac{\rho \times a^3 \times 10^{-30} \times N_A}{Z_{\text{eff}}}$
$= \frac{(10.0\ \text{g cm}^{-3} \times (200\ \text{pm})^3 \times 10^{-30}\text{cm}^3 \times 6 \times 10^{23}\text{atoms})}{4}$
$= 12\ \text{g mol}^{-1}$
Thus, 12 g mol^{-1} contains$= N_A$ atoms $= 6 \times 10^{23}$ atoms
$\therefore$ 100 g contains $= \frac{6 \times 10^{23}}{12} \times 100$

$= 5 \times 10^{24}$ atoms

65 **(c)**

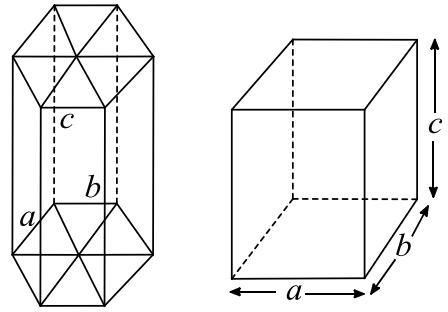
Electrical conductivity of semiconductors lies in the range $10^{-9} - 10^{2}$ ohm^{-1} cm^{-1}

66 **(b)**

$$\text{Ratio} = \frac{abc}{6 \times \left(\frac{\sqrt{3}}{4}a^2\right) \times c} = \frac{2}{3\sqrt{3}}$$

Note: $\frac{c}{a} = \frac{2\sqrt{2}}{\sqrt{3}}$ *for an ideal hcp*

[*Refer section* 1.22(*f and* g)]



Hexagonal unit cell Tetragonal unit cell

67 **(d)**

Number of octahedral sites = Number of ions in the packing.

∴ Number of octahedral sites per share =1

68 **(c)**

The next nearest neighbours to $Cs^{\oplus}$ are $Cs^{\oplus}$ of neighbour unit which are 6 in number

69 **(a)**

It is clear from the figure that the arrangement is sc, with coordination number (CN) of each point = 6

(The arrangement shown in figure consists of 4 unit cells. Taking a view of one unit cell, the atoms are not present at the face centers of each unit cell, hence it cannot be fcc, since in fcc lattice points are occupied at corners and face centers of each unit cell)

70 **(d)**

For close-packed structure (fcc type)

Number of $O^{2-} = 4$/unit cell

Number of $A^{2+} = \frac{1}{8} \times \text{TV} = \frac{1}{8} \times 8 = 1$

Number of $B^{3+} = \frac{1}{2} \times \text{OV} = \frac{1}{2} \times 4 = 2$

Formula: $A_1{}^{2+}B_2{}^{3+}O_4{}^{2-} \Rightarrow AB_2O_4$

71 **(d)**

Number of unit cell for bcc is 2 and fcc is 4

72 **(b)**

All factual statements

73 **(b)**

CN of (8:8) of $Li^{\oplus}$and $Ag^{\oplus}$ suggest bcc structure

74 **(b)**

$$\rho = \frac{\left[\sum (\text{Number of atom of each kind}) \times (Mw \text{ of each kind}) \times 1.66 \times 10^{-27}\text{kg}\right]}{a^3}$$

7717 kg m^{-3}

$$= \frac{\left[\begin{array}{c}(\text{Number of Sn atoms}) \times 118.7 \times 1.66 \times 10^{-27}) \\ +(\text{Number of Cu atoms}) \times (63.54 \times 1.66 \times 10^{-27})\end{array}\right]}{(3.903 \times 10^{-10})^3 \text{m}^3}$$

$276.4 = n_{\text{Sn}}(118.7) + n_{\text{Cu}}(63.54)$

$4.35 = 1.86n_{\text{Sn}} + n_{\text{Cu}}$

$n_{\text{Cu}} = 4 \Rightarrow n_{\text{Sn}} = 0.188$

Atomic fraction $= \frac{n_{\text{Sn}}}{n_{\text{Sn}} + n_{\text{Cu}}} = 0.05$

75 **(a)**

Packing fraction ion fcc, bcc, and sc are 0.74, 0.68 and 0.52, respectively

$$\therefore \text{Ratio} = \frac{0.74}{0.74} : \frac{0.68}{0.74} : \frac{0.52}{0.74}$$

$= 1 : 0.92 : 0.70$

76 **(b)**

ABAB type of packing means ccp packing in which 74% space is occupied and 26% is empty

77 **(a)**

Factual statement

78 **(a)**

Sihas fcc structure ($Z_{\text{eff}} = 4$ and Si is also present in alternate TVs (=4). So the total number of atom $= 4 + 4 = 8$/unit cell

Note: *Si has diamond cubic structure, refer section* 1.17

$$\therefore \rho = \frac{Z_{\text{eff}} \times Aw}{N_{\text{A}} \times a^3} \left[\text{Mass of Si atom} = \frac{Aw}{N_{\text{A}}}\right]$$

$$= \frac{8 \times \text{Mass of Si atom}}{a^3}$$

$$= \frac{8 \times (28.08 \times 1.66 \times 10^{-27})\text{kg}}{(5.43 \times 10^{-10})^3 \text{m}^3}$$

[1 Å $= 10^{-10}$m]

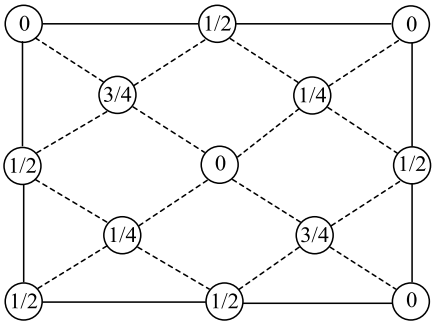
$= 2330$ kg m^{-3}

79 **(c)**

Due to Frenkel defects, density does not change

80 **(a)**

The space lattice of diamond is fcc. The primitive basis has two identical atoms at 0, 0,0 and $\frac{1}{4}, \frac{1}{4}, \frac{1}{4}$ associated with each point of the fcc lattice as shown in the figure



81 **(a,c,d)**
For spinel structure, O^{2-} ions form fcc arrangement
$\therefore$Number of O^{2-} ions $=4$
Number of TV=8, Number of OV=4
Number of Mg^{2+} ions $= \frac{1}{8} \times \text{TV} = \frac{1}{8} \times 8 = 1$
Number of Al^{3+} ions $= \frac{1}{2} \times \text{OV} = \frac{1}{2} \times 4 = 2$
So, 50%, OVs are occupied and 1/8th, i.e., 12.5% TVs are occupied

86 **(a,b,c,d)**
All factual statements

87 **(b,c)**
$$\frac{r_{\oplus}}{r_{\ominus}} = \sqrt{\frac{3}{2}} - 1 = 0.225$$
Hence, it is the limiting case where cation in the void of fcc structure is not distorted
Note: *A fluorite-type structure has ccp arrangement in which cation*(Ca^{2+}ion) *forms fcc arrangement with each* Ca^{2+} *ion surrounded by* 8 *anions*($F^{\ominus}$ *ions*)*and each anion* ($F^{\ominus}$ *ion*)*surrounded by* 4 *cations* (Ca^{2+} *ion*)
So, number of cations surrounding the particular cation= 12. But at the same time 8 anions (present in TVs) touch the particular cation

88 **(a,b,d)**
All factual statements

89 **(a,b,c)**
All factual statements

90 **(a,b,c,d)**
All factual statements

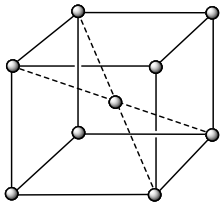
91 **(a,b,d)**
Factual statement

92 **(a,b,c)**
Factual statements

93 **(a,b,d)**
Graphite is a good conductor, sp^2 hybridized, a covalent crystal and crystalline (not amorphous)

94 **(a,b,c,d)**
All factual statements

95 **(b)**
All factual statements

97 **(a,c,d)**

CsCl has body-centered cubic unit cell
Each ion in this structure has a coordination number of 8. In NaCl structure (rock salt structure), chloride ions are arranged in fcc manner, whereas sodium ions occupy edge centers as well as body centers. The ions present on corners, edges, face centers are shared by adjacent unit cells

98 **(b,c,d)**
Factual statements

99 **(a,b,c,d)**
For NaCl, $r_{\oplus}/r_{\ominus} = 0.414 - 0.732$
But radius ratio for LiBr, KCl, RbCl and BaO are 0.34, 0.38, 0.77, and 0.83, respectively, which are not in the range of $0.414 - 0.732$

100 **(a,b,c,d)**
Non-stoichiometric NaCl has F-centers due to anion vacancy defect

101 **(b,d)**
All factual statements

102 **(a,c,d)**
All factual statements

103 **(a,b,c)**
All factual statements

104 **(c,d)**
In both fluorite and antifluorite, 100% TVs are occupied and Z_{eff}(number of formula unit) for both is 4

105 **(a,b,c)**
Number of atoms =4 (for ccp crystal)
Formula $= 4AB_2 = A_4B_8$
$\therefore$ CN of A $= 8$[CNofA =Number of B atoms]
CN of B $= 4$[CN ofB =Number of A atoms]
In ccp arrangement, all TVs are occupied (fluorite-type structure)

106 **(a,b,d)**
In square close packing, CN $= 4$ whereas in hcp, CN(2D) $=$ 6. So, the ratio is
2 : 3

107 **(b,c)**
OVs are formed at the edge center and body center of fcc per unit cell

108 **(a,b,c,d)**

$$Z_{\text{eff}} = \frac{\rho \times a^3 \times 10^{-30} \times N_A}{Mw}$$

$$= \frac{2.75 \times (654)^3 \times 10^{-30} \times 6 \times 10^{23}}{119} = 4$$

$Z_{\text{eff}} = 4$, suggest fcc structure

Thus, there are four KBr units. There are 8 ions at the corners and 6 at the face centers

109 **(a,b,c)**

$r_{\oplus}/r_{\ominus}$=0.732, 0.414, and 0.225 maximum for OV, TV, and triangular void

110 **(a,c)**

1. CN ofZn^{2+}ion in ZnS = 4
2. Number of body diagonal planes in a cube = 6
3. Formula unit is rock salt structure = 4
4. Formula unit in CsCl structure= 1

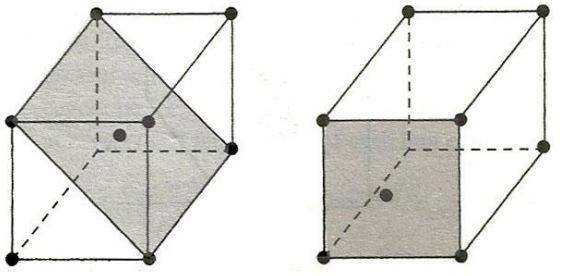
114 **(a,b,c,d)**
Factual statements

115 **(a,b,c,d)**

1. P_1represents one of the close-packed layer having triangular voids only
2. P_2contains location of OVs (edge centers of unit cell)
3. P_3contains 3 OVs locations (one at body center and two at edge center). Also, plane P_3 contains the body diagonals, hence it contains TVs location (TVs lie at body diagonal)

116 **(a,d)**
Use any relation:

122 **(a,d)**



Body-centered cubic
[Central atom touches other four atoms in the shaded plane]

Face-centered cubic
[Central atom touches other four atoms in the shaded plane]

Hence, answer is (a) and (d)

123 **(a,c)**

$$\rho = \frac{Z_{\text{eff}} \times Aw}{N_A \times a^3} \text{ or} \rho = \frac{Z_{\text{eff}} \times Aw \times 1.67 \times 10^{-24}\text{g}}{a^3}$$

$$\therefore 2.72\ \text{g cm}^{-3} = \frac{Z_{\text{eff}} \times 27 \times 1.67 \times 10^{-24}\text{g}}{(404 \times 10^{-10})^3 \text{cm}^3}$$

$\therefore Z_{\text{eff}} \approx 4$

a. $Z_{\text{eff}} = 4$, means fcc structure

d. CN of fcc structure = 12

117 **(a,b,c,d)**
All factual statements

118 **(b,d)**
An octahedron has 8 faces and 12 edges

119 **(a,c)**

$\frac{r_{Cs^{\oplus}}}{r_{Be^{\ominus}}} = \frac{1.69}{1.95} = 0.867$ (bcc structure)

Hence, $Cs^{\oplus}$ ion lies at the "body center of cubic void" where CN of $Cs^{\oplus} = 8$.

CsBr has bcc structure with $Br^{\ominus}$ forming simple cubic lattice and $Cs^{\oplus}$ ion in the void (at body center)

For bcc,

$2(r_{Cs^{\oplus}} + r_{Br^{\ominus}}) = \sqrt{3}a$

$2(1.69 + 1.95) = \sqrt{3}a \Rightarrow a = 4.2$ Å

120 **(a,b)**
OVs are present at edge centers and body center in an fcc unit cell

121 **(a,b)**
Factual statements

The hcp and ccp structures have same CN (12),

same packing fraction (0.74), but different density as the number of atoms as well as the volume of unit cell differ in both

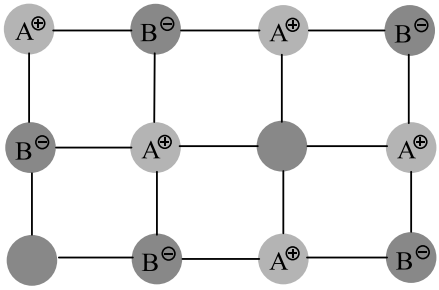
124 **(a,d)**
On a body diagonal, two corner$Cl^{\ominus}$ions and one N

125 **(b,c)**
Two TVs are present on each body diagonal of a fcc unit cell at a distance of $\sqrt{3}a/4$ from each corner

126 **(d)**
Both are facts.

127 **(c)**
Explanation is correct reason for statement.

128 **(a)**



Schottky defect arises when equal number of cations and anions are missing from the lattice

129 **(c)**
(A) is correct but (R) is wrong

Correct(R): For N atoms adoping fcc arrangement, there are $2N$ TVs

130 **(a)**
Same substance adopt different structural arrangements under different conditions, such arrangements are called polymorphic froms. So, diamond and graphite have same molecular formula but different structure. Diamond is tetrahedral and graphite is hexagonal.

131 **(b)**
Assertion is correct

Correct (R): Axial angles are not equal to each other

132 **(c)**
Assertion is correct since higher melting points of covalent crystals are due to network structures

Correct (R): Covalent bonds are weaker than ionic bonds

133 **(c)**
These are the correct facts.

135 **(d)**
Liken quartz and ice, graphite is an example of hexagonal system.

For this $\alpha = \beta = 90°$ and $\gamma = 120°$ and $a = b \neq c$

For a tetragonal system $\alpha = \beta = \gamma = 90°$ and $a = b \neq c$

136 **(c)**
(A) is correct

Correct (R): n stands for negative so electrons are responsible for semiconducting properties

139 **(e)**
Correct (A): Graphite is an example of hexagonal crystal system in which each C-atom is sp^2 hybridized and is linked to three other C-atoms in a hexagonal planer structure

Correct (R): For tetragonal system, $a = b \neq c$and $\alpha = \beta = \gamma = 90°$. For hexagonal systems, $a = b \neq c$and $\alpha = \beta = 90°, \gamma = 120°$

140 **(d)**
Correct(A):$Na^{\oplus}$ ions occupy all OVs but $Cl^{\ominus}$ ions occupy lattice points (corner+ face centers)

(R) is correct; for OV, $r_{\oplus} + r_{\ominus} = 0.414 - 0.732$

141 **(a)**
Glasses are Morphours solid which change their shape on change the melting point. So they do not have the sharp melting point.

142 **(d)**
Both statement and explanation are correct but reason for the statement is different.

144 **(b)**
Correct explanation: $Na^{\oplus}$ ions can be placed only in OVs since TVs are too small to accommodate them

145 **(c)**
The given statement and its explanation are correct.

146 **(b)**
Frenkel defect are commonly found in silver halide Agx. Because Ag^{+}ion is small in size due to this reason, it changes its position to crystal

lattice to interstitial position.

148 **(c)**
Explanation is correct reason for statement

149 **(b)**
Space or crystal lattice is a regular repeating arrangement of point in space and from the basis forms the basis of classification of all structures.

150 **(d)**
Both are facts.

152 **(a)**
In hexagonal close packing voids are triangular voids.

153 **(a)**
Follow text.

154 **(c)**
If $n = 2$ and $\lambda > d$ then $\sin\theta > 1$ which is not possible.

155 **(c)**
Explanation is correct reason for statement.

157 **(a)**
Excess of Na^+ in NaCl solid at F-centres develops yellow colour.

158 **(e)**
Correct (A): OV is larger in size than TV

Correct (R): Cations are generally smaller. They occupy voids instead of lattice points and hence occupy less space

159 **(c)**
Explanation is correct reason for statement.

161 **(e)**
Correct (A): Zinc blende has fcc arrangement of S^{2-}ions while wurtzite has hcp arrangement of S^{2-} ions

Correct (R):A unit cell of zinc blende has 4 formula units while that of wurtzite has 6 formula units of ZnS

162 **(d)**
Correct (A): NaCl and KCl impart yellow and violet colour, respectively

(R) is correct but not correct explanation of (A)

163 **(e)**
Correct (A):hcp and ccp are equally closest packed since space occupied in both = 74%

Correct (R): Both have CN=12

164 **(c)**
Explanation is correct reason for statement.

165 **(d)**
Both statement and explanation are correct but the reason is different.

166 **(a)**
Nacl has fcc structure in which each Na^+ is surrounded by six ions and *vic versa.*In this octahedral arrangement, coordination, number of bothNa^+ and Cl^- is six for which radius ratio lies between 0.414 and 0.732. The radius ratio does not allow Cl^- ions to touch each other.

167 **(c)**
Explanation is correct reason for statement.

168 **(a)**
Packing fraction in fcc = 74%
Packing fraction in bcc = 67.9%

169 **(d)**
Both statement and explanation are correct but reason for the statement is different.

170 **(a)**
(a, b→ r)hcp and ccp, closest packed structure.
Volume occupied = 0.78

Void volume $= 1 - 0.78 = 0.22$

(c → p) For bcc, volume occupied = 0.62

Void volume $= 1 - 0.62 = 0.38$

(d → q) For sc, volume occupied = 0.52

Void volume $= 1 - 0.52 = 0.48$

(e → s) For dc, volume occupied = 0.34

Void volume $= 1 - 0.34 = 0.66$

171 **(b)**
(**a → q**) Defect

(**b →p**) ZnS belongs to cubic system

(**c → s**) Glass and SiO_2 are amorphous solid

(**d → r**) SiO_4 have tetrahedron structure

173 **(a)**
(**a → q**) Intercepts at x, y, z are $1, 1, \infty$

So Miller indices $= \frac{1}{1}, \frac{1}{1}, \frac{1}{\infty} = 1, 1, 0$

(**b → p**) Intercepts at x, y, z are $= 1, \infty, 1$

$\therefore$ Miller indices $= \frac{1}{1}, \frac{1}{\infty}, \frac{1}{1} = 1, 0, 1$

(**c** $\rightarrow$ **s**) Intercepts at x, y, z are $= -1, \infty, 1$

$\therefore$ Miler indices $= -\frac{1}{1}, \frac{1}{\infty}, \frac{1}{1} = \overline{1}, 0, 1$

(**d** $\rightarrow$ **r**) Intercepts at x, y, z are $= \infty, \frac{1}{2}, \frac{1}{2}$

$\therefore$ Miler indices $= \frac{1}{\infty}, \frac{1}{1/2}, \frac{1}{1/2} = (0, 2, 2)$

(**e** $\rightarrow$ **t**) Intercepts at x, y, z are $= \frac{1}{2}, \frac{1}{2}, \infty$

$\therefore$ Miler indices $= \frac{1}{1/2}, \frac{1}{1/2}, \frac{1}{\infty} = 2, 2, 0$

174 **(a)**

(a $\rightarrow$ q, r,s) At body diagonal, two corner ions and one OV (at body center) lies

(b $\rightarrow$ p, r, s)C_4 Axis (tetrad axis) passes through two face-centered ions, body-centered ion (OV)

(c $\rightarrow$r) Rectangular plane passes through 4 face-centered ions, 4 edge-centered ions, body-centered ion

178 **(b)**

(a,b)

a. Ratio of TV/OV occupied in spinel structure

Number of TV occupied $= 1$

Number of OV occupied $= 2$

Ratio $\left(\frac{\text{TV}}{\text{OV}}\right)_{\text{occupied}} = \frac{1}{2} = 1 : 2$

b. Ratio of TV/OV unoccupied in spinel structure

Number of TV unoccupied $= 8 - 1 = 7$

Number of OV unoccupied $= 4 - 2 = 2$

Ratio $\left(\frac{\text{TV}}{\text{OV}}\right)_{\text{unoccupied}} = \frac{7}{2} = 7 : 2$

(c,b)

a. Ratio of TV/OV occupied in inverse spinel structure

179 **(c)**

Face-centered cubic unit cell and a face plane

Number of TV occupied $= 1 + 1 = 2$

Number of OV occupied $= 1$

So, ratio $\left(\frac{\text{TV}}{\text{OV}}\right)_{\text{occupied}} = \frac{2}{1} = 2 : 1$

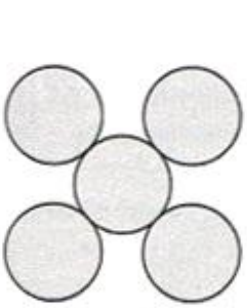
This ratio $\left(\frac{\text{TV}}{\text{OV}}\right)_{\text{occupied}}$ in inverse spinal structure is reverse to that of the spinel structure. Hence, this is called inverse spinel structure

b. Ratio of TV/OV unoccupied in inverse spinel structure

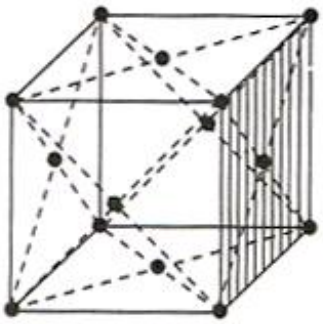
Number of TV unoccupied $= 8 - 2 = 6$

Number of OV unoccupied $= 4 - 1 = 3$

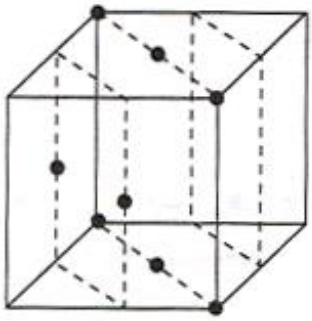
Ratio $\left(\frac{\text{TV}}{\text{OV}}\right)_{\text{unoccupied}} = \frac{6}{3} = 2 : 1$



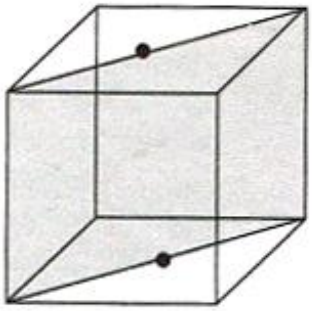
Face plane



Face diagonal plane



Diagonal plane



180 **(a)**

For fcc,

Number of O^{2-} ions $= 8(\text{corners}) \times \frac{1}{8}$per corner share

$+6$ (faces) $\times \frac{1}{2}$per face share$= 4$

Number of Si^{4+} ions $= \frac{1}{4} \times \text{OV} = \frac{1}{4} \times 4 = 1/\text{unit cell}$

Number Fe^{2+} ions $= \frac{1}{4} \times \text{TV} = \frac{1}{4} \times 8 = 2/\text{unit cell}$

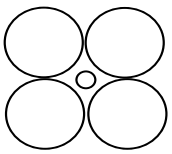
So, formula of "FAYLITE" is $\overset{+2\times2}{Fe_2}\ Si^{4+}O_4^{2-}$

$\Rightarrow Fe_2SiO_4$

181 **(a)**

a. $Y^{\ominus}$ is smaller than $X^{\ominus}$

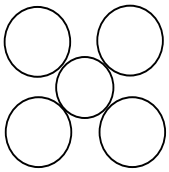
The difference in internucleardistance between AX and BX indicates that the cation must not be touching all the anions in AX (smaller cation, larger anion)



There must be anion-anion contact is this compound

$\therefore$ Anion-anion distance $= 2r_{\ominus}$

The remaining radius ratio is represented in



b. Radius of $X^{\ominus}(r_{\ominus}) = \frac{2.40}{2} = 1.20$ Å

Radius of $B^{\oplus}(r_{\oplus}) = (1.88 - 1.20)$Å $= 0.68$ Å

c. Similarly, radius of $Y^{\ominus}(r_{\ominus}) = (1.48 - 0.68) = 0.80$ Å

Radius of $A^{\oplus}(r_{\oplus}) = (1.15 - 0.80)$Å $= 0.35$ Å

Note: Radius of $A^{\oplus}$ cannot be calculated from the $A^{\oplus} - X^{\ominus}$ distance, sincethere is no cation − anion contact in AX

Radius of $A^{\oplus}$and$B^{\oplus}$, respectively, are $=0.35$ and 0.68 Å

182 **(c)**

The distance 0.204 nm comes out to be "$a/\sqrt{3}$" which corresponds to the perpendicular distance between a corner of unit cell and the plane of the three adjacent corners (Fig. III)

183 **(a)**

AB_2 has bcc structure, A^{2+} possess face centred cubic lattice.

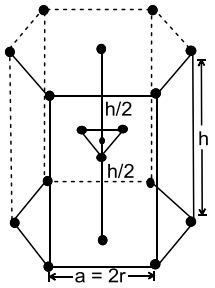
B^- ions occupy all the (100%) tetrahedral voids. Thus each

A^{2+} is in contact with B^- and each B^- with $4A^{2+}$ ions.

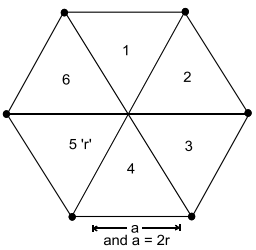
184 **(a)**

In three dimensional closest packing of hcp or ccp (although both are different) only 74% of the available space is occupied by spheres. The remaining 26% space which is vacant, constitutes interstitial voids or interstices sites or interstices. The given packing ($AB\ AB\ AB$ ...)is three dimensional close packing as shown in given figure. In three dimensional close packing three atoms are arranged in the body centred position in such a way, so that it forms equilateral triangle and twelve atoms are places at 12 corners and two atoms at two face centres.

(i) No. of atoms per unit cell $= \frac{1}{6} \times 12 + \frac{1}{2} \times 2 + 3 = 6$



(ii) Thus **coordination number** of three dimensional hcp lattice becomes 12, i.e., 6 from own layer and 3 from above and 3 from lower layer.



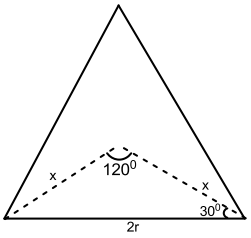
(iii) Base Area (A) of unit cell :

Base area of hcp unit cell is given by :

$$A = 6 \times \frac{\sqrt{3}}{4} \times a^2$$

$$A = \frac{3\sqrt{3}}{2} a^2$$

$$A = \frac{3\sqrt{3}}{2} \times 4r^2 = 6\sqrt{3}\, r^2$$



(iv) Height of unit cell

$$\cos 120^0 = \frac{x^2 + x^2 - (2r)^2}{2x^2}$$

$$\text{or } -\frac{1}{2} = \frac{2x^2 - 4r^2}{2x^2} = \frac{x^2 - 2r^2}{x^2}$$

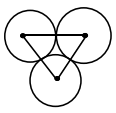
$$\text{or } 3x^2 = 4r^2$$

$$\therefore x = \frac{2r}{\sqrt{3}}$$

$$\text{Now } \left(\frac{h}{2}\right)^2 = a^2 - x^2$$

$$\frac{h^2}{4} = (2r)^2 - \left(\frac{2r}{\sqrt{3}}\right)^2 \text{ or } \frac{h^2}{4} = \frac{8r^2}{3}$$

$$\therefore h^2 = \frac{32r^2}{3} \text{ or h} = 4r \times \sqrt{\frac{2}{3}}$$



(v) Packing fraction : Each corner atom would be common to 6 other unit cell. If r is the radius of each sphere, then

$$\text{Packing fraction} = \frac{6 \times \frac{4}{3}\pi r^2}{v}$$

Where, v = volume of hexagon = Area of base (A) × height (h)

$\therefore$ Packing fraction $= \frac{6 \times \frac{4}{3}\pi r^2}{6 \times \sqrt{3}\, r^2 \times 4r \times \sqrt{\frac{2}{3}}} = \frac{\pi}{3 \times \sqrt{2}}$

$= 0.74$ or 74%

(vi) $V = h \times area = 6\sqrt{3}r^2 \times 4r \times \sqrt{\frac{2}{3}} = 24\sqrt{2}\, r^2$

186 **(8)**

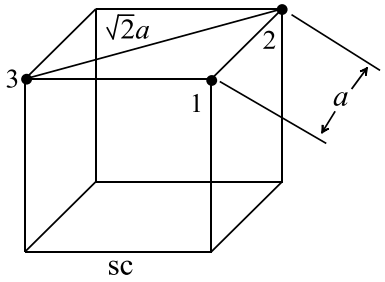
Statements (a), (b), and (d) are correct

a. So total score $= 4 + 3 + 1 = 8$

Nearest neighbour of atom 2 are 1 and 3

Distance between atom 1 and $2 = a$

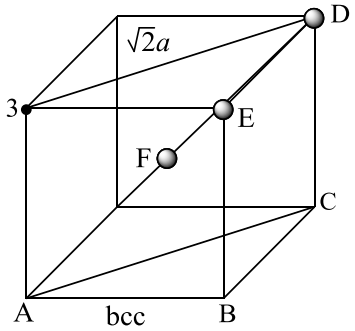
Distance between atom 2 and $3 = \sqrt{2}a$



b. Nearest neighbour of atom D are E and F (F atom is in body center)

body diagonal (AD) $= \frac{\sqrt{3}}{4}a$

Distance DF $= \frac{1}{2}(\text{AD}) = \frac{\sqrt{3}}{2}a$



Distance ED $= a$

c. Option (c) is wrong. ZnS (wurtzite) and ZnS (zinc blende) are polymorphs. Same substance occurring in different crystal forms is called polymorphism

But in both the compounds, cations(Zn^{2+} ions) occupy alternate TVs

In both compounds, S^{2-} occupies lattice points

d. Correct statement

190 **(4)**

a. Number of X atoms $= 8 \times \frac{1}{8} = 1$/unit cell

Number of Y atoms $= 1$/unit cell

Number of O atoms $= 12 \times \frac{1}{4} = 3$/unit cell

Formula is: $XYO_3 \Rightarrow X_aY_bO_c$

b. Number of O atoms missing from two edge centers per unit cell $= 2 \times \frac{1}{4} = \frac{1}{2}$/unit cell

Number of O atoms left $= 3 - \frac{1}{2} = 2.5$/unit cell

Formula is $XYO_{2.5} \Rightarrow X_2Y_2O_5 \Rightarrow X_xY_yO_z$

$\therefore$ The value of

$(x + y + z) - (a + b + c)$

$= (2 + 2 + 5) - (1 + 1 + 3)$

$= 4$

192 **(7)**

For ZnS structure, (Z_{eff} of ZnS $= 4$)

Number of $B^{\ominus} = 4$/unit cell (corner + face center)

Number of $A^{\oplus} = 4$/unit cell (in alternate TVs)

Number of $B^{\ominus}$ ion removed

$= 4$ (Two from each face center) $\times \frac{1}{2}$ (per face center share) $= 2$

Number of $Br^{\ominus}$ ions left $= 4 - 2 = 2$/unit cell

Number of Z^{2-} ions entering in place of $B^{\ominus} = 1$

[To maintain electrical neutrality, 2 $B^{\ominus} = 1\ Z^{2-}$]

Formula $= A_4B_2Z_1$

$\therefore x + y + c = 4 + 2 + 1 = 7$

194 **(13)**

Single unit cell consist of three cubes

Number of Ba^{2+} ions $= 2$ per unit cell

Number of Y^{4+} ions $= 1$ per unit cell

Number of Cu^{2+} ions $= 8$ in each cube at corners)

8×3 (in three cubes) $\times \frac{1}{8}$ (per corner share)

$= 3$/unit cell

Number of O^{2-} ions $= 10$ (at edge center of cube 1) $+ 8$ (at edge center of cube 2) $+ 10$ (at edge center of cube 3)

$= 28$ (edge center) $\times \frac{1}{4}$ (per edge center share)

$= 7$/unit cell

Formula: $Y^{4+}_{(a)}Ba^{2+}_{(b)}Cu^{2+}_{(c)}O^{2-}_{(d)}$

$\Rightarrow Y_1^{4+}Ba_2^{2+}\ Cu_3^{2+}O_7^{2-}$ $\left[\begin{array}{c}\text{Total + ve charge (14)}\\ \text{is equal to total} - \text{ve}\\ \text{charge (14)]}\end{array}\right]$

$\therefore a + b + c + d = 1 + 2 + 3 + 7 = 13$

197 **(7)**

Let radius of hollow sphere B $= r$

$\therefore$ Edge length $(a) = 4r/\sqrt{3}$

Volume of unit cell $= a^3 = \left(4r/\sqrt{3}\right)^2$

Volume of B unoccupied by A (having radius $= r/2$)

In unit cell $= 2 \times \left[\frac{4}{3}\pi r^3 - \frac{4}{3}\pi\left(\frac{r}{2}\right)^3\right]$

$$\therefore \frac{\text{Volume of B unoccupied by A in uni cell}}{\text{Volume of unit cell}} = \frac{\frac{4}{3}\pi \times \frac{7r^3}{8} \times 2}{\left(\frac{4r}{\sqrt{3}}\right)^3}$$

$$= \frac{7\pi\sqrt{3}}{64}$$

$$\therefore A \times \frac{7\pi\sqrt{3}}{64} = \frac{7\pi\sqrt{3}}{64}$$

$$\therefore A = 7$$

198 **(8)**

Diameter of Cs $= 2 \times 2.6 = 5.2$ Å $= 5.2 \times 10^{-8}$cm

Number of atoms in 2.50 cm row $= \frac{2.50}{5.2\times10^{-8}}$

$= 0.48 \times 10^8$

$= 4.8 \times 10^7$ Cs atoms

$\therefore$ Moles of Cs atoms $= \frac{4.8\times10^7}{6\times10^{23}} = 0.8 \times 10^{-16}$

$= 8 \times 10^{-17}$

$\therefore x \times 10^{-17} = 8 \times 10^{-17}$

$\Rightarrow x = 8$

199 **(4)**

Na_2O has fcc structure

$\therefore Z_{\text{eff}} = 4$/unit cell

$\therefore$ Formula $= 4Na_2O = N_8O_4$

$\therefore$ Coordination number of $Na^{\oplus} = 4$

Note: *CN of cation = Number of anions*

CN of anion = Number of cations

Antifluorite-type structures have (4 : 8) CN and $Na^{\oplus}$ ions are in all TVs

200 **(2)**

Void volume $= 0.22$/unit volume of unit cell

$0.11A = 0.22 \Rightarrow A = 2$

202 **(6)**

Statements (a), (b), and (c) are correct

So total score $= 1 + 2 + 3 = 6$

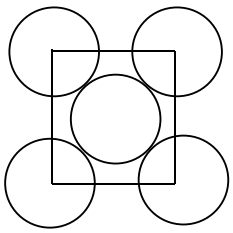
Statement (a, b) are factual

Statement (c): $\frac{r_{\oplus}}{r_{\ominus}} = \frac{0.35}{0.95} = 0.368$

The radius ratio lies in the range of $0.225 - 0.414$, which corresponds to TV and the CN of TV $= 4$

204 **(2)**

Consider one face of unit cell as shown below



Number of atoms on one face

$= 4$ (corners) $\times \frac{1}{8}$(Per corner share) $+ 1$(face center) $\times \frac{1}{2}$ (face center share)

$= \frac{1}{2} + \frac{1}{2} = 1$/per face

Given number of atoms on all faces $= 6 \times 10^{30}$

Given number of atoms on one face $= \frac{1}{6} \times 6 \times 10^{30}$

$= 10^{30}$ atoms

Number of unit cells at one face of crystal

$= \frac{6 \times 10^{30}}{6} = 10^{30}$

So, number of unit cells at the edge of crystal

$= \sqrt{10^{30}}$

$= 10^{15}$

Now, edge length of unit cell $= \frac{4}{\sqrt{2}} \times 50$ nm

Edge length of cubical crystal $= \frac{4}{\sqrt{2}} \times 50 \times 10^{15}$nm

So, area of face of crystal $= \left(\frac{4}{\sqrt{2}} \times 50 \times 10152\right)$nm2

$= \frac{16}{2} \times 25 \times 10^2 \times 10^{30}$

$= 2 \times 10^{34}\text{nm}^2$

$= 2 \times 10^{-18+34}\text{m}^2$

$= 2 \times 10^{16}\text{m}^2$

$\therefore A \times 10^{16}\text{m}^2 = 2 \times 10^{16}\text{m}^2$

$A = 2$