THE SOLID STATE

CHEMISTRY

Single Correct Answer Type

1. Schottky defect generally appears in
   a) NaCl b) KCl c) CsCl d) All of these
2. Which arrangement of electrons leads ferromagnetism?
   a) ↑↑↑↑ b) ↑↓↑↓ c) ↑↑↑↓↓ d) None of these
3. The crystal are bounded by plane faces (f), straight edges (e) and interfacial angel (c). The relationship between these is :
   a) $f + c = e + 2$ b) $f + e = c + 2$ c) $c + e = f + 2$ d) None of these
4. The melting point of RbBr is 682°C, while that of NaF is 988°C. The principle reason that melting point of NaF is much higher than that of RbBr is that :
   a) The two crystals are not isomorphous
   b) The molar mass of NaF is smaller than that of RbBr
   c) The internuclear distance $r_c + r_a$ is greater for RbBr than for NaF
   d) The bond is RbBr has more covalent character than the bond in NaF.
5. If a crystal lattice of a compound, each corner of a cube is enjoyed by sodium, each edge of a cube has oxygen and centre of a cube is enjoyed by tungsten (W), then give its formula
   a) Na_2WO_4 b) $NaWO_3$ c) Na_3WO_3 d) Na_2WO_3
6. In antifluorite structure, the negative ions:
   a) Occupy tetrahedral voids
   b) Occupy octahedral voids
   c) Are arranged in ccp
   d) Are arranged in hcp
7. An insulator oxide is :
   a) CuO b) C_OO c) Fe_2O_3 d) All of these
8. A solid with high electrical and thermal conductivity from the following is :
   a) Si b) Li c) NaCl d) ice
9. The radius ratio $\left(\frac{r_+}{r_-}\right)$ of an ionic solid (A^+B^-) is 0.69. What is the coordination number of B^-?
   a) 6 b) 8 c) 2 d) 10
10. The axial angles in triclinic crystal system are
    a) $\alpha = \beta = \gamma = 90°$ b) $\alpha = \gamma = 90°, \beta \neq 90°$ c) $\alpha \neq \beta \neq \gamma \neq 90°$ d) $\alpha = \beta = \gamma \neq 90°$
11. In NaCl crystal each Cl^- ion is surrounded by
    a) 4 Na^+ ions b) 6 Na^+ ions c) 1 Na^+ ion d) 2 Na^+ ions
12. For an ionic crystal of the general formula A^+B^- and co-ordination number 6, the radius ration will be :
    a) Greater than 0.73
    b) Between 0.73 and 0.41
    c) Between 0.41 and 0.22
    d) Less than 0.22
13. The ratio of cations to anion in a octahedral close packing is :
    a) 0.414 b) 0.225 c) 0.02 d) None of these
14. Electrons in a paramagnetic compound are
    a) Shared b) Unpaired c) Donated d) Paired
15. Crystals which are good conductor of electricity and heat are known as :
    a) Ionic crystals b) Covalent crystals c) Metallic crystals d) Molecular crystal
16. An element has bcc structure having unit cells 12.08×10^{23}. The number of atoms in these cells is :

a) 12.08×10^{23} b) 24.16×10^{23} c) 48.38×10^{23} d) 12.08×10^{22}

17. Among the following types of voids, which one is the largest void?
a) Triangular b) Cubic c) Tetrahedral d) Octahedral

18. The crystalline structure of NaCl is
a) Hexagonal close packing b) Face centred cubic
c) Square planar d) Body centred cubic

19. Metals have conductivity of the order of (ohm^{-1} cm^{-1}) :
a) 10^{12} b) 10^{8} c) 10^{2} d) 10^{-6}

20. Of the elements Sr, Zr, Mo, Cd and Sb, all of which are in V period, the paramagnetics are:
a) Se, Cd and Sb b) Zr, Mo and Cd c) Sr, Zr and Cd d) Zr, Mo and Sb

21. The radius ratio of CsCl is 0.93. The expected lattice structure is
a) Tetrahedral b) Square planar c) Octahedral d) Body centred cubic

22. Which one of the following defects in the crystals lowers its density?
a) Frenkel defect b) Schottky defect c) F-centres d) Interstitial defect

23. The yellow colour of ZnO and conducting nature produced in heating is due to:
a) Metal excess defects due to interstitial cation
b) Extra positive ions present in an interstitial site
c) Trapped electrons
d) All of the above

24. A metal has bcc structure and the edge length of its unit cell is 3.04 Å. The volume of the unit cell in cm^3 will be
a) 1.6×10^{-21} cm^3 b) 2.81×10^{-23} cm^3 c) 6.02×10^{-23} cm^3 d) 6.6×10^{-24} cm^3

25. The edge length of a face centred cubic cell of an ionic substance is 508 pm. If the radius of the cation is 110 pm, the radius of the anions is
a) 288 pm b) 398 pm c) 618 pm d) 144 pm

26. An ionic compound is expected to have tetrahedral structure if r_+/r_- lies in the range of
a) 0.414 to 0.732 b) 0.225 to 0.414 c) 0.155 to 0.225 d) 0.732 to 1

27. The interparticle forces in solid hydrogen are :
a) Hydrogen bonds b) Covalent bonds c) Co-ordinate bonds d) Van der Waals' forces

28. If Z is the number of atoms in the unit cell that represents the closest packing sequence $-ABC\ ABC\ -$, the number of tetrahedral voids in the unit cell is equal to :
a) Z b) 2Z c) $\frac{Z}{2}$ d) $\frac{Z}{4}$

29. Quartz is an example of :
a) Chain silicate b) Infinite sheet silicate c) Framework silicate d) Cyclic silicate

30. For AX ionic crystal to exist in bcc structure, the ratio of radii $\left(\frac{r_{cation}}{r_{anions}}\right)$ should be
a) Between 0.41 and 0.73 b) Greater then 0.73
c) Less than 0.41 d) Equal to 1.0

31. Which crystal is expected to be soft and have low melting point?
a) Covalent b) Metallic c) Molecular d) Ionic

32. The elements commonly used for making transistors are
a) C and Si b) Ga and In c) P and As d) Si and Ge

33. 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

34. The first order reflection ($n = 1$) from a crystal of the X-ray from a copper anode tube $(\lambda = 1.54$ Å$)$occurs at an angle of 45°. What is the distance between the set of plane causing the diffraction?
a) 0.1089 nm b) 0.1089 m c) 0.905 Å d) 1.089×10^{-9}m

35. What is the number of tetrahedral voids per atom in a crystal?
a) 1 b) 2 c) 6 d) 8

36. Iodine is a
a) Electrovalent solid b) Atomic solid c) Molecular solid d) Covalent solid

37. In CsCl type structure the coordination number of $Cs^+$and Cl^- are
a) 6, 6 b) 6, 8 c) 8, 8 d) 8, 6

38. Structure of a mixed oxide is cubic close-packed (c.c.p). The cubic unit cell of mixed oxide is composed of oxide ions. One fourth of the tetrahedral voids are occupied by divalent metal A and the octahedral voids are occupied by a monovalent metal B. The formula of the oxide is :
a) $AB\ O_2$ b) A_2BO_2 c) $A_2B_3O_4$ d) AB_2O_2

39. The example of orthosilicate is :
a) $MgCaSi_2O_6$ b) Mg_2SiO_4 c) $Fe_2O_3SiO_2$ d) $Ba_3Al_2Si_6O_8$

40. A compound CuCl has face centred cubic structure. Its density is 3.4 g cm^{-3}. The length of unit cell is :
a) 5.783Å b) 6.783Å c) 7.783Å d) 8.783Å

41. The orthorhombic, the value of a, $b$and $c$are respectively 4.2 Å, 6.8A Å and 8.3 Å. Given the molecular mass of the solute is 155 g mol^{-1} and that of density is 3.3g/cc, the number of formula units per unit cell is
a) 2 b) 3 c) 4 d) 6

42. Which one of the following is a covalent crystal?
a) Rock salt b) Ice c) Quartz d) Dry ice

43. LiF is a/an :
a) Ionic crystal b) Metallic crystal c) Covalent crystal d) Molecular crystals

44. A binary solid (A^+B^-) has a rock salt structure. If the edge length is 400 pm and radius of cation is 75 pm the radius of anion is :
a) 100 pm b) 125 pm c) 250 pm d) 325 pm

45. The limiting radius ratio for tetrahedral shape is
a) 0 to 0.155 b) 0.255 to 0.414 c) 0.155 to 0.225 d) 0.414 to 0.732

46. A metallic element has a cubic lattice. Each edge of the unit of cell is 2Å. The density of the metal is 2.5 g cm^{-3}. The unit cells in 200 g of metal are
a) 1×10^{24} b) 1×10^{20} c) 1×10^{22} d) 1×10^{25}

47. Potassium has a bcc structure with nearest neighbour distance 4.52 Å. Its atomic weight is 39. Its density will be :
a) 454 kg m^{-3} b) 804 kg m^{-3} c) 852 kg m^{-3} d) 910 kg m^{-3}

48. Lithium forms body centred cube structure. The length of the side of its unit cell is 351 pm. Atomic radius of the lithium will be :
a) 300 pm b) 240 pm c) 152 pm d) 75 pm

49. Bragg's equation is :
a) $n\lambda = 2\theta \sin\theta$ b) $n\lambda = 2d \sin\theta$ c) $2n\lambda = d \sin\theta$ d) $\lambda = (2d/n) \sin\theta$

50. The intermetallic compound LiAg has a cubic crystalline structure in which each Li atom has 8 nearest neighbor silver atoms and $vice - versa$. What is the type of unit cell?
a) Body centred cubic
b) Face centred cubic
c) Simple cubic for either Li atoms alone or Ag atoms alone
d) None of the above

51. In the face centred cubic lattice, atom A occupies the corner positions and atom B occupies the face centre positions. If one atom of B is missing from one of the face centred points, the formula of the compound is
a) A_2B b) AB_2 c) A_2B_2 d) A_2B_5

52. Which compound has highest lattice energy?
a) LiBr b) LiCl c) LiI d) LiF

53. In a face centred cubic cell, an atom at the face centre is shared by :
a) 4 unit cells b) 2 unit cells c) 1 unit cell d) 6 unit cells

54. Extremely pure samples of Ge and Si are non-conductors, but their conductivity increases suddenly on introducing ….in their crystal lattice.

a) As b) B c) Both (a) and (b) d) None of these

55. Iodine crystals are :
a) Metallic solid b) Ionic solid c) Molecular solid d) Covalent solid

56. Which of the following statements about amorphous solids is incorrect?
a) They melt over a range of temperature b) They are anisotropic
c) There is no orderly arrangement of particles d) They are rigid and incompressible

57. The number of atoms present in a simple cubic unit cell are :
a) 4 b) 3 c) 2 d) 1

58. An AB_2 type structure is found in :
a) NaCl b) CaF_2 c) Al_2O_3 d) N_2O

59. A cubic crystal possesses in all ……elements of symmetry.
a) 9 b) 13 c) 1 d) 23

60. A solid compound contains X, Y and Z atoms in a cubic lattice with X atom occupying the corners. Y atoms in the body centred positions and Z atoms at the centres of faces of the unit cell. What is the empirical formula of the compound?
a) XY_2Z_3 b) XYZ_3 c) $X_2Y_2Z_3$ d) X_8YZ_6

61. The oxide which shows transition from metal to insulation, *i.e.*, semiconductors are :
a) V_2O_3 b) VO_2 c) Ti_2O_3 d) All of these

62. Edge length of a cube is 400 pm. Its body diagonal would be :
a) 600 pm b) 566 pm c) 693 pm d) 500 pm

63. Crystals can be classified into ……. Basic crystal habits.
a) 7 b) 4 c) 14 d) 3

64. The unit cell with crystallographic dimensions $a = b \neq c$; $\alpha = \beta = \gamma = 90^0$ is :
a) Cubic b) Tetragonal c) Monoclinic d) Hexagonal

65. The number of octahedral void(s) per atom present in a cubic close-packed structure is :
a) 2 b) 4 c) 1 d) 3

66. The hardness of metals increases with increase in number of ……involved in metallic bonding.
a) Atoms b) Molecules c) Electrons d) All of these

67. The substance which possesses zero resistance as 0 K :
a) Conductor b) Super conductor c) Insulator d) Semiconductor

68. Sodium metal crystallises at room temperature in a body centred cubic lattice with a cell edge $a = 4.29$ Å. The radius of sodium atom is
a) 1.40 b) 2.65 c) 1.85 d) 2.15

69. The oxide which shows metallic conduction:
a) ReO_3 b) VO c) CrO_2 d) All of these

70. The number of hexagonal faces that are present in a truncated octahedron is
a) 2 b) 4 c) 6 d) 8

71. Which of the following statement is true?
a) Some complex metal oxides behave as superconductor
b) Zinc oxide can act as superconductor
c) An impurity of tetravalent germanium in trivalent gallium creates electron deficiency
d) A Frenkel defect is formed when an ion is displaced from its lattice site to an interstitial site

72. Schottky defect defines imperfection in the lattice structure of a :
a) Solid b) Gas c) Liquid d) Plasma

73. When electrons are trapped into the crystal in anion vacancy, the defect is known as :
a) Schottky defect b) Frenkel defect c) Stoichiometric defect d) F-centres

74. Which of the following has highest value of energy gap?
a) Aluminum b) Silver c) Germanium d) Diamond

75. If 'a' stands for the edge length of the cubic systems : simple cubic, body-centred cubic and face-centered, then the ratio of radii of the spheres in these systems will be respectively,

a) $\frac{1}{2}a:\sqrt{3}\,a:\frac{1}{\sqrt{2}}\,a$ b) $\frac{1}{2}a:\frac{\sqrt{3}}{2}\,a:\frac{\sqrt{2}}{2}\,a$ c) $\frac{1}{2}a:\sqrt{3}a:\sqrt{2}a$ d) $\frac{1}{2}a:\frac{\sqrt{3}}{4}\,a:\frac{1}{2\sqrt{2}}\,a$

76. In a face centred cubic lattice the number of nearest neighbours for a given lattice point are :
a) 6 b) 8 c) 12 d) 14

77. Percentage of free space in cubic close packed structure and in body centred packed structure are respectively
a) 30% and 26% b) 26% and 32% c) 32% and 48% d) 48% and 26%

78. Lithium borohydride crystallizes in an orthorhombic system with 4 molecule per unit cell. The unit cell dimensions are $a = 6.8$ Å, $b = 4.4$ Å and $c = 7.2$ Å. If the molar mass is 21.76, then the density of crystals is :
a) 0.6708 g cm^{-3} b) 1.6708 g cm^{-3} c) 2.6708 g cm^{-3} d) None of these

79. Total volume of atoms present in a face centred cubic unit cell of a metal is (r=atomic radius)
a) $\frac{20}{3}\pi r^3$ b) $\frac{24}{3}\pi r^3$ c) $\frac{12}{3}\pi r^3$ d) $\frac{16}{3}\pi r^3$

80. Which has no rotation of symmetry?
a) Hexagonal b) Orthorhombic c) Cubic d) Triclinic

81. The unit cell with dimensions $\alpha = \beta = \gamma = 90°, a = b \neq c$ is
a) Cubic b) Triclinic c) Hexagonal d) Tetragonal

82. A fcc element (atomic mass = 60) has a cell edge of 400 pm. Its density is :
a) 6.23 g cm^{-3} b) 6.43 g cm^{-3} c) 6.53 g cm^{-3} d) 6.63 g cm^{-3}

83. For a crystal system $a = b = c$ and $\alpha = \beta = \gamma \neq 90°$
a) Tetragonal b) Hexagonal c) Rhombohedral d) Monoclinic

84. The number of atoms (n) contained within a cubic cell is :
a) 1 b) 2 c) 3 d) 4

85. All the substances becomes diamagnetic at :
a) 4 K b) 10 K c) 20 K d) 25 K

86. The co-ordination number of Ca^{2+} ion in fluorite crystal is :
a) 2 b) 8 c) 6 d) 4

87. What is the structure of NaCl?
a) BCC b) FCC c) Interpenetrating fcc d) None of these

88. Which of the following statements is not correct?
a) Molecular solids are generally volatile
b) The number of carbon atoms in an unit cell of diamond is 4
c) The number of Bravais lattices in which a crystal can be categorized is 14
d) The fraction of the total volume occupied by the atoms in a primitive cell is 0.48.

89. Which is the wrong statement regarding a crystal containing Schottky defect?
a) Electrical neutrality of the crystal is maintained
b) Entropy of the crystal increases
c) The density of the overall crystal remains the same
d) The density of the overall crystal reduces

90. How many 'nearest' and 'next nearest' neighbours respectively potassium have in bcc lattice?
a) 8, 8 b) 8, 6 c) 6, 8 d) 8, 2

91. Ferrimagnetic is converted into paramagnetic at :
a) 300 K b) 400 K c) 600 K d) 850 K

92. A match box exhibits :
a) Cubic geometry
b) Monoclinic geometry
c) Orthorhombic geometry
d) Tetragonal geometry

93. The oxide that possesses electrical conductivity :
a) V_2O_5 b) CrO_2 c) NiO d) MnO

94. The arrangement $ABC\ ABC$……is referred to as,
a) Octahedral close packing
b) Hexagonal close packing
c) Tetrahedral close packing
d) Cubic close packing

95. The lattice points of a crystal of hydrogen iodide are occupied by
a) HI molecules b) H atoms and I atoms
c) H^+ cations and I^- anions d) H_2molecules and I_2molecules

96. A metal crystallises in a bcc lattice. Its unit cell edge length is about 300 pm and its molar mass about 50 g mol^{-1}. What would be the density of the metal(in g cm^{-3})?
a) 3.1 b) 6.2 c) 9.3 d) 12.4

97. The radius of the Na^+ is 95 pm and that of Cl^- ion is 181 pm. Predict the co-ordination number of Na^+ :
a) 4 b) 6 c) 8 d) Unpredictable

98. How many unit cells are present in a cube shaped ideal crystal of NaCl of mass 1.00g?
[Atomic masses : $Na = 23, Cl = 35.5$]
a) 2.57×10^{21} b) 5.14×10^{21} c) 1.28×10^{21} d) 1.71×10^{21}

99. For a covalent solid, the units which occupy lattice points are :
a) Atoms b) Ions c) Molecules d) Electrons

100. The metal surfaces are excellent reflectors because of absorption and re-emission of light by :
a) Protons in atom b) Electrons in atom c) Neutrons in atom d) None of these

101. The fraction of total volume occupies by the atoms present in a simple cube is :
a) $\frac{\pi}{3\sqrt{2}}$ b) $\frac{\pi}{4\sqrt{2}}$ c) $\frac{\pi}{4}$ d) $\frac{\pi}{6}$

102. If we mix a pentavalent impurity in a crystal lattice of germanium, what type of semiconductor formation will occur?
a) p −type b) n −type c) Both (a) and (b) d) None of the two

103. A metal crystallizes with a face-centered cubic lattice. The edge of the unit cell is 408 pm. The diameter of the metal atom is :
a) 144 pm b) 204 pm c) 288 pm d) 408 pm

104. Metallic crystalline solids :
a) Have low melting point and boiling point
b) Are bad conductors
c) Are good conductors of heat and electricity
d) Only conduct heat

105. Most crystals show good cleavage because their atoms, ions and molecules are:
a) Weakly bonded together
b) Strongly bonded together
c) Spherically symmetrical
d) Arranged in planes

106. The structure of MgO is similar to NaCl. The co-ordination number of Mg is :
a) 2 b) 6 c) 4 d) 8

107. If NaCl is dopped with 10^{-4} mole % of $SrCl_2$ the concentration of cation vacancies will be:
a) 6.02 x 10^{16} mol^{-1} b) 6.02 x 10^{17} mol^{-1} c) 6.02 x 10^{14} mol^{-1} d) 6.02 x 10^{15} mol^{-1}

108. What type of crystal defect is indicated in the diagram below?

Na^+, Cl^-, Na^+, Cl^-,Na^+,Cl^-

Cl^- Cl^- Na^+ Na^+

Na^+ Cl^- Cl^-, Na^+ Cl^-

$Cl^-Na^+Cl^-Na^+$ Na^+

a) Frenkel defect b) Schottky defect
c) Interstitial defect d) Frenkel and Schottky defects

109. An ion leaves its regular site occupy a position in the space between the lattice sites is called
a) Frenkel defect b) Schottky defect c) Impurity defect d) Vacancy defect

110. Schottky defects occurs mainly in electrovalent compounds where
a) Positive ions and negative ions are of different size
b) Positive ions and negative ions are of same size
c) Positive ions are small and negative ions are big
d) Positive ions are big and negative ions are small

111. Sodium metal crystallizes in a body centred cubic lattice with the cell edge $a = 4.29$ Å. The radius of sodium atom is :
a) 1.8574 Å b) 2.8574 Å c) 3.8574 Å d) None of these

112. The cation-anion bond have the largest amount of covalent character for:
a) NaBr b) SrS c) CdS d) BaO

113. In a cubic close packing of spheres in three dimensions, the co-ordination number of each sphere is :
a) 6 b) 9 c) 3 d) 12

114. In a cubic structure of diamond which is made from $X$and Y, where Xatoms are at the corners of the cube and Yat the face centres of the cube. The molecular formula of the compound is
a) X_2Y b) X_3Y c) XY_2 d) XY_3

115. Which of the following statements is not correct?
a) The units of surface tension are dynes Cm^{-1}
b) The units of viscosity coefficient of a liquid are 'poise '
c) CsCl crystallizes in body centred cubic type of lattice
d) The coordination number of S^{2-} in ZnS is 6

116. The ability of a given substance to assume two or more crystalline structure is called
a) Amorphism b) Isomorphism c) Polymorphism d) Isomerism

117. With which one of the following element silicon should be doped so as to give p-type semiconductor?
a) As b) Se c) B d) Ge

118. If the radius of K^+ and F^- are 133 pm and 136 pm respectively, the distance between K^+ and F^- in KF is
a) 269 pm b) 134.5 pm c) 136 pm d) 3 pm

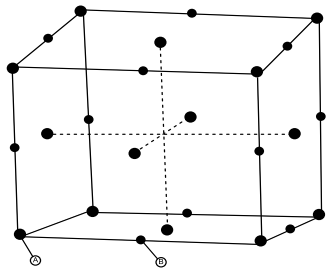
119. Copper crystallises in fcc with a unit cell length of 361 pm. What is the radius of copper atom?
a) 108 pm b) 127 pm c) 157 pm d) 181 pm

120. Which species is paramagnetic?
a) NO b) Fe^{3+} c) Fe^{2+} d) All are correct

121. Density of a crystal remains unchanged as a result of
a) Ionic defect b) Schottky defect c) Frenkel defect d) Crystal defect

122. A metallic element crystallises into lattice containing a sequence of layers of $ABABABAB$..... Any packing of spheres leaves out void in the lattice. The empty space in percentage by volume in this lattice is :
a) 26% b) 32% c) 20% d) 30%

123. For a solid with the following structure, the co-ordination number of the point B is :



a) 3 b) 4 c) 5 d) 6

124. The phenomenon in which crystals on subjecting to a pressure or mechanical stress produce electricity is called :
a) Pyro-electricity b) Piezo-electric effect c) Ferro-electricity d) Ferri-electricity

125. Which arrangement of electron decides ferrimagnetism?
a) ↑↑↑↑↑ b) ↑↓↑↓ c) ↑↑↑↓↓ d) None of these

126. The 8 : 8 type of packing is present in
a) MgF_2 b) CsCl c) KCl d) NaCl

127. Which is not the correct statement for ionic solids in which positive and negative ions are held by strong electrostatic attractive forces?
a) The radius r^+/r^- increases as coordination number increases
b) As the difference in size of ions increases, coordination number increases
c) When coordination number is eight, the r^+/r^- ratio lies between 0.225 to 0.414
d) In ionic solid of the type AX(ZnS, Wurtzite), the coordination number of Zn^{2+}andS^{2-} respectively are 4 and 4

128. Which set of characteristics of ZnS crystal is correct?
a) Coordination number (4 : 4): ccp; Zn^{2+} ion in the alternate tetrahedral voids
b) Coordination number (6 : 6); hcp; Zn^{2+} ion in all tetrahedral voids
c) Coordination number (6 : 4); hcp; Zn^{2+} ion in all octahedral voids
d) Coordination number (4 : 4); ccp; Zn^{2+} ion in all tetrahedral voids

129. NaCl structure consists of :
a) Na and Cl atoms
b) Na^+ and Cl atoms
c) Na atoms and Cl^- ions
d) Na^+ and Cl^- ions

130. A solid metal has ccp or fcc structure. The relation of side of cube $(a)$and radius of atom (r) will be
a) $a = 2r$ b) $a = 2\sqrt{2}r$ c) $a = \frac{4}{\sqrt{3}}r$ d) $a = \sqrt{\frac{3}{2}}r$

131. A solid X melts slightly above 273 K and is a poor conductor of heat and electricity. To which of the following categories does it belong?
a) Ionic solid b) Covalent solid c) Metallic d) Molecular

132. Lubricating properties of graphite are diminished in presence of :
a) High pressure b) Low pressure c) Vacuum d) None of these

133. Lithium metal crystallises in a body centred cubic crystal. If the length of the side of the unit cell of lithium is 351 pm, the atomic radius of the lithium will be :
a) 300.5 pm b) 240.8 pm c) 151.8 pm d) 75.5 pm

134. Close packing is maximum in the crystal lattice of :
a) Simple cubic b) Face centred c) Body centred d) None of these

135. The radii of $Na^+$and Cl^- ions are 95 pm and 181 pm respectively. The edge length of NaCl unit cell is
a) 276 pm b) 138 pm c) 552 pm d) 415 pm

136. The ionic radii of Rb^+ and I^- are 1.46 Å and 2.16 Å. The most probable type of structure exhibited by it is
a) CsCl type b) ZnS type c) NaCl type d) CaF_2 type

137. Which one is diamagnetic?

a) ClO_3 b) Cu^{2+} c) F^- d) Ni^{2+}

138. The statement that "All crystals of the same substance possess the same elements of symmetry" is known as :
   a) Hauy's law of rationality of indices
   b) The law of constancy of interfacial angles
   c) The law of constancy of symmetry
   d) None of the above

139. A solid AB has NaCl type structure with edge length 580.4 pm. The radius of A^+ is 100 pm. What is the radius of B^- ?
   a) 190.2 b) 540.13 c) 525 d) 78.12

140. In a face centred cubic arrangement off A and B atoms whose A atoms are at the corner of the unit cell and B atoms at the face centres. One of the A atom is missing from one corner in unit cell. The simplest formula of compound is :
   a) A_7B_3 b) AB_3 c) A_7B_{24} d) $A_{7/8}B_3$

141. Which one of the following is a covalent crystal?
   a) Rock salt b) Ice c) Quartz d) Dry ice

142. The coordination number of Al in the crystalline state of $AlCl_3$is
   a) 2 b) 4 c) 6 d) 8

143. In crystal structure of rock salt (NaCl), the arrangement of Cl ion is :
   a) Fcc b) Bcc c) Both (a) and (b) d) None of these

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

145. A compound of 'A' and 'B' crystallises in a cubic lattice in which 'A' atoms occupy the lattice points at the corners of the cube. The 'B' atoms occupy the centre of each face of the cube. The probable empirical formula of the compound is
   a) AB_2 b) A_3B c) AB d) AB_3

146. Amorphous solids:
   a) Possess sharp melting points
   b) Undergo clean cleavage when cut with knife
   c) Do not undergo clean cleavage when cut with knife
   d) Possess orderly arrangement over long distances

147. For which crystal anion-anion contact is valid?
   a) NaF b) NaI c) CsBr d) KCl

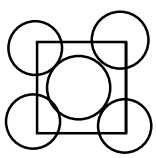
148. The crystal system of a compound with unit cell dimensions $a = 0.387, b = 0.387,$ and $c = 0.504$ nm and $\alpha = \beta = 90°$ and $\gamma = 120°$ is :
   a) Cubic b) Hexagonal c) Orthorhombic d) Rhombohedral

149. Possible number of different type of crystal lattice present in all types of crystals, is
   a) 23 b) 7 c) 230 d) 14

150. Doping of silicon (Si) with boron (B) leads to
   a) n –type semiconductor b) p –type semiconductor
   c) Metal d) Insulator

151. AB crystallises in a bcc lattice with edge length 'a' equal to 387 pm. The distance between two oppositely charged ions in the lattice is :
   a) 335 pm b) 250 pm c) 200 pm d) 300 pm

152. 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%

153. Which is an example of ferroelectric compound?
a) Quartz b) $PbCrO_4$ c) Barium titanate d) None of these

154. An increase in the charge of the positive ions that occupy lattice positions brings in a /an ….in metallic bonding.
a) increase
b) Decrease
c) Neither increase nor decrease
d) Either increase or decrease

155. In a crystal, the atoms are located at the position of …….potential energy.
a) Zero b) Infinite c) Minimum d) Maximum

156. Solids are characterised by their properties :
a) Incompressibility b) Mechanical strength c) Crystalling nature d) All of these

157. Arrangement of sulphide ions in zinc blende is
a) Simple cubic b) hcp c) bcc d) fcc

158. ZnS is :
a) Ionic crystal b) Covalent crystal c) Metallic crystal d) Van der Walls' crystal

159. Which substance shows antiferromagnetism?
a) ZrO_2 b) CdO c) CrO_2 d) Mn_2O_3

160. The appearance of colour in solid alkali metal halide is generally due to:
a) Frenkel defect b) Interstitial position c) F-centres d) Schottky defect

161. In a cubic close packing of spheres in three dimensions, the co-ordination number of each sphere is :
a) 6 b) 9 c) 3 d) 12

162. High thermal conductivity of metals is due to transfer of heat through :
a) Molecule collisions b) Electronic collisions c) Atomic collisions d) All of these

163. A solid having definite geometrical shape with flat faces and sharp edges is :
a) Amorphous solid b) Crystalline solid c) Isotropic solid d) None of these

164. If the positions of Na^+ and Cl^- are interchanges in NaCl, the crystal lattice with respect to Na^+ and Cl^- is :
a) Both fcc b) Both bcc c) Fcc and bcc d) Bcc and fcc

165. Which kind of defect is shown by the given crystal?
K^+ Cl^- K^+ Cl^- K^+ Cl^-
Cl^- □ Cl^- K^+ □ K^+
K^+ Cl^- □ Cl^- K^+ Cl^-
Cl^- K^+ Cl^- K^+ □ K^+
a) Schottky defect b) Frenkel defect
c) Schottky and Frenkel defects d) Substitution disorder

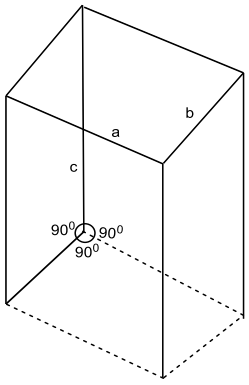
166. An alloy of copper, silver and gold is found to have copper constituting the ccp lattice. If silver atoms occupy the edge centres and gold is present at body centre, the alloy has a formula
a) Cu Ag Au b) Cu_4 Ag_2 Au c) Cu_4 Ag_3 Au d) Cu_4 Ag_4 Au

167. The structure of CsCl crystal is :
a) Body centred cubic lattice
b) Face centred cubic lattice
c) Octahedral lattice
d) None of the abve

168. The pure crystalline substance on being heated gradually first forms a turbid liquid at constant temperature and still at higher temperature turbidity completely disappears. The behavior is a characteristic of substance forming :
a) Allotropic crystal b) Liquid crystals c) Isomeric crystals d) Isomorphous crystals

169. Molecular crystals exist in :
a) Crystalline state b) Amorphous state c) Non-crystalline state d) All of these

170. The unit cell with the structure below refers to……crystal system.



a) Cubic b) Orthorhombic c) Tetragonal d) Trigonal

171. CsBr crystallises in a body centred cubic lattice. The unit cell length is 436.6 pm. Given that the atomic mass of Cs = 133 and that of Br = 80 amu and Avogadro number being 6.02×10^{23} mol^{-1}, the density of CsBr is :
a) 8.25 g/cm^3 b) 4.25 g/cm^3 c) 42.5 g/cm^3 d) 0.425 g/cm^3
172. 8 : 8 co-ordination of CsCl is found to change into 6 : 6 co-ordination on :
a) Applying pressure
b) Increasing temperature
c) Both (a) and (b)
d) None of these
173. Which element is used for making a transistor?
a) Sn b) Sb c) Si d) Mg
174. KCl crystallises in the same type of lattice as dose NaCl. Given that $r_{Na^+}/r_{Cl^-} = 0.55$ and $r_{K^+}/r_{Cl^-} = 0.74$. Calculate the ratio of the side of the unit cell for KCl to that of NaCl.
a) 1.123 b) 0.0891 c) 1.414 d) 0.414
175. The number of atoms (n) contained within a fcc cell is:
a) 1 b) 2 c) 3 d) 4
176. For a crystal, the angle of diffraction ($2.\theta$) is 90°and the second order line has a d value of 2.28 Å. The wavelength (in Å) of X-rays used for Bragg's diffraction is
a) 1.612 b) 2.00 c) 2.28 d) 4.00
177. Wax is an example of :
a) Ionic crystal b) Covalent crystal c) Molecular crystal d) Metallic crystal
178. A binary solid (A^+B^-) has a zinc blende structure with B^- ions constituting the lattice and A^+ ions occupying 25% tetrahedral holes. The formula of solid is :
a) AB b) A_2B c) AB_2 d) AB_4
179. The radius of Ag^+ ion is 126 pm while that of I^- ion is 216 pm. The co-ordination number of Ag in AgI is :
a) 2 b) 4 c) 6 d) 8
180. The statement that, "It is possible to choose along the three co-ordinate axes unit distance a, b, c not necessarily of the same length, such that the ratio of there intercepts of any plane in the crystal is given by in $ma : nb : pc$ where m, n, p are either integral whole numbers including infinity or fraction of whole number" is known as :
a) Hauy's law of rationality of indices
b) The law of constancy of interfacial angles
c) The law of constancy of symmetry
d) None of the above
181. Number of atoms in the unit cell of Na(bcc type crystal) and Mg(fcc type crystal) are respectively
a) 4,4 b) 4,2 c) 2,4 d) 1,1
182. Schottky defect is noticed in :
a) NaCl b) KCl c) CsCl d) All of these
183. Which one is called pseudo solid?

a) CaF_2 b) Glass c) NaCl d) All of these

184. A solid having no definite shape is called :
a) Amorphous solid b) Crystalline solid c) Anisotropic d) None of these

185. The phenomenon in which polar crystals on heating produce electricity is called :
a) Pyro-electricity b) Piezo-electricity c) Ferro-electricity d) Ferri-electricity

186. CaF_2 possesses :
a) Face centred cubic
b) Body centred cubic
c) Simple cubic
d) Hexagonal closed packing

187. The three states of matter are solid, liquid and gas, which of the following statements are correct about them?
a) Gases and liquids have viscosity as a common property
b) The molecules in all the three states possess random translational motion
c) Gases cannot be converted into solids without passing through the liquid phase
d) Solids and liquids have vapour pressure as a common property

188. Which is ferromagnetic?
a) Ni b) Co c) CrO_3 d) All of these

189. Solid CO_2 is an example of :
a) Molecular crystal b) Covalent crystal c) Metallic crystal d) Ionic crystal

190. A solid is made of two elements X and Z. The atoms Z are in ccp arrangement while the atom X occupy all the tetrahedral sites. What is the formula of the compound?
a) XZ b) XZ_2 c) X_2Z d) X_2Z_3

191. A cubic crystal possesses :
a) 9 plane of symmetry b) 13 axis of symmetry c) 1 centre of symmetry d) All of these

192. A substance A_XB_Y crystallises in a face centred cubic (fcc) lattice in which atoms $'A'$ occupy each corner of the cube and atoms $'B'$ occupy the centres of each face of the cube. Identify the correct composition of the substance A_XB_Y :
a) AB_3
b) A_4B_3
c) A_3B
d) Composition cannot be specified

193. Which crystal has the largest lattice energy?
a) KCl b) MgO c) LiBr d) NaF

194. A crystal may have one or more planes and one or more axes of symmetry but it possesses
a) Two centres of symmetry
b) One centre of symmetry
c) No centre of symmetry
d) None of the above

195. In an antifluorite structure, cations occupy
a) Octahedral voids b) Centre of cube c) Tetrahedral voids d) Corners of cube

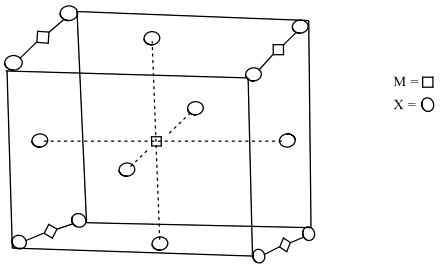
196. In a crystal some ions are missing from normal sites. This is an example of :
a) F-centres b) Interstitial defect c) Frenkel defect d) Schottky defect

197. The number of atoms (n) contained within a body centred cubic cell is:
a) 1 b) 2 c) 3 d) 4

198. The density of KCl is 1.9893 g cm^{-3} and the length of a side unit cell is 6.29082 Å as determined by X-rays diffraction. The value of Avogadro's number calculated from these data is :
a) 6.017×10^{23} b) 6.023×10^{23} c) 6.03×10^{23} d) 6.017×10^{19}

199. Which species is diamagnetic ?
a) Ca^{2+} b) Hg_2Cl_2 c) Sb^{3+} d) All of these

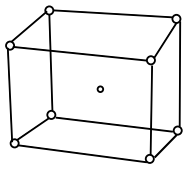
200. Graphite is a soft solid lubricant extremely difficult to melt. The reason for this anomalous behaviour is that graphite :
   a) Is a non-crystalline substance
   b) Is an allotropic form of diamond
   c) Has molecules of variable molecular masses like polymers
   d) Has carbon atoms arranged in large plates of rings of strongly bound carbon atoms with weak interpolate bonds
201. Ionic solids with Schottky defects contain in their structure :
   a) Equal number of cations and anion vacancies
   b) Interstitial anions and anion vacancies
   c) Cation vacancies only
   d) Cation vacancies and interstitial cations
202. Na_2SeO_4 and Na_2SO_4 show :
   a) Isomorphism b) Polymorphism c) Allotropism d) Ferromagnetism
203. The number of molecules of NaCl in an unit cell of its crystal is :
   a) 2 b) 4 c) 6 d) 8
204. A compound $MpXq$ has cubic close packing (ccp) arrangement of X. Its unit cell structure is shown in figure. The empirical formula of the compound is :



   a) MX b) MX_2 c) M_2X d) M_5X_{14}
205. Which one is correct about ferrites?
   a) These possess formula AB_2O_4 (where A is divalent and B is trivalent cation)
   b) These possess spinel structure
   c) $MgAl_2O_4$ is a ferrite
   d) All of the above
206. If the distance between Na^+ and Cl^- ions in sodium chloride crystal is Xpm, the length of the edge of the unit cell is
   a) 4 Xpm b) X/4 pm c) X/2 pm d) 2 Xpm
207. The ratio of cations to anion in a closed pack tetrahedral is :
   a) 0.414 b) 0.225 c) 0.02 d) None of these
208. The pyknometric density of sodium chloride crystal is 2.165×10^3 kg m^{-3} while is X-ray density is 2.178×10^3 kg m^{-3}. The fraction of the unoccupied sites in sodium chloride crystal is :
   a) 5.96 b) 5.96×10^{-2} c) 5.96×10^{-1} d) 5.96×10^{-3}
209. A compound alloy of gold and Cu crystallises in a cubic lattice in which the gold atoms occupy the lattice points at the corners of a cube and the copper atoms occupy the centres of each of the cube faces. What is the empirical formula of this compound?
   a) $AuCu_3$ b) Au_3Cu c) Au_2Cu_3 d) AuCu
210. In a solid lattice, the cation has left a lattice site and is located at an interstitial position, the lattice defect is
   a) Frenkel defect b) Schottky defect c) F-centre defect d) Valency defect
211. The unit cell cube length for LiCl (just like NaCl structure) is 5.14 Å , Assuming anion-anion contact, the ionic radius for chloride ion is:
   a) 1.815 Å b) 2.8 Å c) 3.8 Å d) 4.815 Å
212. Which arrangement of electrons leads to anti-ferromagnetism?
   a) ↑↑↑↑ b) ↑↓↑↓ c) Both (a) and (b) d) None of these

213. Which of the following will show anisotropy?
a) Glass b) $BaCl_2$ c) Wood d) Paper
214. Silicon dioxide is an example of :
a) Metallic crystal b) Ionic crystal c) Covalent crystal d) None of these
215. The number of atoms contained in a fcc unit cell of a monoatomic substance is
a) 1 b) 2 c) 4 d) 6
216. Ionic solids are characterised by :
a) Good conductivity in solid state
b) High vapour pressure
c) Low melting point
d) Solubility in polar solvents
217. The mass of a unit cell of CsCl corresponds to :
a) $8Cs^+$ and Cl^- b) $1Cs^+$ and $6Cl^-$ c) $1Cs^+$ and $1Cl^-$ d) $4Cs^+$ and Cl^-
218. Coordination number of Zn in ZnS (zinc blende) is
a) 6 b) 4 c) 8 d) 12
219. At room temperature, sodium crystallizes in a body centered cubic lattice with $a = 4.24$ Å. the theoretical density of sodium (At. wt. of Na = 23) is :
a) 1.002 g cm^{-3} b) 2.002 g cm^{-3} c) 3.002 g cm^{-3} d) None of these
220. Copper crystallises in fcc lattice with a unit cell edge of 361 pm. The radius of copper atom is
a) 181 pm b) 108 pm c) 128 pm d) 157 pm
221. How many number of atoms are there in a cube based unit cell having one atom on each corner and two atoms on each body diagonal of cube
a) 8 b) 6 c) 4 d) 9
222. When light strikes a photographic (AgBr) paper, silver atoms move in through these defects to :
a) Form –ve images
b) Form tiny clumps of silver atoms
c) Form a colour image
d) None of the above
223. Graphite is a
a) Molecular solid b) Covalent solid c) Ionic solid d) Metallic solid
224. Which is covalent solid?
a) Fe_2O_3 b) Diamond c) Graphite d) All of these
225. The co-ordination number of Na in Na_2O is :
a) 6 b) 4 c) 8 d) 2
226. The coordination number of Na^+inNaCl is
a) 6 b) 8 c) 4 d) 1
227. Number of atoms per unit cell of bcc is
a) 1 b) 2 c) 8 d) 4
228. What is the coordination number of body centred cube?
a) 8 b) 6 c) 4 d) 12
229. Which of the following statements are true?
a) Piezo-electricity is due to net dipole moment
b) Ferro-electricity is due to alignment of dipoles in same direction
c) Pyro-electricity is due to heating polar crystals
d) All of the above
230. A solid has a bcc structure. If the distance of closest approach between the two atoms is 1.73Å. The edge length of the cell is :
a) 200 pm b) $\sqrt{3}/\sqrt{2}\ PM$ c) 142.2 pm d) $\sqrt{2}$ pm
231. The number of octahedral sites in a cubical close pack array of N sphere is :
a) $N/2$ b) $2\ N$ c) $4\ N$ d) N

232. A solid A^+B^- has the B^- ions arranged as below. If the A^+ ions occupy half of the tetrahedral sites in the structure. The formula of solid is :



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

233. Crystalline solids have :
   a) Short range order
   b) Long range order
   c) Anisotropic distribution
   d) No order

234. The statement that, "The crystals of same substance can have different shapes depending upon the number and size of faces but the angle between the corresponding faces remains constant" is known as :
   a) Hauy's law of rationality of indices
   b) The law of constancy of interfacial angles
   c) The law of constancy of symmetry
   d) None of the above

235. Frenkel defect is noticed in :
   a) AgBr b) ZnS c) Agl d) All of these

236. A fcc unit cell of aluminium contains the equivalent of how may atoms?
   a) 1 b) 2 c) 3 d) 4

237. The maximum proportion of available volume that can be filled by hard spheres in diamond is
   a) 0.52 b) 0.34 c) 0.32 d) 0.68

238. The resistance of mercury becomes almost zero at :
   a) 4 K b) 10 K c) 20 K d) 25 K

239. The cubic unit cell of Al (molar mass 27 g mol^{-1})has an edge length of 405 pm. Its density is 2.7 g cm^{-3}. The cubic unit cell is
   a) Face centred b) Body centred c) Primitive d) Edge centred

240. Maximum ferromagnetism is found in :
   a) Fe b) Ni c) Co d) None of these

241. How many tetrahedral holes are occupied in diamond?
   a) 25% b) 50% c) 75% d) 100%

242. The flame colours of metal ions are due to
   a) Frenkel defect b) Schottky defect
   c) Metal deficiency defect d) Metal excess defect

243. Which of the following statements is correct?
   a) Silicon doped with boron is an n −type semiconductor
   b) Silicon doped with arsenic is a p −type semiconductor
   c) Metals are good conductors of electricity
   d) Electrical conductivity of semiconductors decreases with increasing temperature

244. A compound is formed by elements A and B. This crystallises in the cubic structure where the A atoms are at the corners of the cube and B atoms are at the body centres. The simplest formula of the compound is
   a) AB b) A_6B c) A_8B_4 d) AB_6

245. Which pairs shows isomorphism
   a) $KNO_3, NaNO_3$ b) Cr_2O_3, FeO c) Both (a) and (b) d) None of these

246. The elements of symmetry in a crystal are :
   a) Plane of symmetry b) Axis of symmetry c) Centre of symmetry d) All of these

247. How many octahedral and tetrahedral holes are present per unit cell in a face centred cubic arrangement of atoms?

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

248. A solid has structure in which 'W' atoms are located at the corners of a cubic lattice 'O' atoms at the centre of edge and Na atoms at the centre of cube. The formula for the compound is

a) Na_2WO_3 b) Na_2WO_2 c) $NaWO_2$ d) $NaWO_3$

249. Which do not form amalgam with Hg?

a) Pt b) Fe c) Both (a) and (b) d) None of these

250. A crystal of Fe_3O_4 is :

a) Paramagnetic b) Diamagnetic c) Ferromagnetic d) Ferromagnetic

251. A solid XY has NaCl structure. If radius of X^+ is 100 pm. What is the radius of Y^- ion?

a) 120 pm b) 136.6 to 241.6 pm c) 136.6 pm d) 241.6 pm

252. An element (atomic mass = 100 g/mol) having bcc structure has unit cell edge 400 pm. Then density of the element is :

a) 10.376 g/cm^3 b) 5.188 g/cm^3 c) 7.289 g/cm^3 d) 2.144 g/cm^3

253. The ratio of closed packed atoms to tetrahedral holes in cubic close packing is:

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

254. TiO_2 is well known example of :

a) Triclinic system b) Tetragonal system c) Monoclinic system d) None of these

255. In a simple cubic cell, each atom on a corner is shared by :

a) 2 unit cells b) 1 unit cell c) 8 unit cells d) 4 unit cells

256. The vacant space in body centred cubic (bcc) lattice unit cell is about:

a) 32% b) 10% c) 23% d) 46%

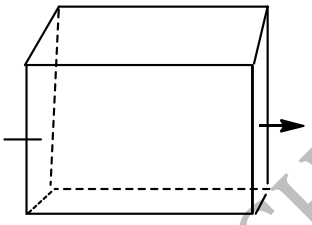
257. Percentage of free space in a body-centred cubic unit cell is :

a) 32% b) 34% c) 28% d) 30%

258. In a compound, atoms of element Y form ccp lattice and those of element X occupy 2/3rd of tetrahedral voids. The formula of the compound will be

a) X_4Y_3 b) X_2Y_3 c) X_2Y d) X_3Y_4

259. In NaCl unit cell, all the ions lying along the axis as shown in the figure are removed. Then the number of Na^+ and Cl^- ions remaining in the unit cell are



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

THE SOLID STATE

CHEMISTRY

: ANSWER KEY :

1)	d	2)	a	3)	a	4)	c	133)	c	134)	b	135)	c	136)	c
5)	b	6)	c	7)	d	8)	b	137)	c	138)	c	139)	a	140)	c
9)	a	10)	c	11)	b	12)	b	141)	b	142)	c	143)	a	144)	b
13)	a	14)	b	15)	c	16)	b	145)	d	146)	c	147)	a	148)	b
17)	d	18)	b	19)	b	20)	d	149)	d	150)	b	151)	a	152)	d
21)	d	22)	b	23)	d	24)	b	153)	c	154)	a	155)	c	156)	d
25)	d	26)	b	27)	d	28)	b	157)	d	158)	a	159)	d	160)	c
29)	c	30)	b	31)	c	32)	d	161)	d	162)	b	163)	b	164)	c
33)	c	34)	c	35)	b	36)	c	165)	a	166)	c	167)	a	168)	b
37)	c	38)	d	39)	b	40)	a	169)	d	170)	b	171)	b	172)	b
41)	c	42)	c	43)	a	44)	b	173)	c	174)	a	175)	d	176)	a
45)	b	46)	d	47)	d	48)	c	177)	c	178)	c	179)	c	180)	a
49)	b	50)	a	51)	d	52)	d	181)	c	182)	d	183)	b	184)	a
53)	b	54)	c	55)	c	56)	b	185)	a	186)	a	187)	a	188)	d
57)	d	58)	b	59)	d	60)	b	189)	a	190)	c	191)	d	192)	a
61)	d	62)	c	63)	a	64)	b	193)	b	194)	b	195)	c	196)	d
65)	c	66)	c	67)	b	68)	c	197)	b	198)	a	199)	d	200)	d
69)	d	70)	d	71)	d	72)	a	201)	a	202)	a	203)	b	204)	b
73)	d	74)	d	75)	d	76)	c	205)	d	206)	d	207)	b	208)	d
77)	b	78)	a	79)	d	80)	d	209)	a	210)	a	211)	a	212)	b
81)	d	82)	a	83)	c	84)	a	213)	b	214)	c	215)	c	216)	d
85)	a	86)	b	87)	b	88)	b	217)	c	218)	b	219)	a	220)	c
89)	c	90)	b	91)	d	92)	c	221)	d	222)	b	223)	b	224)	d
93)	b	94)	d	95)	a	96)	b	225)	b	226)	a	227)	b	228)	a
97)	b	98)	a	99)	a	100)	b	229)	d	230)	a	231)	d	232)	a
101)	d	102)	b	103)	c	104)	c	233)	c	234)	b	235)	d	236)	d
105)	d	106)	b	107)	b	108)	b	237)	b	238)	a	239)	a	240)	a
109)	a	110)	b	111)	a	112)	c	241)	b	242)	d	243)	c	244)	a
113)	d	114)	d	115)	d	116)	c	245)	c	246)	d	247)	c	248)	d
117)	c	118)	a	119)	b	120)	d	249)	c	250)	d	251)	b	252)	b
121)	c	122)	b	123)	d	124)	b	253)	b	254)	b	255)	c	256)	a
125)	c	126)	b	127)	c	128)	a	257)	a	258)	a	259)	a		
129)	d	130)	b	131)	d	132)	c								

THE SOLID STATE

CHEMISTRY

: HINTS AND SOLUTIONS :

1 **(d)**
Schottky defect arises when equal number of a cations and anions are missing from their sites. This defect is generally found in ionic compounds like NaCl, KCl, CsCl, etc.

2 **(a)**
Ferromagnetism is due to spontaneous alignment of the magnetic dipoles in same direction.

3 **(a)**
$f + sc = e + 2$; where f is plane faces, c is interfacial angle and e is straight edges.

4 **(c)**
This leads to stronger coulombic forces of attractions in NaF.

5 **(b)**
No. of Na atoms present at each corner $= 8 \times \frac{1}{8} = 1$
No. of O atoms present at the centre of edges $= 12 \times \frac{1}{4} = 3$
No. of W atoms present at the centre of cube $= 1$
Formula of the compound $= NaWO_3$

6 **(c)**
In antifluorite crystal (Na_2O) the anions are arranged in cubic close packing while the cations occupy all the tetrahedral voids.

7 **(d)**
All are insulator

8 **(b)**
In the given choices lithium has high thermal and electrical conductance.

9 **(a)**
Relation between radius ratio and coordination number

$\frac{r_c}{r_a}$	Coordination number
$0.155 - 0.225$	3
$0.225 - 0.414$	4
$0.414 - 0.732$	6
$0.732 - 1$	8

10 **(c)**
The axial angles in triclinic crystal system are different and none is perpendicular to any of the others $i.e., \alpha \neq \beta \neq \gamma \neq 90°$.

11 **(b)**
In NaCl crystal, Cl^- ions adopt cubic close packed arrangement and Na^+ ions occupy all the octahedral sites. Therefore, Na and Cl have 1 : 1 stoichiometry. In other words, each Na^+ ion is surrounded by six Cl^- ions which are disposed towards the corners of a regular octahedron. Similarly, each Cl^- ion is surrounded by six Na^+ ions.

12 **(b)**
The radius ratio for co-ordination and has 4, 6, and 8 lies in between the ranges $[0.225 - 0.414]$, $[0.414 - 0.732]$ and $[0.732 - 1]$ respectively.

13 **(a)**
$\frac{r^+}{r^-}$ for octahedral void $= 0.414$; $\frac{r^+}{r^-}$ for cubic $= 0.732 - 1$

15 **(c)**
Metallic crystals are good conductor of heat and current due to free electrons on them.

16 **(b)**
One unit cell of bcc has atoms $= 2$. Hence 12.08×10^{23} unit cells will have atoms
$= 2 \times 12.08 \times 10^{23}$
$= 24.16 \times 10^{23}$

17 **(d)**
The vacant spaces between the spheres in closed packed structures is called void. The voids are of two types, tetrahedral voids and octahedral voids. Also, radius of tetrahedral voids and octahedral voids are $r_{void} = 0.225 \times r_{sphere}$ and $r_{void} = 0.414 \times r_{sphere}$ respectively. Thus, octahedral void is larger than tetragonal void.

18 **(b)**
Sodium chloride (NaCl) has face centred cubic structure. It contains 4 Na^+ and 4 Cl^- in the unit cell. Each Na^+ is surrounded by 6 Cl^- ions and $vice - versa.$

19 **(b)**
The conductance order of metals is 10^6 to 10^8 $ohm^{-1}cm^{-1}$

20 **(d)**
Each possess unpaired electrons.

21 **(d)**

The radius ratio of CsCl is 0.93 hence, its structure is body centred cubic.

22 **(b)**

Schottky defects - This defect is due to vacancy at a cation site accompanied by vacancy at an anion site so that the electrical neutrality of the system is maintained. Due to this defect, density decreases.

23 **(d)**

These are characteristics of metal excess defects due to interstitial cation.

24 **(b)**

Edge length $a = 3.04$ Å

$= 3.04 \times 10^{-8}$ cm

Volume of bcc (cubic) cell $= a^3$

$= (3.04 \times 10^{-8})^3$

$= 2.81 \times 10^{-23}$ cm^3

25 **(d)**

For fcc arrangement

$2(r^+ + r^-) =$ edge length

$2(110 + r^-) = 508$

So, $r^- = 114$ pm

26 **(b)**

Radius ratio(r_+/r_-)	**Structure**
< 0.155	linear
$0.155 - 0.225$	planar triangular
$0.225 - 0.414$	tetrahedral
$0.414 - 0732$	octahedral
$0.732 - 1$	bcc

27 **(d)**

Solid hydrogen involves van der Waals' forces.

28 **(b)**

In ccp or fcc and hcp, number of tetrahedral voids is double the number of atoms forming the main lattice.

29 **(c)**

Quartz is a covalent crystal having a framework of silicates, i.e., a three dimensional network when all the four oxygen atoms of each of SiO_4 tetrahedron are shared.

30 **(b)**

For body centred cubic (bcc) structure, the ratio of radii (r_+/r_-) lies in between 0.732−1.00.

∴ The ratio of radii for bcc is greater than 0.73.

31 **(c)**

Follow characteristics of molecular solids.

32 **(d)**

Si and Ge are used for making transistors.

33 **(c)**

Volume of one mole of silver atoms = $\frac{108}{10.5}$ cm^3/mol

Volume of one silver atom = $\frac{108}{10.5} \times \frac{1}{6.022 \times 10^{23}}$ cm^3

So, $\frac{4}{3}\pi r^3 = \frac{108}{10.5} \times \frac{1}{6.022 \times 10^{23}} = 1.708 \times 10^{-23}$

$r^3 = 0.407 \times 10^{-23}cm^3 = 0.407 \times 10^{-29}$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, $x = 7$

34 **(c)**

$n\lambda = 2d \sin\theta$

$1 \times 1.54 = 2d \sin 45°$

$1 \times 1.54 = 2d \times 0.850$

$$2d = \frac{1.54}{0.850} = 0.905 \text{ Å}$$

35 **(b)**

In the close packing of 'n' atoms, the number of tetrahedral voids are '$2n$'. Hence, their number per atom is 2.

37 **(c)**

The coordination number is 8 : 8 in $Cs^+ : Cl^-$

The coordination number is 6 : 6 in $Na^+ : Cl^-$

38 **(d)**

In a cubic close packing, the number of octahedral voids is equal to number of atoms and number of tetrahedral voids is equal to the twice the number of atoms

Number of atoms is a ccp array = 1

∴	A^{2+}	B^+	O^{2-}
	$1 \times 2 \times \frac{1}{4}$	1	1
	$\frac{1}{2}$	1	1
or	1	2	2

AB_2O_2

39 **(b)**

In orthosilicate SiO_4^{2-} ion exist as discrete unit.

40 **(a)**

Molecular mass of CuCl = 99

$n = 4$ for face centred cubic cell

$$\because\ Density = \frac{n \times \text{mol. wt.}}{V \times \text{av. no.}}$$

$$= \frac{4 \times 99}{a^3 \times 6.023 \times 10^{23}}$$

Or $$3.4 = \frac{4 \times 99}{a^3 \times 6.023 \times 10^{23}}$$

∴ $a = 5.783 \times 10^{-8}$ cm

$= 5.783$Å

41 **(c)**

$$Z = \frac{V \times N \times d}{m}$$

$$= \frac{4.2 \times 8.6 \times 8.3 \times 10^{-21} \times 6.023 \times 10^{23} \times 3.3}{155}$$

$$= 3.14$$

$$\approx 4$$

42 **(c)**

Quartz (SiO_2) is a covalent crystal.

43 **(a)**

LiF is an ionic crystal. An ionic solid has ions as constituent units at lattice points held by oppositely charged ions.

44 **(b)**

Edge $= 2r^+ + 2r^-$

$\therefore \quad 400 = 2 \times 75 + 2r^-$

$\therefore \quad r^- = 125$ pm

45 **(b)**

For tetrahedral shape, limiting radius ratio is $0.225 - 0.414$.

46 **(d)**

Number of unit cells $= \frac{\text{mass of metal}}{\text{mass of one unit cell}}$

Given, edge length of unit cell $= 2\text{Å} = 2 \times 10^{-8}$ cm

Mass of metal $= 200$ g

Density of metal $= 2.5$ g cm^{-3}

Volume of unit cell $=$ (edge length)^3 $= (2 \times 10^{-8})^3$

$= 8 \times 10^{-24}$ cm^3

Mass of one unit cell $=$ volume $\times$ density

$= 8 \times 10^{-24} \times 2.5$

$= 20 \times 10^{-24}$

$\therefore$ No. of unit cells in 200 g metal $= \frac{\text{mass of metal}}{\text{mass of one unit cell}}$

$$= \frac{200}{20 \times 10^{-24}}$$

$$= 10 \times 10^{24} = 1.0 \times 10^{25}$$

47 **(d)**

For bcc, $r = \frac{\sqrt{3}}{2} = a$

Or $a = \frac{2r}{\sqrt{3}} = \frac{2 \times 4.52}{1.732}$

$= 5.219\ \text{Å} = 522$ pm.

Density $= \frac{n \times M}{a^3 \times N_A \times 10^{-30}}$

$$= \frac{2 \times 39}{(522)^3 \times (6.02 \times 10^{23}) \times 10^{-30}}$$

$= 0.91$g/cm^3 $= 910$ kg m^{-3}

48 **(c)**

For bcc structure

49 **(b)**

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

50 **(a)**

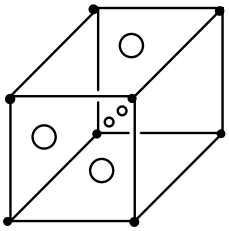
The bcc structure has co-ordination no. of eight.

51 **(d)**

Number of atoms (A) per unit cell $= 8 \times \frac{1}{8} = 1$

Number of atoms (B) per unit cell $= (6 - 1) \times \frac{1}{2} = \frac{5}{2}$

(One atom B is missing)



Thus, formula is $A_1B_{5/2} = A_2B_5$

52 **(d)**

Due to small anion, it possess maximum ionic nature.

53 **(b)**

The fcc unit cell has 8 atoms at the eight corners and one atom at each of six faces. The atom at the face is shared by two unit cells.

54 **(c)**

Doping of elements of group 14 (Ge and Si) with group 15 (As) elements produces excess of electrons and shows n -type conduction, the symbol n indicating flow of negative charge in them. Doping of elements of group 14 (Ge and Si) with group 13 (B) elements products hole (electron deficiency) in the crystal and shows p-type conduction, the symbol p indicating flow of positive charge.

55 **(c)**

Molecular solids are the substances having molecules as constituent units having interparticle forces such as van der waal's forces or hydrogen bonds.

57 **(d)**

The number of atoms present in sc, fcc and bcc unit cell are 1, 4, 2 respectively.

58 **(b)**

N_2O is gas; CaF_2 is AB_2 type crystalline solid.

59 **(d)**

These are characteristic elements of symmetry of a cubic crystal.

60 **(b)**

Since atom X is present at corner and one corner is shared by eight unit cells,

Number of X atoms per unit cell $= \frac{1}{8} \times 8 = 1$

Atom Y is present at body centred position and used by only one unit cell. So, number of Y atoms per unit cell $= 1$

Atom Z is present at the center of each face, so shared by two unit cells,

Thus, number of Z atoms per unit cell $= \frac{1}{2} \times 6 = 3$

Hence, the formula of compound $= XYZ_3$

61 **(d)**

The transition of metal to insulation occurs at a certain temperature due to imperfection.

62 **(c)**

Body diagonal in bcc $= \sqrt{3}\, a = \sqrt{3} \times 400 =$ 692.8 pm

63 **(a)**

The seven basic crystal lattice are cubic, tetragonal, orthorhombic, monoclinic, hexagonal, rhombohedral and triclinic.

64 **(b)**

The conditions for tetragonal systems.

65 **(c)**

The number of octahedral voids in cubic close packed $= 4$

The number of atoms per unit cell in ccp $= 4$

The number of octahedral voids per atom $= 1$

66 **(c)**

An increase in charge of +ve ions also brings in an increase in number of electrons involved in metallic crystals, and thereby metallic bonding becomes stronger.

67 **(b)**

Electrical resistance of metals decreases with decrease in temperature and becomes zero at zero kelvin. Materials in this state are called super conductors and the phenomenon as super conductivity.

68 **(c)**

For a body centred cubic lattice radius, (r)

$$= \frac{\sqrt{3}}{4} a = 0.433a$$

Therefore, radius of $Na^+ = 0.433 \times 4.29 = 1.8575$

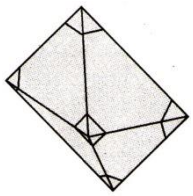
69 **(d)**

All are conductors however shows insulation at a certain temperature.

70 **(d)**

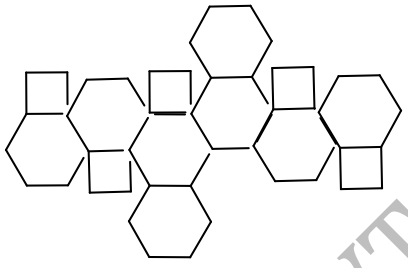
The truncated octahedron is the 14-faced Archimedean solid, with 14 total faces : 6 squares and 8 regular hexagons.

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

71 **(d)**

Frenkel defect is formed by displacement of ion from its lattice to interstitial state.

72 **(a)**

Inperfections are notice in solids.

73 **(d)**

Trapping of electrons in anion vacancies develop F-centres.

74 **(d)**

Diamond has the highest value of energy gap as it is a insulator.

75 **(d)**

$$\text{sc: } r = \frac{a}{2} \text{ fcc : } r = \frac{a}{2\sqrt{2}}; \text{bcc : } r = \frac{\sqrt{3}}{4} a$$

$$\therefore \text{ sc; bcc and fcc are } \frac{a}{2}, \frac{\sqrt{3}}{4}a, \frac{a}{2\sqrt{2}}$$

76 **(c)**

Number of sodium ions are 12 at edge centres in fcc structure which are nearest neighbours for a given lattice point.

77 **(b)**

Packing fraction of ccp $= \frac{\pi}{3\sqrt{2}} = 0.74 \Rightarrow 74\%$

% free space in ccp $= 26\%$

Packing fraction of bcc $= \frac{\pi\sqrt{3}}{8} = 0.68 \Rightarrow 68\%$

% free space in bcc $= 32\%$

78 **(a)**

Density $\frac{n \times \text{mol.wt.}}{V \times \text{av.no.}}$

$n = 4$, $M = 21.76$, av. no. $= 6.023 \times 10^{23}$ and

And $V = a \times b \times c$

$\therefore$ $V = 6.8 \times 10^{-8} \times 4.4 \times 10^{-8} \times 7.2 \times 10^{-8}$

$= 2.154 \times 10^{-22} \times 6.023 \times 10^{23}$

Density $= \frac{4 \times 21.76}{2.154 \times 10^{-22} \times 6.023 \times 10^{23}}$

$= 0.6708 \text{ g cm}^{-3}$

79 **(d)**

Volume of an atom $= \frac{4}{3}\pi r^3$

In fcc, number of atoms per unit cell $= 4$

$\therefore$ Volume of total atoms $= 4 \times \frac{4}{3}\pi r^3$

$$= \frac{16}{3}\pi r^2$$

80 **(d)**

In triclinic lattice, the eight lattice points are located, one each at the corners of triclinic lattice. Also $a \neq b \neq c$ and $\alpha \neq \beta \neq \gamma$. There is no planes and no axes. Thus, triclinic lattice has no rotation of symmetry.

81 **(d)**

The unit cell with dimensions $a = b \neq c,\ \alpha = \beta = \gamma = 90$ is tetragonal.

82 **(a)**

Density $= \frac{n \times \text{at.wt.}}{V \times \text{av.no.}} = \frac{n \times \text{at.wt.}}{a^3 \times \text{av.no.}}$

Given, at.wt. $= 60$

$a = 4 \times 10^2$ pm

$= 4 \times 10^2 \times 10^{-12}$ m

$= 4 \times 10^{-10} \times 10^2$ cm

$= 4 \times 10^8$ cm

($\because$ 1 pm $= 10^{-12}$)

$\therefore$ Density $= \frac{4 \times 60}{(4 \times 10^{-8}) \times 6.023 \times 10^{23}}$

$= 6.23 \text{ g cm}^{-3}$

83 **(c)**

Crystal system	Axial distances	Axial angle
Tetragonal	$a = b \neq c$	$\alpha = \beta = \gamma = 90°$
Hexagonal	$a = b \neq c$	$\alpha \neq \beta = 90°, \gamma = 120°$
Rhombohedral	$a = b = c$	$\alpha = \beta = \gamma \neq 90°$
Monoclinic	$a \neq b \neq c$	$\alpha = \gamma = 90, \beta \neq 90°$

84 **(a)**

The cubic unit cell has 8 atmos at eight corners. Each atom is shared by 8 unit cells.

$\therefore \quad n = 8 \times \frac{1}{8} = 1$

85 **(a)**

Most of the metals have their transition temperature (i.e., the temperature at which a substance starts to behave as super conductor) in the range of 2-5 K.

86 **(b)**

CaF_2 has fcc structure with 8 : 4 co-ordination and has 4 units of CaF_2 per unit cell.

87 **(b)**

NaCl has fcc arrangement of ions. The coordination number of Cl^- as well as Na^+ ion is six. Therefore, it is termed 6 : 6 coordination crystal.

88 **(b)**

No. of carbon atoms in unit cell of diamond is 8. Also fraction of volume occupied by the atoms in primitive cell is 52%.

89 **(c)**

When equal number of cations and anions are missing from their position in a crystal lattice so that electrical neutrality is maintained, the defect is called Schottky defect. Due to missing of ions, the overall density of the crystal decreases. Moreover, defect leads to randomness, thus entropy also increases.

90 **(b)**

It is a fact for crystal structure (bcc) potassium.

91 **(d)**

At high temperature randomization of spins changes.

92 **(c)**

Orthorhombic geometry has $a \neq b \neq c$ and $\alpha = \beta = \gamma = 90°$. The shape of match box obey this geometry.

93 **(b)**

CrO_2 is metallic conductor, V_2O_5, NiO and MnO are insulators.

94 **(d)**

It represents ccp arrangement.

96 **(b)**

Given,

Molar mass, M =50g/mol

$N_A = 6.02 \times 10^{23}$

$Z = 2$ (for bcc crystal)

Edge length $a = 300$ pm

$= 3 \times 10^{-8}$cm

$$d = \frac{Z \times M}{N_A \times a^3}$$

$$= \frac{2 \times 50}{6.02 \times 10^{23} \times (3 \times 10^{-8})^3}$$

$= 6.15$

≈ 6.2

97 **(b)**

$\frac{r_{Na^+}}{r_{Cl^-}} = \frac{95}{181} = 0.524$, i.e., in between 0.414 to 0.732 and thus, co-ordination no.=6

98 **(a)**

Mass of one unit-cell (m)

$= \text{volume} \times \text{density}$

$= a^3 \times d = a^3 \times \frac{MZ}{N_0 a^3} = \frac{MZ}{N_0}$

$m = \frac{58.5 \times 4}{6.02 \times 10^{23}}$ g

$\therefore$ Number of unit cells in 1 g $= \frac{1}{m}$

$= \frac{6.02 \times 10^{23}}{58.5 \times 4}$

$= 2.57 \times 10^{21}$

99 **(a)**

In covalent molecules atoms occupy the lattice points.

100 **(b)**

The presence of free electrons in metals, they are opaque, strongly reflecting and possess metallic lustre.

101 **(d)**

Volume of cube $= a^3$

Volume of unit cell $= 1 \times \frac{4}{3} \pi r^3$

$= \frac{4}{3}\pi \left(\frac{a}{2}\right)^3 = \frac{\pi a^3}{6}$

$\therefore$ packing density $= \frac{\pi a^3}{6 \times a^3} = \frac{\pi}{6}$

102 **(b)**

On adding a pentavalent impurity with germanium, we get $n-$type of semiconductors because excess of electrons is responsible for conduction.

103 **(c)**

For fcc structure $r = \frac{a}{2\sqrt{2}}$

$\therefore$ diameter $= 2r = \frac{a}{\sqrt{2}} = \frac{408}{1.414} = 288.5$ pm

104 **(c)**

It is a fact.

105 **(d)**

Due to different plane arrangement, cleavage becomes easier at these points.

106 **(b)**

Na has 6 co-ordination number (fcc structure).

107 **(b)**

Dopping of $SrCl_2$ to NaCl brings in replacement of two Na^+ by each Sr^{2+} ion, but Sr^{2+} occupies one lattice point. This produces one cation vacancy.

No. of cation vacancies $= 10^{-4}$

100 mole of NaCl will have cationic vacancy $= 10^{-4}$

$\therefore$ 1 mole of NaCl will have cationic vacancy $= 10^{-4}/100 = 10^{-6}$

$\therefore$ No. of cationic vacancies $= 10^{-6} \times 6.02 \times 10^{23} = 6.02 \times 10^{17}$

108 **(b)**

When equal number of cations and anions (such, that charges are equal) are missing $(1\ Na^+, 1\ Cl^- / 1\ Fe^{2+}, 2\ Cl^-)$.

It is a case of Schottky defect.

109 **(a)**

Frenkel defects arises when an ion is missing from its normal position and occupies an interstitial site between the lattice points.

110 **(b)**

When equal number of cations or anions are missing from their lattice sites (to maintain electrical neutrality), then the defect is called Schottky defect. The defect is observed in highly ionic compounds which have cations and anions of similar size *e*. *g*., NaCl, KCl etc.

111 **(a)**

Radius of Na(if bcc lattice) $= \frac{\sqrt{3}}{4} a$

$= \frac{\sqrt{3} \text{ x } 4.29}{4}$

$= 1.8574$ Å

112 **(c)**

More is deformation in anion more is covalent character.

113 **(d)**

In hexagonal close packing and cubic close packing, the co-ordination number is 12.

114 **(d)**

Number of atoms at corner $= 8 \times \frac{1}{8} = 1$

Number of atoms at face centres $= 6 \times \frac{1}{2} = 3$

$\therefore$ The formula of the compound is XY_3.

115 **(d)**

Zinc blende (ZnS) has ccp arrangement of S^{2-} and Zn^{2+} in alternative tetrahedral sites. The coordination number of $Zn^{2+} = 4$ and $S^{2-} = 4$ in ZnS

116 **(c)**

The phenomenon by which a certain crystalline compound exists in two or more different crystalline forms, is called polymorphism *e.g.,* $CaCO_3$ occurs in two polymorphic forms, *i*. *e*., calcite (rhombohedral) and aragonite (orthorhombic).

117 **(c)**

Ge and Si are doped with gp 13(boron) element to give *p*-type conductor.

118 **(a)**

Distance between K^+ and F^- in KF

$= r_{K^+} + r_{F^-} = 133 + 136 = 269$ pm

119 **(b)**

In fcc unit cell

$$\sqrt{2}a = 4r \quad \Rightarrow r = \frac{\sqrt{2}\,a}{4}$$

$$= \frac{\sqrt{2} \times 361}{4} = 127 \text{ pm}$$

120 **(d)**

Each possess unpaired electrons.

121 **(c)**

Due to Frenkel defect, density of a crystal remains unchanged.

122 **(b)**

$ABABAB$.....packing has empty space of 28% in sc, 32% in bcc, 26% in hcp and ccp.

123 **(d)**

It is evident from figure that B occupies tetrahedral voids and thus, co-ordination number is six.

124 **(b)**

It is the definition of piezo-electric effect or piezo-electricity.

125 **(c)**

Ferrimagnetism involves magnetic dipoles oriented in parallel and antiparallel direction in unequal number to give some net dipole moment.

126 **(b)**

The 8:8 type of packing is present in caesium chloride (CsCl). In this structure each Cs^+ ion is surrounded by 8 Cl^- ions and each Cl^- ion is also surrounded by 8 Cs^+ ions.

127 **(c)**

When coordination number is eight, the radius ratio $\frac{r^+}{r^-}$ lies between 0.732 to 1.000.

128 **(a)**

ZnS has zinc blende type structure ($i.e.$, ccp structure). The S^{2-} ions are present at the corners of the cube and at the centre of each face. Zinc ions occupy half of the tetrahedral sites. Each zinc ion is surrounded by four sulphide ions which are disposed towards the corner of regular tetrahedron. Similarly, S^{2-} ion is surrounded by four Zn^{2+} ions.

129 **(d)**

NaCl has Na^+ and Cl^- ions in solid state.

130 **(b)**

In case of ccp or fcc structure

$$4r = \sqrt{2}a \quad \Rightarrow \quad a = \frac{4r}{\sqrt{2}}$$

$$\therefore \quad a = 2\sqrt{2}r$$

131 **(d)**

Molecular solids just melt above 273 and are poor conductor of heat and electricity.

132 **(c)**

In vacuum, there is no friction.

133 **(c)**

In bcc $r = \frac{\sqrt{3}}{4}a = \frac{\sqrt{3}}{4} \times 351 = 151.98$ pm

134 **(b)**

The maximum packing or the maximum proportion of volume filled by hard spheres in various arrangements are :

1. Simple cubic $= \frac{\pi}{6} = 0.52$
2. bcc $= \frac{\pi\sqrt{3}}{8} = 0.68$
3. fcc $= \frac{\pi\sqrt{2}}{6} = 0.74$
4. hcp $= \frac{\pi\sqrt{2}}{6} = 0.74$
5. Diamond $= \frac{\pi\sqrt{3}}{6} = 0.34$

135 **(c)**

NaCl has fcc structure.

In fcc lattice

$$r^+ + r^- = \frac{a}{2}$$

Where, $a =$ edge length

$$r^+ = 95 \text{ pm}, r^- = 181 \text{ pm}$$

Edge length $= 2r^+ + 2r^-$

$$= (2 \times 95 + 2 \times 181) \text{ pm}$$

$$= 190 + 362 = 552 \text{ pm}$$

136 **(c)**

Radius ratio	Coordination no	Example
0.155 – 0.225	3	B_2O_3
0.225 – 0.414	4	ZnS
0.414 – 0.732	6	NaCl
0.732 – 1	8	CsCl

In ionic solids the shape of crystal depends upon relative size of ions.

Given, $r_{c^+}(Rb^+) = 1.46$ Å

$$r_{a^-}(I^-) = 2.16 \text{ Å}$$

$$\therefore \quad \frac{r_{c^+}}{r_{a^-}} = \frac{1.46}{2.16} = 0.676$$

$\therefore$ It will have coordination number 6 and structure will be same as of NaCl.

137 **(c)**

F^- has no unpaired electron and thus, diamagnetic. A diamagnetic does not contain any unpaired electron.

138 **(c)**

This is the law of constancy of symmetry.

139 **(a)**

NaCl has fcc structure and thus,

$$r_c + r_a = \frac{a}{2}$$

$$100 + r_a = \frac{580.4}{2}$$

$$= 290.2$$

$$100 + r_a = 290.2$$

$$r_a = 290.2 - 100$$

$$= 190.2$$

140 **(c)**

No. of atoms of A from corners of unit cell $= 7 \times \frac{1}{8} = 7/8$

No. of atoms of B from faces of unit cell $= 6 \times \frac{1}{2} = 3$

Thus, $A : B :: 7/8 : 3$ or $7 : 24$ Thus, formula is A_7B_{24}

142 **(c)**

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

143 **(a)**

Rock salt has fcc structure.

144 **(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.

145 **(d)**

A occupies corners, thus number of A atoms per unit cell

$$= 8 \times \frac{1}{8} = 1$$

B occupies face centres, thus number of B atoms per unit cell

$$= 6 \times \frac{1}{2} = 3$$

$\therefore$ The empirical formula of the compound is AB_3.

146 **(c)**

Amorphous solids neither have ordered arrangement (i.e., no definite shape) nor have sharp melting point like crystals, but when heated they become pliable until they assume the properties usually related to liquids. If is therefore, they are regarded as super cooled liquids.

147 **(a)**

Due to smaller size of F.

148 **(b)**

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

150 **(b)**

Doping of silicon with boron leads to p −type semiconductor.

151 **(a)**

For a bcc lattice,

$$2(r^+ + r^-) = \sqrt{3}\, a$$

$$\therefore \quad r^+ + r^- = \frac{\sqrt{3} \times 387}{2} = 335 \text{ pm}$$

152 **(d)**

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

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

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

$$= 78.54\%$$

153 **(c)**

The dipoles in certain solids are spontaneously aligned in a particular direction, even in the absence of electric field. Such substances are called ferroelectric.

154 **(a)**

An increase in charge of +ve ions also brings in an increase in number of electrons involved in metallic crystals, and thereby metallic bonding becomes stronger.

155 **(c)**

Lowest potential energy level provides stable arrangement.

156 **(d)**

These are characteristics of solids.

157 **(d)**

Arrangement of sulphide ions (S^{2-}) in zinc blende (ZnS) is fcc while Zn^{2+} ions occupy alternate tetrahedral voids.

158 **(a)**

ZnS has fcc structure and is an ionic crystal having 4 : 4 co-ordination number.

159 **(d)**

Substances which are expected to be paramagnetic or ferromagnetic on the basis of unpaired electron but actually they possess zero net magnetic moment are called antiferoomagnetic.

160 **(c)**

Presence of excess Na in NaCl and there by causing anion vacancy defect makes it yellow, presence of excess Li in LiCl makes it pink and presence of excess K in KCl makes it violet. Greater the number of F-centres, greater is intensity of colour.

161 **(d)**
In simple cubic close packing of sphere, co-ordination number is 12.

162 **(b)**
Electronic collisions are responsible for metallic conduction and heat conduction in metals.

163 **(b)**
A crystalline solid is one in which atoms are arranged in an orderly manner in a three dimensional region to provide a definite shape and sharp melting point. These have flat faces, sharp edges bounded by well defined plane faces.

164 **(c)**
Each Na^+ (in bcc) in NaCl is surrounded by six Cl^- (in fcc) and each Cl^- in NaCl is surrounded by six Na^+ and thus, on interchanging Na^+ and Cl^- the fcc structure of NaCl will not change but with respect to Na^+ it will be fcc and with respect to Cl^- it will be bcc.

165 **(a)**
In the given crystal equal number of cations and anions are missing (two K^+ and two Cl^-) from their normal lattice sites and the crystal maintains electrical neutrality. Hence, this is Schottky defect.

166 **(c)**
Number of Cu atoms at corners $= 8 \times \frac{1}{8} = 1$
Number of Ag atoms at edge centres $= 12 \times \frac{1}{4} = 3$
Number of Au atoms at body centre $= 1 \times 1 = 1$
$\therefore$ Formula is Cu_4Ag_3Au.

167 **(a)**
The co-ordination number of sc, fcc and bcc structure are 6,12 and 8 respectively. CsCl has body centred cubic structure having 8 : 8 co-ordination number.

168 **(b)**
It is a characteristic of liquid crystal.

169 **(d)**
A molecular crystal may have crystalline state (I_2), amorphous state (S_8), i.e., a non-crystalline state.

170 **(b)**
Note that $a \neq b \neq c$ and $\alpha = \beta = \gamma = 90°$, the conditions for orthorhombic system.

171 **(b)**
Density $= \frac{Z \times M}{a^3 \times N_0}$ $(\because Z = 1, \text{for } M_{CsBr} = 213)$
$a = 436.6 \times 10^{-12}\ \text{m} = 4.366 \times 10^{-10}\ \text{m}$
$= 4.366 \times 10^{-8}\ \text{cm}$
Density $= \frac{1 \times 213}{(4.366 \times 10^{-8})^3 \times 6.02 \times 10^{-23}} = 4.25\ \text{g/cm}^3$
No doubt for bcc $Z = 2$, but in CsBr it is 8 : 8 co-ordination and here one Cs^+ ion is present in body centre and a net contribution of 1 Br^- per unit cell is calculated due to its presence at the corners.

172 **(b)**
High temperature changes 8 : 8 co-ordination to 6 : 6 whereas high pressure changes 6:6 co-ordination to 8 : 8.

173 **(c)**
Silicon is used for making a transistor.

174 **(a)**
Given, $r_{Na^+}/r_{Cl^-} = 0.55$
$r_{K^+}/r_{Cl^-} = 0.74$
$\frac{r_{KCl}}{r_{NaCl}} = ?$
$\frac{r_{Na^+}}{r_{Cl^-}} = 0.55$
$\frac{r_{Na^+}}{r_{Cl^-}} + 1 = 0.55 + 1$
$\frac{r_{Na^+} + r_{Cl^-}}{r_{Cl^-}} = 1.55$ ... (i)
$\frac{r_{K^+}}{r_{Cl^-}} = 0.74$
$\frac{r_{K^+}}{r_{Cl^-}} + 1 = 0.74 + 1$
$\frac{r_{K^+} + r_{Cl^-}}{r_{Cl^-}} = 1.74$ ... (ii)
Eq (ii) devide by Eq (i)
$\frac{r_{K^+} + r_{Cl^-}}{r_{Na^+} + r_{Cl^-}} = \frac{1.74}{1.55} = 1.1226$

175 **(d)**
The face centred cubic unit cell consists of 8 atoms at the eight corners and one atom at each of the six faces. This atom at the face is shared by two unit cells.
$\therefore \quad n = 8 \times \frac{1}{8} + \left(6 \times \frac{1}{2}\right) = 4$

176 **(a)**
Given, angle of diffraction $(2\theta) = 90°$
$\theta = 45°$
Distance between two planes, $d = 2.28$ Å
$n = 2$ [$\because$ Second order diffraction]
Bragg's equation is
$n\lambda = 2d \sin\theta$
$2 \times \lambda = 2 \times 2.28 \times \sin 45°$
$\lambda = 1.612$

177 **(c)**
Molecular solids are the substances having molecules as constituent units having interparticle forces such as van der waal's forces or hydrogen bonds.

178 **(c)**

No. of B^- ions in unit cell $= 8 \times \frac{1}{8} + 6 \times \frac{1}{2} = 4$

Now A^+ ions occupies 25% of tetrahedral holes $= \frac{8 \times 25}{100} = 2$

Thus, ratio of B^- and A^+ is 2 : 1 or formula is AB_2.

179 **(c)**

Radius ratio $\frac{r^+}{r^-} = \frac{126}{216} = 0.58$; Thus, fcc structure and co-ordination no. is six.

180 **(a)**

This is Hauy's law of rationality of indices.

181 **(c)**

Number of atoms in unit cell of Na are 2 (bcc).

Number of atoms in unit cell of Mg (fcc) are 4.

182 **(d)**

All these show Schottky defect.

183 **(b)**

Substances which look like solids but are actually not solid are called pseudo solids. Glass is super cooled liquid and thus, called pseudo solid.

184 **(a)**

Amorphous solids neither have ordered arrangement (i.e., no definite shape) nor have sharp melting point like crystals, but when heated they become pliable until they assume the properties usually related to liquids. It is therefore, they are regarded as super cooled liquids.

185 **(a)**

It is the definition of pyro-electricity.

186 **(a)**

CaF_2 has fcc structure with 8 : 4 co-ordination and has 4 units of CaF_2 per unit cell.

187 **(a)**

The facts reported in b, c, d are wrong.

188 **(d)**

Ferromagnetics are the substances which are strongly attracted in magnetic field and retain magnetism in absence of magnetic field.

189 **(a)**

Molecular solids are the substances having molecules as constituent units having interparticle forces such as van der waal's forces or hydrogen bonds.

190 **(c)**

Given, A solid has two elements $= X$ and Z

$Z$are in ccp arrangement and X occupy all tetrahedral sites.

Let the number of atoms of Z in ccp arrangement $= 100$

$\therefore$ Number of atoms of tetrahedral sites $= 200$

$\therefore$ Number of atoms of $X = 200$ ($\because$ They occupy all tetrahedral sites)

$\therefore$ Ratio of $X : Z = 200 : 100$

$= 2 : 1$

$\therefore$ The formula of compound is X_2Z.

191 **(d)**

These are characteristic elements of symmetry of a cubic crystal.

192 **(a)**

Effective number of corner atom (A)

$= 8 \times \frac{1}{8} = 1 = X$

Effective number of face centred atom (B)

$= \frac{1}{2} \times 6 = 3 = Y$

Thus, composition of substance $= AB_3$.

193 **(b)**

Smaller cation and smaller anion leads to higher lattice energy.

194 **(b)**

A crystal possesses only one centre of symmetry.

195 **(c)**

In antifluorite structure, the anions are oxide ions. The oxide ions form a face centred cubic array and the metal ion (cation) fill half of the tetrahedral voids. $e.g.,$ -Na_2O.

196 **(d)**

Schottky defects are arised when one positive ion and one negative ion are missing from their respective positions leaving behind a pair of holes. These are more common in ionic compounds with high co-ordination number and having almost similar size of cations and anions.

197 **(b)**

The body centred cubic cell consists of 8 atoms at the corners and one atom at centre.

$\therefore \quad n = \left(8 \times \frac{1}{8}\right) + 1 = 2$

198 **(a)**

KCl has face centred cubic structure

$\therefore n = 4$

Given, Density $= 1.9893$ g cm^{-3}, $a = 6.29082 \times 10^{-8}$ cm

$\because$ Density $= \frac{n \text{ x mol.wt.}}{V \times \text{av.no.}} = \frac{n \times \text{mol.wt.}}{a^3 \times \text{av.no.}}$

$\therefore \quad 1.9893 = \frac{4 \times 74.5}{(6.29083 \times 10^{-8})^3 \times N}$

$N = 6.017 \times 10^{23}$

199 **(d)**

There is no unpaired electron in either of them.

200 **(d)**

It is a fact.

201 **(a)**

Schottky defects are arised when one positive ion and one negative ion are missing from their respective positions leaving behind a pair of holes. These are more common in ionic compounds with high co-ordination number and having almost similar size of cations and anions.

202 **(a)**

Both are isomorphs to each other because of same molecular formula and same molecular geometry or same crystalline form.

203 **(b)**

In NaCl : No. of Na^+ ions $= 12$ (at edge centre) $\times \frac{1}{4}$ $+ 1$ (at body centre) $\times 1 = 4$

No. of Cl^- ions $= 8$ (at corners) $\times \frac{1}{8} + 6$ (at face centre) $\times \frac{1}{2} = 4$

Thus, 4 units of NaCl.

204 **(b)**

M_pX_q has ccp structure, therefore,

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

$M = 4 \times \frac{1}{4} + 1 = 2$

So, unit cell formula of the compound is M_2X_4 and the empirical formula of the compound is MX_2.

205 **(d)**

All these are characteristics of ferrites.

206 **(d)**

In NaCl, the length of the edge of the unit cell is $= 2 \times$ distance between Na^+ and Cl^- ions hence, $a = 2X$ pm.

207 **(b)**

$\frac{r^+}{r^-}$ for tetrahedral void $= 0.225 - 0.414$;

$\frac{r^+}{r^-}$ for triangular $= 0.155 - 0.225$

208 **(d)**

Molar volume from pyknometric density $\frac{M}{d} = \frac{M}{2.165 \times 10^3}\ \text{m}^3 \quad (M \text{in kg})$

Molar volume from X-ray density $= \frac{M}{d}$

$$= \frac{M}{2.178 \times 10^3}\,\text{m}^3$$

$\therefore$ volume unoccupied $= \frac{M}{10^3}\left(\frac{1}{2.65} - \frac{1}{2.178}\right)\text{m}^3$

$\therefore$ Fraction unoccupied $= \left(\frac{0.013\,M \times 10^{-3}}{2.165 \times 2.178}\right) / \left(\frac{\text{M} \times 10^{-3}}{2.165}\right)$

$$= 5.96 \times 10^{-3}$$

209 **(a)**

Au atoms are at eight corners of the cube. Thus, no. of Au atoms in the unit cell $= \frac{8}{8} = 1$.

Cu atoms are at the face centre of six faces. Therefore, its share in the unit cell $= \frac{6}{2} = 3$. Thus, formula is $AuCu_3$.

210 **(a)**

When an ion (generally cation due to its small size) is missing from its normal position and occupy an interstitial site between the lattice points, the lattice defect obtained is known as Frenkel defect.

211 **(a)**

The distance between Li^+ and Cl^- ion can be derived as half of the edge length of cube.

$\therefore \quad d_{Li^+-Cl^-} = \frac{5.14}{2} = 2.57\text{Å}$

$\therefore \quad d_{Cl^- - Cl^-} = \sqrt{(2.57)^2 + (2.57)^2} = 3.63\ \text{Å}$

$\therefore \quad r_{Cl^-} = \frac{d_{Cl^- - Cl^-}}{2} = \frac{3.63}{2} = 1.815\text{Å}$

212 **(b)**

Antiferromagnetic possess complementary dipoles alignment giving net dipole moment equal to zero

213 **(b)**

Crystalline solids are anisotropic since, they exhibit different properties in all directions.

214 **(c)**

SiO_2 is covalent crystal like diamond and graphite.

215 **(c)**

In fcc → contribution of each atom present at the corner $= \frac{1}{8}$

Contribution of each atom at the face centre $= \frac{1}{2}$

Hence, the total number of atoms in fcc

$$= \left(8 \times \frac{1}{8}\right) + \left(6 \times \frac{1}{2}\right) = 1 + 3 = 4$$

216 **(d)**

Ionic compounds are soluble in polar solvents due to dipole ion attraction.

217 **(c)**

An unit cell of CsCl having bcc structure consists of 8 atoms at the corner and one atom at centre.

Thus, no. of $Cl^- = 8 \times \frac{1}{8} = 1$

and no. of $Cs^+ = 1 \times 1 = 1$

Thus, no. of CsCl unit per unit cell $= 1$

218 **(b)**

In ZnS each sulphide ion is tetrahedrally surrounded by four zinc ions and each zinc ion is surrounded by four sulphide ions. Thus, zinc sulphide possesses 4 : 4 coordination.

219 **(a)**

A body centred cubic unit cell contains 8 atoms at the 8 corners and one in the centre.

$\therefore$ Total number of atoms per unit cell

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

$$\because \text{Density} = \frac{n \times \text{at. wt.}}{\text{av. no.} \times a^3}$$

$$= \frac{2 \times 23}{6.023 \times 10^{23} \times (4.24 \times 10^{-8})^3}$$

$$= 1.002 \text{ g cm}^{-3}$$

220 **(c)**

Copper crystallises in fcc lattice.

If, $r =$ radius

$a =$ edge length

Then $r = \frac{a}{2\sqrt{2}} = \frac{361}{2\sqrt{2}}$ pm

$= 127.633 \text{ pm} \approx 128 \text{ pm}$

221 **(d)**

There are four body diagonals. Atoms on the body diagonals are not shared by any other unit cell.

Contribution by atoms on corners

$= 8 \times \frac{1}{8} = 1$ and

Contribution by atoms on body diagonal

$= 2 \times 4 = 8$

Hence, total number of atoms = 9

222 **(b)**

The ions leave its correct lattice site and occupies an interstitial site.

223 **(b)**

Graphite is an example of covalent solid.

224 **(d)**

All are covalent molecules. A covalent solid has atoms as constituent units at lattice points held together by covalent bonds.

225 **(b)**

In Na_2O, O^{2-} ion possesses fcc lattice having Na^+ ions at all tetrahedral sites.

226 **(a)**

In sodium chloride, each Na^+ ion is surrounded by six Cl^- ions and Cl^- ion is surrounded by six Na^+ ions. Thus, both the ions have coordination number six.

227 **(b)**

For bcc unit cell, number of atoms at corners (per unite cell)$= \frac{1}{8} \times 8 = 1$

Number of atoms at body centre =1

Total number of atoms $= 1 + 1 = 2$

228 **(a)**

The unit cell of body centred cube has one atom at each of the eight corners and one atom at the centre of the body. Thus, the atom at centre remains in contact with 8 corner atoms. Hence, the coordination number of bcc is 8.

229 **(d)**

All these are characteristic facts.

230 **(a)**

$r_{\text{atom}} = \frac{\sqrt{3}}{4}a$; Also closest approach in bcc Lattice is $\frac{1}{2}$ of body diagonal, $i.e.$, $\frac{\sqrt{3}}{4}a = 1.73$ Å

or $a = \frac{1.73 \times 2}{\sqrt{3}} = 1.996$ Å $= 199.6$ pm

231 **(d)**

Each sphere has one octahedral hole and two tetrahedral holes.

232 **(a)**

In a closed packed structure, the number of tetrahedral voids per atom of the crystal is two. Since, half of the tetrahedral voids are occupied by A^+, the number of A^+ is same as that of B^- in the crystal. Thus, formula is AB. Or

No. of B^- ions in unit cell $= 8 \times \frac{1}{8} + 6 \times \frac{1}{2} = 4$

A^+ ions occupies 50 of tetrahedral voids $= \frac{8 \times 50}{100} = 4$

The ratio of B^- and A^+ is 1 : 1

233 **(c)**

Crystalline solids are anisotropic in nature.

234 **(b)**

This is the law of constancy of interfacial angles.

235 **(d)**

Frenkel defect is arised when the cations are missing from their lattice sites and occupy interstitial sites. As a result of Frenkel defect, density remains unchanged but dielectric constant increases.

236 **(d)**

In fcc atoms are present at faces and corners.

Number of atoms in fcc = atoms at corners + atoms at faces of unit cell.

= (no. of corners × contribution by one atom) + (no. of faces × contribution by one atom)

$= \left(8 \times \frac{1}{8}\right) + \left(6 \times \frac{1}{2}\right) = 1 + 3 = 4$

237 **(b)**

In diamond,

the maximum proportion of available volume that can be filled by hard spheres $= \frac{\pi\sqrt{3}}{16} = 0.34$

238 **(a)**

Most of the metals have their transition temperature (i.e., the temperature at which a

substance starts to behave as super conductor) in the range of 2-5 K.

239 **(a)**

Density $(\rho) = \frac{Z \times M}{a^3 \times N_0}$

$$2.7 = \frac{Z \times 27}{(405 \times 10^{-10})^3 \times 6.023 \times 10^{23}}$$

$$Z = \frac{2.7 \times (405)^3 \times 10^{-30} \times 6.023 \times 10^{23}}{27} = 4$$

For face centred cubic unit cell, number of atoms are 4.

240 **(a)**

More is the number of unpaired electron, more is magnetic nature.

241 **(b)**

It is a fact. Four out of 8 tetrahedral voids are occupied by carbon.

242 **(d)**

Flame colours are due to metal excess defect. What happens that in some ionic crystals, there becomes an excess of metal atom, which by loosing e^-, change into ions. These electrons can absorb energy and go into excited states from ground state. Thus, the absorption of certain wavelength of light takes place and crystal becomes coloured according to complementary colour. The spaces occupied by extra e^- are called F-centres.

244 **(a)**

Since A atoms are present at the corners of the cube,

Number of A atoms per unit cell $= 8 \times \frac{1}{8} = 1$

Number of B atoms per unit cell $= 1$

($\because$ Present at the body centre of the cube)

Hence, the formula of the compound $= AB$

245 **(c)**

$NaNO_3$ and KNO_3 are not isomorphs because they have same molecular formula but different crystal structure.

246 **(d)**

A crystal has these three types of symmetry.

247 **(c)**

In fcc octahedral voids : at the centre $= 1$

at the edges $= 12 \times \frac{1}{4} = 3$

$\therefore$ Total $= 4$

In fcc tetrahedral voids : 8

248 **(d)**

In a unit cell, W atoms at the corner

$$= \frac{1}{8} \times 8 = 1$$

O-atoms at the centre of edge

$$= \frac{1}{4} \times 12 = 3$$

W : O : Na $= 1 : 3 : 1$

Hence, formula $= NaWO_3$

249 **(c)**

Both Pt and Fe does not form amalgam with Hg.

250 **(d)**

Fe_3O_4 is ferrimagnetic because it is strongly attracted in magnetic field.

251 **(b)**

The $\frac{r^+}{r^-}$ for NaCl $= 0.414$ to 0.732 (due to fcc structure)

$\therefore$ $r^- = 241.54$ to 136.6 pm

252 **(b)**

$$\text{Density} = \frac{n \times M}{a^3 \times N_A \times 10^{-30}}$$

$$= \frac{2 \times 100}{(400)^3 \times 6.02 \times 10^{23} \times 10^{-30}}$$

$$= 5.188 \text{ g/cm}^3$$

253 **(b)**

Every constituent has two tetrahedral voids .

In ccp lattice atoms $= 8 \times \frac{1}{8} + 6 \times \frac{1}{2} = 4$

$\therefore$ tetrahedral void $= 4 \times 2 = 8$;

Thus, ratio $= 4 : 8 :: 1 : 2$

254 **(b)**

TiO_2 has tetragonal system with five plane of symmetry and five axes of symmetry.

255 **(c)**

The cubic unit cell has 8 atoms at eight corners. Thus, each atom is shared by 8 unit cells.

256 **(a)**

In bcc structure 68% of the available volume is occupied by spheres. Thus, vacant space is 32%.

257 **(a)**

Packing fraction in bcc is 68% and thus, empty space is 32%.

258 **(a)**

Suppose atoms of element Y in ccp $= 100$

Number of tetrahedral voids $= 2 \times 100$

Number of atoms of element $X = \frac{2}{3} \times 200$

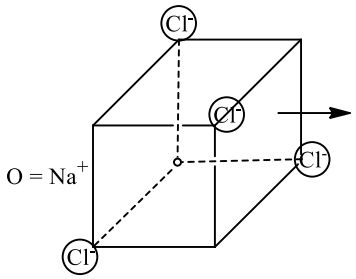
$$= \frac{400}{3}$$

$$\frac{X}{Y} = \frac{400}{300}$$

Formula $= X_4Y_3$

259 **(a)**

Since, in a unit cell of NaCl crystal, the ions are arranged in the following manner.



When all the ions lying along the shown axis, the remaining unit cell contains 4 Na^+ and 4 Cl^- ions.