CHAPTER

15

THE SOLID STATE

FACT/DEFINITION TYPE QUESTIONS

1. Which of the following is not a characteristic property of solids?
(a) Intermolecular distances are short.
(b) Intermolecular forces are weak.
(c) Constituent particles have fixed positions.
(d) Solids oscillate about their mean positions.

2. Most crystals show good cleavage because their atoms, ions or molecules are
(a) weakly bonded together
(b) strongly bonded together
(c) spherically symmetrical
(d) arranged in planes

3. "Crystalline solids are anisotropic in nature. What is the meaning of anisotropic in the given statement?
(a) A regular pattern of arrangement of particles which repeats itself periodically over the entire crystal.
(b) Different values of some of physical properties are shown when measured along different directions in the same crystals.
(c) An irregular arrangement of particles over the entire crystal.
(d) Same values of some of physical properties are shown when measured along different directions in the same crystals.

4. A crystalline solid
(a) changes abruptly from solid to liquid when heated
(b) has no definite melting point
(c) undergoes deformation of its geometry easily
(d) has an irregular 3-dimensional arrangements

5. Which of the following is not a characteristic of a crystalline solid ?
(a) Definite and characteristic heat of fusion.
(b) Isotropic nature.
(c) A regular periodically repeated pattern of arrangement of constituent particles in the entire crystal.
(d) A true solid

6. Which of the following is not a crystalline solid?
(a) KCl (b) CsCl
(c) Glass (d) Rhombic S

7. 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

8. Which of the following is not a crystalline solid?
(a) KCl (b) CsCl
(c) Glass (d) Rhombic S

9. Which of the following is an amorphous solid ?
(a) Graphite (C) (b) Quartz glass (SiO_2)
(c) Chrome alum (d) Silicon carbide (SiC)

10. Which of the following statement is not true about amorphous solids ?
(a) On heating they may become crystalline at certain temperature.
(b) They may become crystalline on keeping for long time.
(c) Amorphous solids can be moulded by heating.
(d) They are anisotropic in nature.

11. The sharp melting point of crystalline solids is due to _____.
(a) a regular arrangement of constituent particles observed over a short distance in the crystal lattice.
(b) a regular arrangement of constituent particles observed over a long distance in the crystal lattice.
(c) same arrangement of constituent particles in different directions.
(d) different arrangement of constituent particles in different directions.

12. Why some glass objects from ancient civilisations are found to become milky in appearance?
(a) Glass is a crystalline solid, milky appearance is due to its crystalline nature.
(b) Glass is amorphous but on heating it become crystalline at some temperature.
(c) Because of reaction of glass with impurities present in the atmosphere.
(d) None of these.

13. Which of the following amorphous solid is used as photovoltaic material for conversion of sunlight into electricity?
(a) Quartz glass (b) Quartz
(c) Silicon (d) Both (a) and (b)

14. Solid CH_4 is
(a) ionic solid (b) covalent solid
(c) molecular solid (d) does not exist

15. An example of a covalent crystalline solid is:
(a) Si (b) Al
(c) NaF (d) Ar

16. Among solids, the highest melting point is exhibited by
(a) Covalent solids (b) Ionic solids
(c) Pseudo solids (d) Molecular solids

17. Which of the following exists as covalent crystals in the solid state ?
(a) Iodine (b) Silicon
(c) Sulphur (d) Phosphorus

18. The major binding force of diamond, silicon and quartz is
(a) electrostatic force (b) electrical attraction
(c) covalent bond force (d) non-covalent bond force

19. In graphite electrons are :
(a) localised on each carbon atom
(b) spread out between the sheets
(c) localised on every third carbon atom
(d) present in antibonding orbital.

20. Which one of the following forms a molecular solid when solidified?
(a) Silicon carbide (b) Calcium fluoride
(c) Rock salt (d) Methane

21. Which of the following is a network solid ?
(a) SO_2 (solid) (b) I_2
(c) Diamond (d) H_2O (Ice)

22. Which of the following solids is not an electrical conductor?
(a) Mg (s) (b) TiO (s)
(c) I_2 (s) (d) H_2O (s)

23. Iodine molecules are held in the crystals lattice by ______.
(a) london forces
(b) dipole-dipole interactions
(c) covalent bonds
(d) coulombic forces

24. Which of the following is not the characteristic of ionic solids?
(a) Very low value of electrical conductivity in the molten state.
(b) Brittle nature.
(c) Very strong forces of interactions.
(d) Anisotropic nature.

25. Graphite is a good conductor of electricity due to the presence of ______.
(a) lone pair of electrons (b) free valence electrons
(c) cations (d) anions

26. Graphite cannot be classified as ______.
(a) conducting solid (b) network solid
(c) covalent solid (d) ionic solid

27. Which of the following cannot be regarded as molecular solid ?
(i) SiC (Silicon carbide) (ii) AlN
(iii) Diamond (iv) I_2
(a) (i), (ii) and (iii) (b) (ii) and (iii)
(c) (iv) (d) (ii) and (iv)

28. Crystals can be classified into basic crystal units, equal to
(a) 7 (b) 4
(c) 14 (d) 2

29. How many three dimensional crystal lattice are possible?
(a) 20 (b) 7
(c) 14 (d) 10

30. Which of the following represents monoclinic crystal system?
(a) $a \neq b \neq c, \alpha \neq \beta \neq \gamma \neq 90°$
(b) $a = b = c, \alpha = \beta = \gamma \neq 90°$
(c) $a \neq b \neq c, \alpha = \gamma = 90° \ \beta \neq 90°$
(d) $a = b = c, \alpha = \beta = \gamma = 90°$

31. In face−centred cubic lattice, a unit cell is shared equally by how many unit cells
(a) 2 (b) 4
(c) 6 (d) 8

32. For orthorhombic system axial ratios are $a \neq b \neq c$ and the axial angles are
(a) $\alpha = \beta = \gamma \neq 90°$ (b) $\alpha = \beta = \gamma = 90°$
(c) $\alpha = \beta = \gamma = 90°, \beta = 90°$ (d) $\alpha \neq \beta \neq \gamma = 90°$

33. The unit cell dimensions of a cubic lattice (edges a, b, c and the angles between them, α, β and γ) are
(a) $a = b = c, \alpha = \beta = \gamma = 90^0$
(b) $a = b \neq c, \alpha = \beta = \gamma = 90^0$
(c) $a = b = c, \alpha = \gamma = 90^0, \beta \neq 90^0$
(d) $a \neq b \neq c, \alpha = \beta = 90^0, \gamma \neq 90^0$

34. Tetragonal crystal system has the following unit cell dimensions
(a) $a = b = c, \alpha = \beta = \gamma = 90°$
(b) $a = b \neq c, \alpha = \beta = \gamma = 90°$
(c) $a \neq b \neq c, \alpha = \beta = \gamma = 90°$
(d) $a = b \neq c, \alpha = \beta = 90° \ \gamma = 120°$

35. The number of atoms contained in a *fcc* unit cell of a monoatomic substance is
(a) 1 (b) 2
(c) 4 (d) 6

36. In face−centred cubic lattice, a unit cell is shared equally by how many unit cells
(a) 2 (b) 4
(c) 6 (d) 8

37. The number of atoms per unit cell of bcc structure is
(a) 1 (b) 2
(c) 4 (d) 6

38. When molten zinc is converted into solid state, it acquires *hcp* structure. The number of nearest neighbours of Zn will be
(a) 6 (b) 12
(c) 8 (d) 4

39. Hexagonal close packed arrangement of ions is described as
(a) ABCABA (b) ABCABC
(c) ABABA (d) ABBAB

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

41. Which of the following metal(s) show(s) hexagonal close packed structure (hcp) and which show face centred cubic (fcc) structure?

	hcp	fcc
(a)	Ag, Zn	Mg, Cu
(b)	Mg, Zn	Ag, Cu
(c)	Cu, Fe	Al, Sn
(d)	Na, Li	Zn, Cu

42. The number of octahedral voids present in a lattice is <u>A</u>. The number of closed packed particles, the number of tetrahedral voids generated is <u>B</u> the number of closed packed particles
(a) A- equal, B- half
(b) A- twice, B- equal
(c) A- twice , B- half
(d) A- equal, B- twice

43. In the hexagonal close packed structure of a metallic lattice, the number of nearest neighbours of a metallic atom is
(a) twelve
(b) four
(c) eight
(d) six

44. The Ca^{2+} and F^- are located in CaF_2 crystal, respectively at face centred cubic lattice points and in
(a) tetrahedral voids
(b) half of tetrahedral voids
(c) octahedral voids
(d) half of octahedral voids

45. If Germanium crystallises in the same way as diamond, then which of the following statement is not correct?
(a) Every atom in the structure is tetrahedrally bonded to 4 atoms.
(b) Unit cell consists of 8 Ge atoms and co-ordination number is 4.
(c) All the octahedral voids are occupied.
(d) All the octahedral voids and 50% tetrahedral voids remain unoccupied.

46. The arrangement ABC ABC .... is referred to as
(a) Octahedral close packing
(b) Hexagonal close packing
(c) Tetrahedral close packing
(d) Cubic close packing

47. The total number of tetrahedral voids in the face centred unit cell is ______.
(a) 6
(b) 8
(c) 10
(d) 12

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

49. In the cubic close packing, the unit cell has ______.
(a) 4 tetrahedral voids each of which is shared by four adjacent unit cells.
(b) 4 tetrahedral voids within the unit cell.
(c) 8 tetrahedral voids each of the which is shared by four adjacent unit cells.
(d) 8 tetrahedral voids within the unit cells.

50. In which of the following arrangements octahedral voids are formed ?
(i) *hcp*
(ii) *bcc*
(iii) simple cubic
(iv) *fcc*
(a) (i), (ii)
(b) (i), (iv)
(c) (iii)
(d) (ii), (iv)

51. Which of the following is the correct increasing order of packing efficiency for hcp, bcc and simple cubic lattice?
(a) hcp < bcc < simple cubic
(b) bcc < hcp < simple cubic
(c) simple cubic < bcc < hcp
(d) simple cubic < hcp < bcc

52. Total volume of atoms present in bcc unit cell is.
(a) $\frac{16}{3}\pi r^3$
(b) $\frac{4}{3}\pi r^3$
(c) $\frac{8}{3}\pi r^3$
(d) $\frac{12}{3}\pi r^3$

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

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

55. The fraction of total volume occupied 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) $\frac{\pi}{6}$

56. Percentages of free space in cubic close packed structure and in body centered packed structure are respectively
(a) 30% and 26%
(b) 26% and 32%
(c) 32% and 48%
(d) 48% and 26%

57. The empty space in the body centred cubic lattice is
(a) 68%
(b) 52.4%
(c) 47.6%
(d) 32%
(e) 74%

58. Which one of the following statements about packing in solids is **incorrect** ?
(a) Coordination number in bcc mode of packing is 8.
(b) Coordination number in hcp mode of packing is 12.
(c) Void space in hcp mode of packing is 32%.
(d) Void space is ccp mode of packing is 26%.

59. A metallic crystal crystallizes into a lattice containing a sequence of layers AB AB AB......Any packing of spheres leaves out voids in the lattice. What percentage of volume of this lattice is empty space?
(a) 74%
(b) 26%
(c) 50%
(d) none of these.

60. In NaCl, the centre-to-centre nearest-neighbour distance of ions is

(a) $\frac{1}{4}a$ (b) $\frac{\sqrt{3}}{2}a$

(c) $\frac{1}{2}a\sqrt{2}$ (d) $\frac{1}{2}a$

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

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

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

62. CsBr crystallises in a body centered 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) 0.425 g/cm^3 (b) 8.5 g/cm^3

(c) 4.25 g/cm^3 (d) 82.5 g/cm^3

63. An element occuring in the bcc structure has 12.08×10^{23} unit cells. The total number of atoms of the element in these cells will be

(a) 24.16×10^{23} (b) 36.18×10^{23}

(c) 6.04×10^{23} (d) 12.08×10^{23}

64. Pottasium has a bcc structure with nearest neighbour distance 4.52 Å. Its atomic weight is 39. Its density (in kg m^{-3}) will be

(a) 454 (b) 804

(c) 852 (d) 910

65. The cubic unit cell of a metal (molar mass = 63.55g mol^{-1}) has an edge length of 362 pm. Its density is 8.92g cm^{-3}. The type of unit cell is

(a) primitive (b) face centered

(c) body centered (d) end centered

66. AB; crystallizes in a body centred cubic 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

67. Iron crystallizes in a b.c.c. system with a lattice parameter of 2.861 Å. Calculate the density of iron in the b.c.c. system (Atomic weight of Fe = 56, $N_A = 6.02 \times 10^{23}$ mol^{-1})

(a) 7.92 g ml^{-1} (b) 8.96 g ml^{-1}

(c) 2.78 g ml^{-1} (d) 6.72 g ml^{-1}

68. 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^{36}

69. A metal crystallizes in 2 cubic phases fcc and bcc whose unit cell lengths are 3.5 Å and 3.0Å respectively. The ratio of their densities is

(a) 0.72 (b) 2.04

(c) 1.46 (d) 3.12

70. Which of the following statements is not correct ?

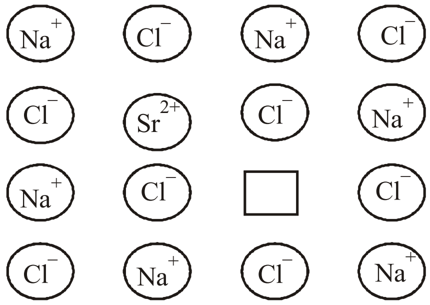
(a) Vacancy defect results in decrease in density of substance.

(b) Vacancy defect can develop when a substance is heated.

(c) Interstitial defect increases the density of the substance.

(d) Ionic solids show interstitial defects only.

71. Which defect is shown in the given figure?



(a) Frenkel defect (b) Impurity defect

(c) Schottky defect (d) Vacancy defect

72. Each of the following solids show, the Frenkel defect except

(a) ZnS (b) AgBr

(c) AgI (d) KCl

73. Schottky defect defines imperfection in the lattice structure of

(a) solid (b) gas

(c) liquid (d) plasma

74. 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-centre

75. Schottky defect in crystals is observed when

(a) an ion leaves its normal site and occupies an interstitial site

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

(c) density of the crystal increases

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

76. The appearance of colour in solid alkali metal halides is generally due to

(a) Schottky defect (b) Frenkel defect

(c) Interstitial positions (d) F-centre

77. Crystal defect indicated in the diagram below is

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

(a) Interstitial defect

(b) Schottky defect

(c) Frenkel defect

(d) Frenkel and Schottky defects

78. Schottky defect generally appears in :
(a) NaCl (b) KCl
(c) CsCl (d) all of these

79. Which defect causes decrease in the density of crystal
(a) Frenkel (b) Schottky
(c) Interstitial (d) F – centre

80. Which statement does not make sense?
(a) Frenkel defect is not found in alkali metal halides
(b) Schottky defect is very common in alkali metal halides
(c) Schottky defect lowers the density of the crystal
(d) Frenkel defect lowers the density of the crystal.

81. Frenkel and Schottky defects are :
(a) nucleus defects (b) non-crystal defects
(c) crystal defects (d) nuclear defects

82. Equal number of atoms or ion missing from normal lattice point creating a vacancy due to
(a) Frenkel defect (b) Mass defect
(c) Schottky defect (d) Interstitial defect

83. In stoichiometric defects, the types of compound exhibit Frenkel defects have/has
(a) Low co-ordination nos.
(b) High co-ordination
(c) Small difference in the size of cations and anions
(d) None of these

84. The crystal with metal deficiency defect is
(a) NaCl (b) FeO
(c) KCl (d) ZnO

85. Which of the following has Frenkel defects?
(a) Sodium chloride (b) Graphite
(c) Silver bromide (d) Diamond

86. Which of the following crystals does not exhibit Frenkel defect?
(a) AgBr (b) AgCl
(c) KBr (d) ZnS

87. Due to Frenkel defect, the density of ionic solids
(a) decreases (b) increases
(c) neither (a) nor (b) (d) does not change

88. In a solid lattice the cation has left a lattice site and is located at an interstitial position, the lattice defect is :
(a) Interstitial defect (b) Valency defect
(c) Frenkel defect (d) Schottky defect

89. Doping of AgCl crystals with $CdCl_2$ results in
(a) Frenkel defect
(b) Schottky defect
(c) Substitutional cation vacancy
(d) Formation of F - centres

90. Cations are present in the interstitial sites in ________.
(a) Frenkel defect (b) Schottky defect
(c) Vacancy defect (d) Metal deficiency defect

91. What is the energy gap between valence band and conduction band in crystal of insulators ?
(a) Both the bands are overlapped with each other
(b) Very small
(c) Infinite
(d) Very large

92. Which of the following is non stoichiometric defect?
(i) Metal excess defect (ii) Impurity defect
(iii) F-centre (iv) Metal deficiency defect
(a) (i) and (iv) (b) (i), (iii) and (iv)
(c) (iii) and (ii) (d) All of these

93. Which kind of defects are introduced by doping ?
(a) Dislocation defect (b) Schottky defect
(c) Frenkel defects (d) Electronic defects

94. Silicon doped with electron – rich impurity forms _______.
(a) p-type semiconductor
(b) n-type semiconductor
(c) intrinsic semiconductor
(d) insulator

95. Which of the following defects is also known as dislocation defect ?
(a) Frenkel defect
(b) Schottky defect
(c) Non – stoichiometric defect
(d) Simple interstitial defect

96. Doping of silicon (Si) with boron (B) leads to :
(a) *n*-type semiconductor (b) *p*-type semiconductor
(c) metal (d) insulator

97. On doping Ge metal with a little of In or Ga, one gets
(a) p-type semi conductor (b) n-type semi conductor
(c) insulator (d) rectifier

98. With which one of the following elements silicon should be doped so as to give *p*-type of semiconductor ?
(a) Germanium (b) Arsenic
(c) Selenium (d) Boron

99. To get a n- type semiconductor, the impurity to be added to silicon should have which of the following number of valence electrons
(a) 1 (b) 2
(c) 3 (d) 5

100. 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.

101. The addition of arsenic to germanium makes the latter a
(a) metallic conductor (b) intrinsic semiconductor
(c) mixed conductor (d) extrinsic semiconductor

102. Pure silicon doped with phosphorus is a
(a) metallic conductor (b) insulator
(c) *n*-type semiconductor (d) *p*-type semiconductor

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

104. Which of the following compound is like metallic copper in its conductivity and appearance?
(a) VO_3 (b) TiO_3
(c) ReO_3 (d) CrO_2

105. Magnetic moment of electron is due to which of the following reason?
(a) Due to its orbital motion around the nucleus.
(b) Due to its spin around its own axis.
(c) Due to negative charge on electron.
(d) Both (a) and (b).

106. What is the value of Bohr magneton μ_B in A m^2?
(a) 9.27×10^{-24} Am^2 (b) 9.27×10^{-20} Am^2
(c) 9.00×10^{-30} Am^2 (d) 9.27×10^{-25} Am^2

107. Which of the following type of substances can be permanently magnetised?
(a) Diamagnetic (b) Ferromagnetic
(c) Ferrimagnetic (d) Antiferromagnetic

108. Which of the following structure represents ferrimagnetism?
(a) ↑ ↓ ↑ ↓ ↑ ↓ (b) ↑ ↑ ↑ ↑ ↑
(c) ↓ ↓ ↓ ↓ ↓ (d) ↑ ↑ ↓ ↑ ↑ ↓

109. Which of the following statement is not correct?
(a) Paramagnetic substances lose their magnetism in the absence of magnetic field.
(b) Diamagnetic substances are weakly magnetised in magnetic field in opposite direction.
(c) Ferromagnetic substances becomes paramagnetic on heating.
(d) In antiferromagnetism domains are oppositely oriented and cancel out each other's magnetic moment.

110. An element containing an odd number of electrons is:
(a) Paramagnetic (b) Diamagnetic
(c) Antiferromagnetic (d) None of these

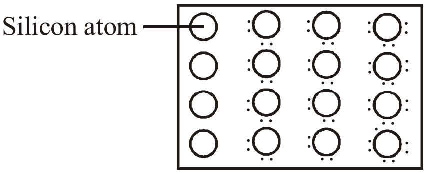
111. Which of the following oxides behaves as conductor or insulator depending upon temperature ?
(a) TiO (b) SiO_2
(c) TiO_3 (d) MgO

112. Which of the following oxides shows electrical properties like metals ?
(a) SiO_2 (b) MgO
(c) SO_2 (s) (d) CrO_2

113. Which of the following statements is not true ?
(a) Paramagnetic substances are weakly attracted by magnetic field.
(b) Ferromagnetic substances cannot be magnetised permanently
(c) The domains in antiferromagnetic substances are oppositely oriented with respect to each other.
(d) Pairing of electrons cancels their magnetic moment in the diamagnetic substances.

114. A ferromagnetic substance becomes a permanent magnet when it is placed in a magnetic field because ________.
(a) all the domains get oriented in the direction of magnetic field.
(b) all the domains get oriented in the direction opposite to the direction of magnetic field.
(c) domains get oriented randomly.
(d) domains are not affected by magnetic field.

115. A perfect crystal of silicon interchange is doped with some elements as given in the options. Which of these options show n-type semiconductors ?



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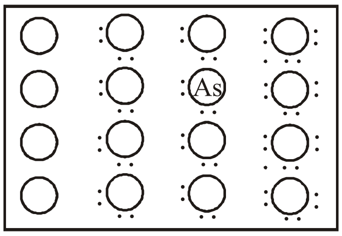

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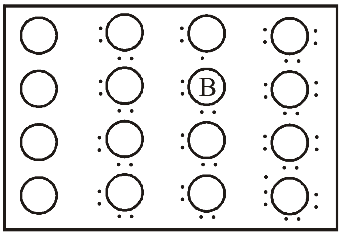

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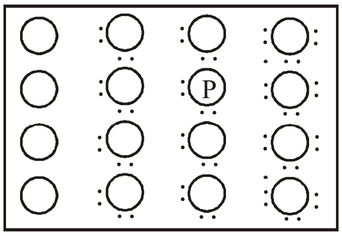

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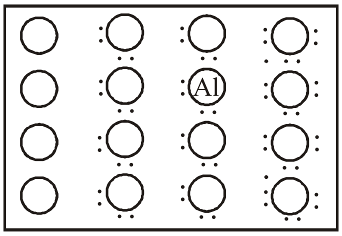


(a) (i) and (iii) (b) (i)
(c) (ii) and (iv) (d) (iii)

STATEMENT TYPE QUESTIONS

116. Which of the following statement(s) is/are correct?
(i) Crystalline solids have definite characteristic geometrical shape.
(ii) Crystalline solids have long range order.
(iii) Sodium chloride and quartz glass are examples of crystalline solids.
(iv) Crystalline solids are isotropic in nature.
(a) (i), (ii) and (iii) (b) (i), (ii) and (iv)
(c) (i) and (ii) (d) (i) only

117. Which of the following sequence of T and F is correct for given statements. Here T stands for true statement and F stands for false statement?
(i) Ionic solids are electrical insulators in the solid state but conduct electricity in molten state.
(ii) Graphite is a covalent solid.
(iii) Covalent solids are conductor of electricity.
(iv) Non polar molecular solids are held by weak dispersion forces or London forces while polar molecular solids are held by stronger dipole - dipole interactions.
(a) TTTF (b) FTTF
(c) TFTT (d) TTFT

118. Which of the following statements(s) is/are incorrect?

(i) Only 1/8th portion of an atom located at corner of a cubic unit cell is its neighbouring unit cell.

(ii) Total number of atoms per unit cell for a face centered cubic unit cell is 3 .

(iii) Atom located at the body center is shared between two adjacent unit cells.

(a) (iii) only (b) (ii) only
(c) (i) and (ii) (d) (ii) and (iii)

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

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

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

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

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

(a) (i) and (iv) (b) (iii) and (iv)
(c) (ii) and (iii) (d) (iv) only

120. Which of the following sequence of T and F is true for given statements. Here T stands for true statement and F stands for false statement?

(i) Frenkel defect results in increase in density of the solid.

(ii) ZnS, AgCl, AgBr and AgI shows Frenkel defect.

(iii) Schottky defect results in decrease in density of the solid.

(iv) AgBr shows Schottky defect only.

(v) For NaCl there is one Schottky defect per 10^{16} ions.

(a) TTTFT (b) TTTFF
(c) FTTFT (d) FTTFF

121. Which of the following statements is /are correct?

(i) LiCl crystals are pink due to metal excess defect due to presence of extra L^+i ion at interstitial sites.

(ii) Zinc oxide on heating turns yellow because its anionic sites are occupied by unpaired electrons.

(iii) In FeO crystals some Fe^{2+} are missing and the loss of positive charge is made up by the presence of required number of Fe^{3+} ions.

(a) (i) and (ii) (b) (i), (ii) and (iii)
(c) (ii) and (iii) (d) (iii) only

122. Which of the following sequence of T and F is correct? Here 'T' stands for true and 'F' stands for false statement.

(i) Solids have conductivities in the order of 10^{-20} to 10^{7} ohm^{-1} m$^{-1.}$

(ii) In semiconductors the gap between filled valence band and conduction band is small.

(iii) Electrical conductivity of insulators increases with rise in temperature.

(iv) Insulators have conductivities ranging between 10^{-6} to 10^{4} ohm^{-1} m^{-1} .

(a) TTFF (b) TTFT
(c) FTFF (d) FTTF

123. White crystal of zinc oxide is heated

(i) Metal excess defect is created.

(ii) Crystal become *p*-type semiconductor

(iii) Crystal become yellow in color.

(iv) Free electron are created.

(a) All statement(s) are correct. (b) (i), (ii) and (iv)
(c) (i), (ii) and (iii) (d) (ii) and (iv)

124. Consider the Oxygen and chromium dioxide, both are placed in magnetic field:

(i) Oxygen is attracted strongly in a magnetic field.

(ii) Magnetic field persist in chromium dioxide while in Oxygen not.

(a) Both Statements are correct.
(b) Statements (i) is correct only.
(c) Statements (ii) is correct only.
(d) Both Statements are incorrect.

MATCHING TYPE QUESTIONS

125. Match the columns

	Column-I (Type of solid)		**Column-II (Example of solid)**
(A)	Molecular solid	(p)	Ag
(B)	Ionic solid	(q)	SiC
(C)	Metallic solid	(r)	CCl_4
(D)	Covalent solid	(s)	MgO

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

126. Match the columns

	Column-I (Type of unit cell)		**Column-II (Characteristic feature)**
(A)	Primitive cubic unit cell	(p)	Each of the three perpendicular edges compulsorily have the different edge length i.e.; $a \neq b \neq c$.
(B)	Body centered cubic unit cell	(q)	Number of atoms per unit cell is one
(C)	Face centered cubic unit cell	(r)	Each of the three perpendicular edges compulsorily have the same edge length i.e.; a = b = c.
(D)	End centered orthorhombic unit cell	(s)	In addition to the contribution from the corner atoms the number of atoms present in a unit cell is one.
		(t)	In addition to the contribution from the corner atoms the number of atoms present in a unit cell is three.

(a) A – (q), B – (s), C – (r, t), D – (p)
(b) A – (q, r), B – (r, s), C – (r, t), D – (p,s)
(c) A – (r, s), B – (q, r), C – (r), D – (p)
(d) A – (t), B – (r, s), C – (p, s), D – (q)

127. Match the columns

	Column-I **(Crystal system)**		**Column-II** **(Compounds)**
(A)	Rhombohedral	(p)	KNO_3
(B)	Orthorhombic	(q)	Zinc blende
(C)	Cubic	(r)	CdS
(D)	Hexagonal	(s)	Calcite

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

128. Match the columns

	Column-I		**Column-II**
(A)	Square close packing in two dimensions	(p)	Triangular voids
(B)	Hexagonal close packing in two dimensions	(q)	Pattern of spheres is repeated every fourth layer
(C)	Hexagonal close packing in three dimensions	(q)	Coordination number 4
(D)	Cubic close packing in three dimensions	(s)	Pattern of sphere is repeated alternate layers

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

129. Match Column-I (Type of close packed structure) with Column-II (Coordination number) and choose the correct option.

	Column-I		**Column-II**
(A)	One dimensional close packed arrangement.	(p)	12
(B)	Square close packing in two dimensions.	(q)	6
(C)	Two dimensional hexagonal close packing.	(r)	2
(D)	Cubic close packed arrangement.	(s)	4

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

130. Match the columns

	Column-I		**Column-II**
(A)	Impurity defect	(p)	NaCl with anionic sites F-centres
(B)	Metal excess defect	(q)	FeO with Fe^{3+}
(C)	Metal deficiency defect	(r)	NaCl with Sr^{2+} and some cationic sites vacant

(a) A – (r), B – (p), C – (q)
(b) A – (p), B – (q), C – (r)
(c) A – (r), B – (q), C – (p)
(d) A – (q), B – (p), C – (r)

131. Match the columns

	Column-I		**Column-II**
(A)	Mg in solid state	(p)	*p*-Type semiconductor
(B)	$MgCl_2$ in molten state	(q)	*n*-Type semiconductor
(C)	Silicon with phosphorus	(r)	Electrolytic conductors
(D)	Germanium with boron	(s)	Electronic conductors

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

132. Match the columns

	Column-I **(Molecule/ion)**		**Column-II** **(Magnetic property)**
(A)	C_6H_6	(p)	Antiferromagnetic
(B)	CrO_2	(q)	Ferrimagnetic
(C)	MnO	(r)	Ferromagnetic
(D)	Fe_3O_4	(s)	Paramagnetic
(E)	Fe^{3+}	(t)	Diamagnetic

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

133. Match the columns

	Column-I **(Compound)**		**Column-II** **(Magnetic Property)**
(A)	NaCl	(p)	Ferrimagnetic
(B)	MnO	(q)	Paramagnetic
(C)	$CrCl_3$	(r)	Ferromagnetic
(D)	CrO_2	(s)	Diamagnetic
(E)	$MgFe_2O_4$	(t)	Antiferromagnetic

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

ASSERTION-REASON TYPE QUESTIONS

Directions : Each of these questions contain two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

134. Assertion : Crystalline solids have long range order.
Reason : Amorphous solids have short range order.

135. Assertion: Glass panes fixed to windows or panes of old buildings are found to be slightly thicker at the bottom.
Reason: Amorphous solids have a tendency to flow.

136. Assertion : In crystal lattice, the size of the tetrahedral hole is larger than an octahedral hole.
Reason : The cations occupy less space than anions in crystal packing.

137. Assertion : In close packing of spheres, a tetrahedral void is surrounded by four spheres whereas an octahedral void is surrounded by six spheres.

Reason : A tetrahedral void has a tetrahedral shape whereas an octahedral void has an octahedral shape.

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

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

139. Assertion : In any ionic solid (MX) with Schottky defects, the number of positive and negative ions are same.

Reason : Equal number of cation and anion vacancies are present.

140. Assertion : Electrical conductivity of semiconductors increases with increasing temperature.

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

141. Assertion : On heating ferromagnetic or ferrimagnetic substances, they become paramagnetic.

Reason : The electrons change their spin on heating.

CRITICAL THINKING TYPE QUESTIONS

142. Which of the following type of solid has high melting point and do not conduct electricity but its aqueous solution and melt conduct electricity ?

(a) Covalent (b) Ionic
(c) Molecular (d) Metallic

143. A group 1 hydride crystal when heated in presence of its constituent metal vapour shows pink color. This metal can be

(a) Na (b) K
(c) Rb (d) Li

144. A solid with high electrical and thermal conductivity is

(a) Si (b) Li
(c) NaCl (d) Ice

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

(a) Same in all directions
(b) Different in different directions
(c) Cannot be measured
(d) Always zero

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

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

(a) (i) and (iii) (b) (iii) and (iv)
(c) (i), (ii) and (iv) (d) (iii) only

147. The number of carbon atoms per unit cell of diamond unit cell is :

(a) 8 (b) 6
(c) 1 (d) 4

148. Na and Mg crystallize in *bcc* and *fcc* type crystals respectively, then the number of atoms of Na and Mg present 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

149. In a cubic lattice A atom occupy all the corners. If B atom occupy one of the opposite face, and atom C occupy the remaining faces. The simplest formulae of the compound is

(a) ABC_3 (b) ABC_2
(c) ABC (d) AB_2C

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

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

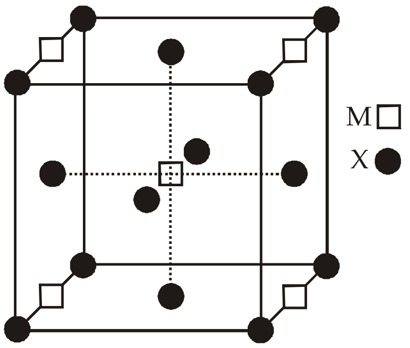
151. Potassium crystallizes with a

(a) body-centred cubic lattice
(b) face-centred cubic lattice
(c) simple cubic lattice
(d) orthorhombic lattice

152. 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

153. A compound M_pX_q has cubic close packing (ccp) arrangement of X. Its unit cell structure is shown below. The empirical formula of the compound is



(a) MX (b) MX_2
(c) M_2X (d) M_5X_{14}

154. A substance A_xB_y crystallizes 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 can't be specified

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

(a) Cl^- ion form *fcc* lattice and Na^+ ions occupy all octahedral voids of the unit cell.
(b) Ca^{2+} ions form *fcc* lattice and F^- ions occupy all the eight tetrahedral voids of the unit cell.
(c) O^{2-} ions form *fcc* lattice and Na^+ ions occupy all the eight tetrahedral voids of the unit cell.
(d) S^{2-} ions form *fcc* lattice and Zn^{2+} ions go into alternate tetrahedral voids of the unit cell.

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

(a) $\frac{1}{2}a : \frac{\sqrt{3}}{4}a : \frac{1}{2\sqrt{2}}a$ (b) $\frac{1}{2}a : \sqrt{3}a : \frac{1}{\sqrt{2}}a$

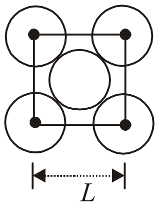
(c) $\frac{1}{2}a : \frac{\sqrt{3}}{2}a : \frac{\sqrt{3}}{2}a$ (d) $1a : \sqrt{3}a : \sqrt{2}a$

157. Packing efficiency by arrangement of atoms in two dimensional hexagonal close packing is

(a) 60.43 (b) 65.78

(c) 59.78 (d) 68.76

158. 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%

159. Edge length of unit cell is 3.608×10^{-8} cm, which crystallizes in fcc and is determined to have a density of 8.92 g/cm^3. The mass of four atoms is

(a) 4.18×10^{-22} (b) 1.67×10^{-21}

(c) 2.09×10^{-22} (d) 8.37×10^{-22}

160. The edge length of unit cell of a metal having molecular weight 75 g/mol is 5Å which crystallizes in cubic lattice. If the density is 2g/cc then find the radius of metal atom. ($N_A = 6 \times 10^{23}$). Give the answer in pm.

(a) 217 pm (b) 210 pm

(c) 220 pm (d) 205 pm

161. The number of atoms in 100 g of an *fcc* crystal with density, $d = 10\ g/cm^3$ and cell edge equal to 100 pm, is equal to

(a) 1×10^{25} (b) 2×10^{25}

(c) 3×10^{25} (d) 4×10^{25}

162. A metallic element exists as cubic lattice. Each edge of the unit cell is 2.88 Å. The density of the metal is 7.20 g cm^{-3}. How many unit cell will be present in 100 g of the metal?

(a) 6.85×10^2 (b) 5.82×10^{23}

(c) 4.37×10^5 (d) 2.12×10^6

163. A metal has a *fcc* lattice. The edge length of the unit cell is 404 pm. The density of the metal is 2.72 g cm^{-3}. The molar mass of the metal is :

(N_A Avogadro's constant = 6.02×10^{23} mol^{-1})

(a) 30 g mol^{-1} (b) 27 g mol^{-1}

(c) 20 g mol^{-1} (d) 40 g mol^{-1}

164. Al (at. wt 27) crystallizes in the cubic system with a cell edge of 4.05 Å. Its density is 2.7 g per cm^3. Determine the unit cell type calculate the radius of the Al atom

(a) fcc, 2.432 Å (b) bcc, 2.432 Å

(c) bcc, 1.432 Å (d) fcc, 1.432 Å

165. A compound is formed by elements A and B. The crystalline cubic structure has the A atoms at the corners of the cube and B atoms at the body centre. The simplest formula of the compound is

(a) AB (b) A_6B

(c) AB_6 (d) A_8B_4

166. What type of semiconductors respectively are formed when the group 14 are doped with the group 13 and group 15?

(a) p,n (b) n,p

(c) p,p (d) n,n

167. Which of the following is ferroelectric compound?

(a) $BaTlO_3$ (b) $K_4[Fe(CN)_6]$

(c) Pb_2O_3 (d) None of these

168. Substance which is weakly repelled by a magnetic field is

(a) O_2 (b) H_2O

(c) CrO_2 (d) Fe_3O_4

(e) $ZnFe_2O_4$

169. Which one of the following statements is correct?

(a) NaCl is a paramagnetic salt

(b) $CuSO_4$ is a diamagnetic salt

(c) MnO is an example of ferromagnetic substance

(d) Ferrimagnetic substance like $ZnFe_2O_4$ becomes paramagentic on heating

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

(a) positive

(b) neutral

(c) negative

(d) depends on concentration of *p* impurity

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

(a) $K_{metals} >> K_{insulators} < K_{semiconductors}$

(b) $K_{metals} << K_{insulators} < K_{semiconductors}$

(c) K_{metals} ; $K_{insulators} > K_{semiconductors}$ = zero

(d) $K_{metals} < K_{semiconductors} > K_{insulators} \neq$ zero

HINTS AND SOLUTIONS

FACT/DEFINITION TYPE QUESTIONS

1. **(b)** Intermolecular forces are strong in solids.

2. **(d)** Crystals show good cleavage because their constituent particles are arranged in planes.

3. **(b)** Crystalline solids are anisotropic in nature that is some of their physical properties like electrical resistance or refractive index show different values when measured along different directions in the same crystals.

4. **(a)** In crystalline solid there is perfect arrangement of the constituent particles only at 0 K. As the temperature increases the chance that a lattice site may be unoccupied by an ion increases. As the number of defects increases with temperature solid changes into liquid.

5. **(b)**

6. **(c)** Glass is amorphous solid.

7. **(b)** Amorphous solids are isotropic, because these substances show same properties in all directions.

8. **(c)** Glass is amorphous solid.

9. **(b)** **10.** **(d)** **11.** **(b)**

12. (b) On heating, amorphous solids become crystalline at some temperature. The milky appearance of glass is because of some crystallisation.

13. **(c)** Amorphous silicon is used as best photovoltaic material available for conversion of sunlight into electricity.

14. **(c)** Solid CH_4 is a molecular solid. In this, the constituent molecules are held together by van der Waal's forces.

15. **(a)** Si is an example of covalent crystalline solid among the given choices. Si atoms are covalently linked in tetrahedral manner.

16. **(a)** Covalent as in case of diamond.

17. **(b)** Among the given crystals, only silicon exists as a covalent solid. It has diamond like structure.

18. **(c)** Covalent bond force

19. **(b)** In graphite, the electrons are spread out between the sheets.

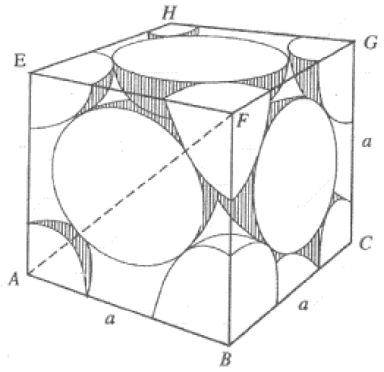
20. **(d)** **21.** **(c)** **22.** **(c)** **23.** **(a)** **24.** **(a)**

25. **(b)** **26.** **(d)** **27.** **(a)** **28.** **(a)**

29. **(c)** There are only 14 possible three dimensional lattice. These are called Bravais lattices.

30. **(b)**

31. **(c)**



An isolated fcc cell is shown here. Each face of the cell is common to two adjacent cells. Therefore, each face centre atom contributes only half of its volume and mass to one cell. Arranging six cells each sharing the remaining half of the face centred atoms, constitutes fcc cubic lattice. e.g., Cu and Al.

32. **(b)** For orthorhombic system $\alpha = \beta = \gamma = 90°$

33. **(a)** It is based on the definition of the cubic lattice.

34. **(b)** For tetragonal $a = b \neq c$, $\alpha = \beta = \gamma = 90°$

35. **(c)** The no. of atoms is a unit cell may be calculated by the the formula

$$Z = \frac{n_c}{8} + \frac{n_b}{1} + \frac{n_f}{2} + \frac{n_e}{4}$$

Where n_c = no. of atom at the corner

n_b = no. of atoms at body centre

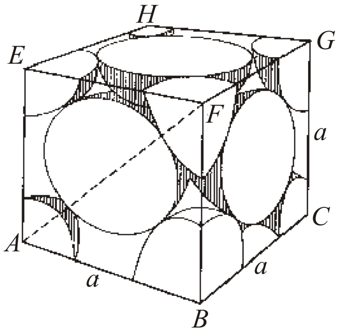
n_f = no. of atoms at face centre

n_e = no. of atoms at edge centre.

An *fcc* crystal contains

$$= \frac{8}{8} + \frac{6}{2} = 4 \text{ atoms in a unit cell.}$$

36. **(c)**



An isolated fcc cell is shown here. Each face of the cell is common to two adjacent cells. Therefore, each face centre atom contributes only half of its volume and mass to one cell. Arranging six cells each sharing the remaining half of the face centred atoms, constitutes fcc cubic lattice. e.g., Cu and Al.

37. **(b)** In bcc structure,
no. of atoms at corner = (1/8) × 8 = 1
no. of atoms at body centre = 1
∴ Total no. of atoms per unit cell = 1 + 1 = 2.

38. **(b)** *hcp* is a closed packed arrangement in which the unit cell is hexagonal and coordination number is 12.

39. **(c)** ABAB...... is hexagonal close packing.

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

41. **(b)** Metals such as copper and silver crystallise in fcc structure while metals Mg and Zn crystallise in hcp structure.

42. **(d)**

43. **(a)** Co-ordination number in *hcp* and *ccp* arrangement is 12.

44. **(a)** **45.** **(c)**

46. **(d)** It represents ccp arrangement.

47. **(b)** **48.** **(c)** **49.** **(d)** **50.** **(b)**

51. **(c)** hcp and ccp structures have maximum packing efficiency = 74%.
For bcc = 68%
For simple cubic = 52.4%

52. Total volume of atoms present in bcc unit cell is.

(a) $\frac{16}{3}\pi r^3$ (b) $\frac{4}{3}\pi r^3$

(c) $\frac{8}{3}\pi r^3$ (d) $\frac{12}{3}\pi r^3$

52. (c) For bcc structure total number of atoms = 2.

$$\therefore \text{Total volume} = 2\times\frac{4}{3}\pi r^3$$

$$=\frac{8}{3}\pi r^3$$

53. **(b)** The face centered cubic unit cell contains 4 atom

$$\therefore \text{ Total volume of atoms } = 4\times\frac{4}{3}\pi r^3 = \frac{16}{3}\pi r^3$$

54. **(c)** As CsCl is body-centred, $d = \sqrt{3}a/2$.

55. **(d)** Number of atoms per unit cell = 1

Atoms touch each other along edges. Hence $r = \frac{a}{2}$

(r = radius of atom and a = edge length)

$$\text{Therefore \% fraction} = \frac{\frac{4}{3}\pi r^3}{(2r)^3} = \frac{\pi}{6}$$

56. **(b)** Packing fraction is defined as the ratio of the volume of the unit cell that is occupied by the spheres to the total volume of the unit cell.
P.F. for *cpp* and *bcc* are 0.74 and 0.68 respectively.
So, the free space in *ccp* and bcc are 26% & 32% respectively.

57. **(d)** Packing fraction of bcc = 68%
Empty space = 100 – 68 = 32%

58. **(c)** The *hcp* arrangement of atoms occupies 74% of the available space and thus has 26% vacant space.

59. **(b)** In AB AB packing spheres occupy 74%. 26% is empty.

60. **(d)** In NaCl the Cl^- and Na^+ touch along edge of cube the distance between ions is $\frac{a}{2}$

61. **(a)**

62. **(b)** For body centred cubic lattice Z = 2
Atomic mass of unit cell = 133 + 80 = 213 a.m.u
Volume of cell = $(436.6 \times 10^{-10})^3$ cm^3

$$\text{Density,} \quad \rho = \frac{ZM}{a^3 N_A} = \frac{2\times 213}{(436.6\times 10^{-10})^3 \times 6.02\times 10^{23}}$$

$= 8.50$ g/cm^3

63. **(a)** There are two atoms in a *bcc* unit cell.
So, number of atoms in 12.08×10^{23} unit cells
$= 2 \times 12.08 \times 10^{23} = 24.16 \times 10^{23}$ atoms.

64. **(d)** For *bcc*, $d = \frac{\sqrt{3}}{2}a$ or $a = \frac{2d}{\sqrt{3}} = \frac{2\times 4.52}{1.732} = 5.219\text{Å}$
$= 522$ pm

$$\rho = \frac{z\times M}{a^3 \times N_A \times 10^{-30}}$$

$$= \frac{2\times 39}{(522)^3 \times (6.023\times 10^{23})\times 10^{-30}}$$

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

65. **(b)** $\rho = \frac{Z\,M}{N_A V}$

$$Z = \frac{\rho N_A V}{M} = \frac{8.92\times 6.02\times 10^{23} \times (362)^3 \times 10^{-30}}{63.55}$$

$= 4$
∴ It has *fcc* unit cell

66. **(a)** For *bcc* lattice body diagonal = $a\sqrt{3}$.
The distance between the two oppositely charged ions

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

$$= \frac{387\times 1.732}{2} = 335\text{pm}$$

67. **(a)** For b.c.c., Z = 2, Now, $d = \frac{ZM}{NV}$ and $V = a^3$

$$\therefore\ d = \frac{2\times 56}{(6.02\times 10^{23})\times(2.861\times 10^{-8})^3} = 7.92 \text{ g ml}^{-1}$$

68. (b) $$\rho = \frac{Z\times M}{N_A \times a^3} = \frac{2\times 100}{6.023\times 10^{23}\times (400\times 10^{-10})^3}$$

$$= 5.188\ g/cm^3$$

69. (c) $$\frac{d_1}{d_2} = \frac{(a_2)^3}{(a_1)^3}\times\frac{z_1}{z_2} = \left(\frac{3}{3.5}\right)^3\times\frac{4}{2} = 1.46$$

70. (d) Ionic solids must always maintain electrical neutrality. Ionic solids show vacancy or interstitial defects as Frenkel and Schottky defect.

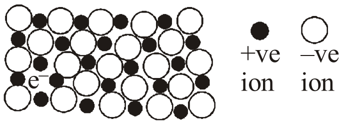
71. (b)

72. (d) In KCl, co-ordination number of cation and anion is 6 and 6 respectively. KCl is highly ionic so Schottky defect is common.

Note : Schottky defect is common in compounds having high coordination nummber while Frenkel defect is common in compounds with low coordination number.

73. (a) Schottky defects are found in solid.

74. (d) When electrons are trapped in anion vacancies, these are called F-centre.



F- centre in crystal

75. (d) If in an ionic crystal of the type A^+, B^-, equal number of cations and anions are missing from their lattice sites so that the electrical neutrality is maintained. The defect is called Schottky defect.

76. (d) The appearance of colour in solid alkali metal halide is due to presence of F-centre found as defect in the crystal structure.

77. (b) When equal number of cations (Na^+) and anions (Cl^-) are missing from their regular lattice positions, we have Schottky defect.

78. (d) Schottky defect occurs in ionic crystals of type A^+ B, when equal number of cations and anions are missing from their lattice sites so that the electrical neutrality is maintained. This defect generally appears in highly ionic compounds which have high coordination number. NaCl, KCl and CsCl all have high coordination numbers i.e., 6, 6 and 8 respectively. So, Schottky defect appear in all of the given compounds.

79. (b) More is the Schottky defect in crystal more is the decrease in density.

80. (d) Frenkel defect does not lower the density of the crystal since the ions do not leave the crystal lattice.

81. (c) Frenkel and Schottky defects are crystal defects. It arises due to dislodgement of cation or anion from their places in the crystal lattice.

82. (c) The vacancy created due to missing of equal no. of atoms or ions form normal lattice point is called Schottky defect. In this type of defect electrical neutrality of ionic crystal is maintained.

83. (a) In stoichiometric Frenkel defects occurs in those compound which have

(i) Low C.N.

(ii) Large difference in size of cations and anions

84. (b) Transition metals exhibit this defect due to metal deficiency, the compound obtained are non stoichiometric e.g. It is difficult to prepare ferrous oxide with the ideal composition of FeO what we actually obtain is $Fe_{0.95}O$ or Fe_xO with x = 0.93 to 0.96

85. (c) AgBr exhibit Frenkel defect.

86. (c) KBr does not exhibit Frenkel defect.

87. (d) No change in density

88. (c) Frenkel defect is due to dislocation of ion from its usual lattice site to interstitial position.

89. (c) **90. (a)**

91. (d) When insulators (non metal atoms) interact to form a solid, their atomic orbitals mix to form two bunch of orbitals, separated by a large band gap. Electrons cannot therefore be promoted to an empty level, where they could move freely.

92. (b) **93. (d)** **94. (b)** **95. (a)** **96. (b)**

97. (a) *p*-type of semiconductors are produced

(i) due to metal deficiency defects

(ii) by adding impurity containing less electrons (i.e., atoms of group 13)

Ge belongs to Group 14 and In to Group 13. Hence on doping, p-type semicondutor is obtained.

98. (d) The semiconductors formed by the introduction of impurity atoms containing one elecron less than the parent atoms of insulators are termed as *p*-type semiconductors. Therefore silicon containing 14 electrons is to be doped with boron containing 13 electrons to give a *p*-type semi-conductor.

99. (d) For n-type, impurity added to silicon should have more than 4 valence electrons.

100. (b) n-type, since electron is set free.

101. (d) Extrinsic semiconductor

102. (c) Pure silicon doped with phosphorus is a *n*-type semiconductor, as *n*-type extrinsic semiconductor (Si) is made by doping the semiconductor with pentavalent element.

103. (a) MnO_2

104. (c) Rhenium oxide ReO_3 is like metallic copper in conductivity.

105. (d) **106. (a)** **107. (b)**

108. (d) Ferrimagnetism is observed when the magentic moments of the domains in the substance are aligned in parallel and antiparallel directions in unequal numbers.

109. (c) Ferrimagnetic substances lose ferrimagnetism on heating and become paramagnetic.

110. (a) An element containing an odd number of electrons is paramagnetic.

111. (c) **112. (d)** **113. (b)** **114. (a)** **115. (a)**

STATEMENT TYPE QUESTIONS

116. (c) Quartz glass is an example of amorphous solid and crystalline solids are anisotropic in nature.

117. (d) Covalent solids are insulator of electricity. Graphite is a covalent solid but it is a conductor of electricity due to its structure.

118. (d) Total number of atoms per unit cell for a face centered cubic unit is 4.

The atom at the body center completely belongs to the unit cell in which it is present.

119. (b)

120. (c) Frenkel defect does not change the density of the solid.

$\therefore$ AgBr shows both Frenkel and Schottky defects.

121. (d) LiCl crystals are pink because its anionic sites are occupied by unpaired e^{-}_{online}. Zinc oxide shows metal excess defect due to presence of extra cations at interstitial sites.

122. (a) Electrical conductivity of semiconductors increases with rise in temperature. Insulators have conductivities ranging between 10^{-20} to 10^{-10} ohm^{-1} m^{-1}.

123. (b) Due to release of electrons, the crystal can conducts electricity but conductivity is not as high as that of metals. Its conductivity is very low and because conduction is due to electrons so it is *n*-type semiconductor, also excitation of these electron give rise to yellow color in crystal.

124. (c) CrO_2 is a ferromagnetic whereas O_2 is paramagnetic.

MATCHING TYPE QUESTIONS

125. (d) **126. (b)** **127. (c)** **128. (a)** **129. (a)**

130. (a) **131. (c)** **132. (c)** **133. (d)**

ASSERTION-REASON TYPE QUESTIONS

134. (b) In crystalline solids constituents are arranged in definite orderly arrangement. This regular arrangement of constituents extends throughout the three dimensional network of crystal. Thus crystalline substances said to have long range order. Whereas amorphous solids have no regular arrangement.

135. (a)

136. (d) Tetrahedral holes are smaller in size than octahedral holes. Cations usually occupy less space than anions.

137. (c) Tetrahedral void is so called because it is surrounded by four spheres tetrahedrally while octahedral void is so called because it is surrounded by six spheres octahedrally.

138. (b)

139. (a) Schottky defect is due to missing of equal number of cations and anions.

140. (a) In case of semiconductors, the gap between valence band and the conduction band is small and therefore some of the electrons may jump from valence band to conduction band and thus on increasing temperature conductivity is also increased.

141. (a) All magnetically ordered solids (ferromagnetic, ferrimagnetic and antiferromagnetic solids) transform to the paramagnetic state at high temperature due to the randomisation of spins.

CRITICAL THINKING TYPE QUESTIONS

142. (b)

143. (d) Excess of lithium makes LiCl crystal pink.

144. (b) Out of the given substances, only Li has high electrical and thermal conductivity as Li is a metallic solid.

145. (a) **146. (a)**

147. (a) Diamond is like ZnS. In diamond cubic unit cell, there are eight corner atoms, six face centered atoms and four more atoms inside the structure.

Number of atoms present in a diamond cubic cell

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

(corners) (face centered) (inside body)

148. (d) The *bcc* cell consists of 8 atoms at the corners and one atom at centre. Contribution of each atom at each corner is equal to $\frac{1}{8}$.

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

The *fcc* 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.

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

149. (b) $A:B:C=\frac{1}{8}\times 8:\frac{1}{2}\times 2:\frac{1}{2}\times 4=1:1:2$

150. (d) In a unit cell, W atoms at the corner $=\frac{1}{8}\times 8=1$

O-atoms at the centre of edges $=\frac{1}{4}\times 12=3$

Na-atoms at the centre of the cube = 1

W : O : Na = 1 : 3 : 1

Hence, formula = $NaWO_3$

151. (a) Potassium crystallises in *bcc* lattice.

152. (a) From the given data, we have

Number of Y atoms in a unit cell = 4

Number of X atoms in a unit cell $= 8 \times \frac{2}{3} = \frac{16}{3}$

From the above we get the formula of the compound as $X_{16/3}Y_4$ or X_4Y_3

153. (b) No. of M atoms $= \frac{1}{4} \times 4 + 1 = 1 + 1 = 2$

No. of X atoms $= \frac{1}{2} \times 6 + \frac{1}{8} \times 8 = 3 + 1 = 4$

So, formula $= M_2X_4 = MX_2$

154. (a) Number of A atoms $= \frac{1}{8} \times 8 = 1$

Number of B atoms $= \frac{1}{2} \times 6 = 3$

$\therefore$ Formula AB_3

155. (a)

156. (a) Following generalization can be easily derived for various types of lattice arrangements in cubic cells between the edge length (a) of the cell and r the radius of the sphere.

For simple cubic : $a = 2r$ or $r = \frac{a}{2}$

For body centred cubic :

$a = \frac{4}{\sqrt{3}} r$ or $r = \frac{\sqrt{3}}{4} a$

For face centred cubic :

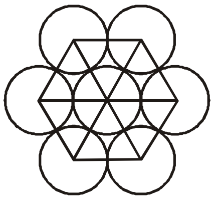
$a = 2\sqrt{2} r$ or $r = \frac{1}{2\sqrt{2}}$ a

Thus the ratio of radii of spheres for these will be simple : bcc : fcc

$= \frac{a}{2} : \frac{\sqrt{3}}{4} a : \frac{1}{2\sqrt{2}}$ a

i.e. option (a) is correct answer.

157. (a)



Let radius of the sphere = r

Area occupied by sphere in hexagonal close packing

$$\pi r^2 + 6 \times \left(\frac{1}{6} \times \pi r^2\right) = 2\pi r^2$$

Area of hexagonal $= 6 \times \left[\frac{\sqrt{3}}{4} \times (2r)^2\right]$

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

$= 6\sqrt{3} \times r^2$

% occupied by $= \frac{2\pi r^2}{6 \times \sqrt{3} \times r^2} \times 100$

$= \frac{2 \times 3.14}{6 \times \sqrt{3}} \times 100 = 60.43\%$

158. (d) Packing efficiency

$= \frac{\text{Area occupied by circles within the square}}{\text{Area of square}}$

$= \frac{2\pi r^2}{L^2} \times 100 = \frac{2\pi r^2}{2(\sqrt{2}r)^2} \times 100 = \frac{\pi}{4} \times 100 = 78.54\%$

159. (a) In fcc structure one unit cell consist 4 atoms, hence density × a^3 = The mass of four atoms

$= 8.92 \times (3.608 \times 10^{-8})^3$

$= 4.18 \times 10^{-22}$

160. (a) $\rho = \frac{ZM}{N_A V}$

$Z = \frac{\rho N_A V}{M} = \frac{2 \times 6 \times 10^{23} \times (5 \times 10^{-8})^3}{75}$

Z = 2, which represents *bcc* structure

$\therefore\ r = \frac{\sqrt{3}}{4} a = \frac{\sqrt{3}}{4} \times 5 = 2.165 Å = 216.5$ pm

≈ 217 pm

161. (d) $M = \frac{\rho \times a^3 \times N_A \times 10^{-30}}{Z}$

$= \frac{10 \times (100)^3 \times 6.02 \times 10^{23} \times 10^{-30}}{4} = 15.05$

$\therefore$ Number of atoms in 100 g $= \frac{6.02 \times 10^{23}}{15.05} \times 100$

$= 4 \times 10^{25}$

162. (b) The volume of the unit cell

$= (2.88 Å)^3 = 23.9 \times 10^{-24}\ cm^3$.

The volume of 100 g of the metal

$= \frac{m}{\rho} = \frac{100}{7.20} = 13.9\ cm^3$

Number of unit cells in this volume

$= \frac{13.9\ cm^3}{23.9 \times 10^{-24}\ cm^3} = 5.82 \times 10^{23}$

163. (b) Density is given by

$d = \frac{Z \times M}{N_A a^3}$; where Z = number of formula units present in unit cell, which is 4 for *fcc*

a = edge length of unit cell. M = Molecular mass

$$2.72 = \frac{4 \times M}{6.02 \times 10^{23} \times \left(404 \times 10^{-10}\right)^3} \quad (\because 1\,\text{pm} = 10^{-10}\,\text{cm})$$

$$M = \frac{2.72 \times 6.02 \times (404)^3}{4 \times 10^7} = 26.99 = 27 \text{ gm mole}^{-1}$$

164. (d) $\rho = \frac{Z \times M}{N_o \times a^3}$,

$$2.7 = \frac{Z \times 27}{6.02 \times 10^{23} \times (4.05)^3 \times 10^{-24}} \qquad \therefore Z = 4$$

Hence it is face centred cubic unit lattice.

Again $4r = a\sqrt{2} = 5.727$ Å

$\therefore r = 1.432$ Å

165. (a) Given: Atoms are present in the corners of cube = A and atom present at body centre = B. We know that a cubic unit cell has 8 corners. Therefore contribution of each atom at the corner = $\frac{1}{8}$. Since number of atoms per unit cell is 8, therefore total contribution = $8 \times \frac{1}{8} = 1$. We also know that atoms in the body centre, therefore number of atoms per unit cell = 1. Thus formula of the compound is AB.

166. (a) In first case conduction is due to hole,while in second case it is due electron.

167. (a) $BaTlO_3$

168. (b) Substances which are weakly repelled by external magnetic field are called diamagnetic substances, *e.g.,* H_2O.

169. (d) Ferrimagnetic substance become para-magnetic on heating. This is due to randomisation of spins on heating.

170. (b) **171. (a)**