CHEMISTRY

BOOKS - CHHAYA CHEMISTRY (BENGALI ENGLISH)

SOLID STATE

Example

1. Sodium (atomic mass = $23g \cdot mol^{-1}$) crystallises in body-centred cubic lattice. How

many unit cell does 9.2 g of sodium metal contain ?

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2. Copper (atomic mass = $63.5 g \cdot mol^{-1}$) has a crystal structure of cubical shape. A 6.35 g sample of copper contains 1.506×10^{22} unit cells. What type of unit cell does the copper crystal consists of ?

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3. A crystalline ionic compound consisting of M^+ and X^- ions crystallises in cubic structure. The unit cell of the compound has M^+ ions at its corners and an X^- ion at its body centre. Determine the simplest formula of the compound.

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4. A substance consisting of elements A and B crystallises in a cubical lattice structure with a unit cell having B atoms at the centre of its face and A atoms at its corners. Determine the simplest formula of the compound.

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5. A compound of elements P and Q has a crystalline structure based on cubic unit cells. The corners and face centres of the unit cell are occupied by P atoms, while its body centre and edge centres are occupied by Q atoms. Predict the probable formula of the compound.

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6. A compound of element A and B crystallises in the form of face-centered cubic lattice. The unit cell of the lattice contains A atom at each of its corner and a B atom at the centre of its each face. If a B atom from one of the faces is found missing, then what would be the formula of the compound?

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7. Silver crystallises in a face-centred cubic structure with unit cells having an edge length of 407pm. What is the radius of a silver atom in nm unit?

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8. Chromium crystallises in a body-centred cubic structure. The radius of a chromium atom is 125pm. What is the edge length of a unit cell in chromium crystal?

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9. Sodium crystallises in a body-centred cubic lattice with unit cells of edge length 4.29Å. Calculate the radius of a sodium atom and the distance between the nearest neighbours in the lattice.

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10. An element crystallises in a face-centred cubic lattice. The distance between the

nearest neighbours in the unit cell is 282.8pm. Calculate the edge length of the unit cell, and the radius of an atom of the element.

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11. Iron crystallises in a body-centred cubic lattice. The edge length of a unit cell in the lattice is 288pm. What is the density of iron? Atomic mass of iron = $55.85g \cdot mol^{-1}$.

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12. Copper crystallises in a face-centred cubic lattice. Molar mass and density of copper are $63.5g \cdot mol^{-1}$ and $8.9g \cdot cm^{-3}$ respectively. Calculate the edge length of a unit cell in copper lattice and the radius of a copper atom.

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13. A metal with a molar mass of $75g \cdot mol^{-1}$ crystallises in a cubic lattice structure with unit cells of an edge length of 5Å. If the density of the metal is $2g \cdot cm^{-3}$, calculate the radius of metal atom.

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14. A metal, under different sets of conditions, can crystallise in a face-centred cubic (fcc) structure with a unit cell edge length of 3.5Å and in a body-centered cubic (bcc) structure with a unit cell edge length of 3.0Å. Find the ratio of the densities of fcc and bcc structures.

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15. A crystalline compound consists of elements A and B. Atoms of element B from the cubic close-packed structure, in which half of the tetrahedral voids are occupied by A atoms. Determine the empirical formula of the compound.

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16. A crystalline compound is made of elements X and Y. Y atoms form hexagonal close-packed (hcp) structure with X atoms occupying half of the octahedral voids in the structure. Determine the empirical formula of the compound.

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17. The two ions A^{+} and B^{-} have radii 102 and 200 pm respectively. Predict the coordination number of A^{+} and crystal structure of compound AB.

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18. For SrF_2, the radius of Sr^{2+} is 1.13Å, and that of F^- is 1.35Å. What structure is SrF_2 likely to assume?

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19. Radii of K^+ and O^{2-} ions are 1.51Å and 1..62Å, respectively. Predict the structure of K_2O.

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20. The arrangement of X^- ions around A^+ ion in solid AX is given in the figure (not drawn to scale). If the radius of X^- is 250pm, what is the radius of A^+?

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Warm Up Exercise

1. Why does a solid substance possess a definite shape & volume?

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2. A solid usually possesses high density and incompressibility. Explain with reasons.

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3. (a) What are crystalline solids? Give two examples.

(b) Why is a solid incompressible?

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4. Mention two characteristics of a crystalline solid which are the expressions of its internal regularity.

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5. What are amorphous solids? Give two examples.

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6. Why is an amorphous solid sometimes regarded as a supercooled liquid of high viscosity?

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7. A crystalline solid is anisotropic, whereas an amorphous solid is isotropic. Explain with reasons.

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8. The coefficients of thermal expansion of a solid are found to be the same when measured in different directions. Is this an amorphous or crystalline?

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9. Both quartz and glass are made up of silica (SiO_2). However, quartz exists in crystalline form, whereas glass in amorphous form. Why is this difference?

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10. Why are the lower parts of the glass panes in the windows of very old buildings found to be thicker than the upper parts?

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11. Classify the following substances as molecular, covalent, or ionic crystalline solids.

Boron nitride, ice, solid $CHCl_3$, silicon carbide, $Cacl_2$, silicon, LiI, Solid P_4, solid Ar, zinc sulphide.

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12. A very hard crystalline solid that melts at very high temperature, cannot conduct electricity either in solid state or in molten state. What kind of crystalline solid is this? What type of constituent particles does this solid consist of? What is the nature of forces that holds the particles in this solids?

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13. Define the terms (a) crystal (b) crystal lattice (c) lattice point.

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14. What is unit cell of a crystal lattice? What parameters are used to characterise a unit cell?

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15. Define (a) simple or primitive unit cell (b) body-centred unit cell (c) face-centred unit cell (d) end-centred unit cell.

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16. Which type of unit cells are called non-primitive unit cells?

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17. How many types of two-dimensional lattices are possible?

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18. How many types of crystal systems are there? Name them.

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19. How many Bravais lattice are there? How many of these do belong to the types of primitive, body-centred face-centred or end-centred?

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20. Which crystal systems have the following axial characteristics? (i) a = b = c, (ii) $a \ne b \ne c$.

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21. Which crystal system has all possible types of unit cells, i.e., primitive, body-centred, face-centred and end-centred?

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22. Name a compound and an element whose crystals consist of cubic unit cell.

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23. Name a compound and an element whose crystals consist of hexagonal unit cell.

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24. Calculate the number of particles per unit cell of three possible cubic crystal structures, i.e., (a) Simple or Primitive (b) Body-centred (c) Face-centred.

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25. Calculate the number of particles per unit cell of the following two-dimensional lattices.

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26. The given figure represents the unit cell of a solid with a cubic crystal structure consisting of elements A, B and C. Calculate the total number of atoms present in the unit cell, and predict the simplest formula of the compound.

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27. Molar mass of an element is $Mg \cdot mol^{-1}$. The element crystallises in a cubic structure with face-centred unit cells. What will be the number of unit cells in x g of the element?

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28. A metal (molar mass = 108 $g \cdot mol^{-1}$) crystallises in a cubic structure. If 1.08g of the metal contains 1.5057×10^{21} unit cells, then how many atoms are there in a unit cell?

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29. A cubic unit cell contains one atom at each of its corner and two atoms on each of its body diagonal. How many atoms does the unit cell contain?

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30. A crystalline compound formed by elements A and B has facecentred cubic unit cell. The corners and the face-centred of the unit cell are occupied by A and B atoms, respectively. If one of the corner-atoms is found to be missing, then what would the formula of the compound be?

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31. What is packing efficiency of a unit cell? Show that the packing efficiency of a simple cubic unit cell is 52.4%.

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32. Show that 32% of the total space within a body-centred cubic unit cell remains unoccupied.

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33. Silver crystallises in a face-centred cubic structure. If the edge length of the unit cell be a and the diameter of Ag-atom be d, then show that $a = d\sqrt{2}$. What fraction of the total volume in the unit cell is occupied by Ag atoms?

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34. In a simple, body-centred and face-centred cubic unit cell, the radii of constituent particles are r_1, r_2 and r_3, respectively. If the edge length of each type of these unit cells be a, then find the ratio of r_1, r_2 and r_3.

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35. Show that for a body-centred cubic unit cell made up of identical particles, the radius is 0.43 times the edge length of the unit cell.

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36. A cubic unit cell with an edge length of a cm consists of identical particles. The mass of each particle is m g and the density of the unit cell is $\frac{4m}{a^3} g \cdot cm^{-3}$. Identify the type of the cubic unit cell.

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37. What do you mean by coordination number of a constituent particle in a crystal lattice? What are the coordination numbers in each of the close-packing of spheres: (a) square close-packing (b) hexagonal close-packing in two dimensions?

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38. In two dimensions, which one represents the close-packed structure of spheres with highest packing efficiency, a square close-packing or a hexagonal close-packing? Explain in it terms of coordination number of sphere in each case.

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39. Which close-packed structure is represented by ABAB... arrangement, and which one by ABCABC... arrangement?

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40. What are hcp and ccp structures? What are their unit cells? In what ways are these structures similar?

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41. What are tetrahedral and octahedral voids in a close-packed structure of particles? How many voids are there in a ccp structure of 'N' atoms? Why is the number of octahedral voids in an hcp or a ccp arrangement of particles equal to the number of packed particles?

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42. In a crystalline compound AB, B atoms form hexagonal close-packed structure. What is the total number of voids in 0.25 mol of the compound?

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43. The crystal lattice of the compound M_xO_y has cubic close-packed array of oxygen atom with M atoms occupying two-thirds of the octahedral voids. Determine the values of x and y.

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44. The crystal structure of a compound consisting of atoms M and N shows that it has a cubic-packed array of N atoms, with M atoms occupying one-third of the tetrahedral voids. Determine the formula of the compound.

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45. Nickel (density = $8.9g \cdot cm^{-3}$, atomic mass = $58.7g \cdot mol^{-1}$) crystallise in a cubical crystal structure with unit cells having an edge length of 359pm. What kind of unit cell does its crystal associate with?

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46. What do you mean by defect in a crystal? What are point defects in a crystal?

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47. What are vacancy and interstitial defects? How do these defects affect the density of a non-ionic crystal?

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48. What is Schottky defect? Is it a stoichiometric or non-stoichiometric defect? What type of ionic crystals are likely to show this type of defect? Does the presence of this defect in a crystal increase or decrease the density of the crystal? Explain.

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49. What is Frenkel defect? What type of ionic solids are likely to develop this defect? Why does the presence of Frenkel defect in a crystal not affect the density of the crystal?

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50. What type of stoichiometric defect are shown by the following compounds? NaCl, AgCl, ZnS, CsCl

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51. What are non-stoichiometric defects in an ionic crystal? Explain how metal excess defects occur in an ionic crystal.

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52. What is F-centre? Why is it called colour centre? What kind of defect is associated with F-centres?

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53. Why does the colour of NaCl turn yellow when it is heated in an atmosphere of Na-vapour?

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54. How are vacancies created in the crystal lattice of NaCl when a small amount of $SrCl_2$ is introduced into NaCl crystal?

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55. What will be the number of cation vacancies if 10^{-3} mol% of $CdCl_2$ is added to the crystal of AgCl?

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56. Based on band theory, explain why metals are good conductors of electricity, while insulators are non-conductors of electricity.

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57. Explain with the help of band theory why a semiconductor is neither a good conductor nor a good insulator.

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58. In terms of band theory, what is the difference (i) between a conductor and an insulator (ii) between a conductor and a semiconductor.

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59. What are intrinsic and extrinsic semiconductors? Give two examples of each type.

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60. (a) On raising the temperature, electrical conductivity of a metal decreases, while that of a semiconductor increases. Explain. (b) At very low temperature (0K), intrinsic semiconductors behave like insulators but their electrical conductivities increase with rise in temperature. Why?

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61. Write two ways by which the electrical conductivity of a semiconductor can be increased.

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62. What are n-type and p-type semiconductors?

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63. Why is the electrical conductivity of phosphorus-doped silicon is more than that of pure silicon?

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64. Mention the type of semiconductor (n-type or p-typr) that is formed when germanium is doped with each of the following elements. (a) Al (b) Sb (c) B (d) As

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65. Why does a substance exhibit magnetic property?

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66. What are paramagnetic substances? What is the reason of paramagnetism? Give two examples of paramagnetic substance.

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67. What are diamagnetic substances? Give two examples of this substance. What causes diamagnetism in a substance?

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68. Define: (i) ferromagnetic (ii) ferrimagnetic and (iii) anti-ferromagnetic substance. Give one example of each substance.

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69. Which of the following substances can exist in a permanently magnetised state even when the magnetic field is removed, and why?

(i) Paramagnetic (ii) Ferromagnetic (iii) Ferrimagnetic

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70. Why does an anti-ferromagnetic substance have zero resultant magnetic moment?

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Very Short Answer Type

1. What are the constituent particles in a network or covalent solid?

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2. Between crystalline and amorphous solids, which one is isotropic and which one is anisotropic?

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3. Corners and face-centres of a cubic unit cell are occupied by atoms. What fractions of a corner particle and a face-centred particle belong to the unit cell?

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4. Differentiate between a crystalline and an amorphous solid on the basis of the order of arrangement of their constituent particles.

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5. A crystalline solid has high melting point and high heat of fusion. It is rigid and brittle in nature. It is a non-conductor of electricity in its solid state, but can conduct electricity in its molten state or in dissolved state. What type of crystalline solid is this?

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6. How many of 14 Bravais lattices belong to simple or primitive type?

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7. How many particles are there in a body-centred and a face-centred cubic unit cell?

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8. The packing efficiency of a face-centred unit cell is 74%. What does it mean?

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9. What is the relation between the edge length (a) and the radius of the constituent particle (r) of a simple cubic unit cell?

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10. What is the distance between the nearest neighbours of a face-centred cubic unit cell?

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11. What is the unit cell in a cubic close-packed (ccp) structure of particles?

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12. What is the unit cell in a hexagonal close-packed (hcp) structure of particles?

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13. What is the coordination number of each atom in HCP and CCP structures?

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14. What are the packing efficiencies in ccp and hcp structures of particles?

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15. Which of the following defects in a non-ionic crystal causes increase or decrease in density of the crystal?

(1) Vacancy defect (2) Interstital defect.

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16. Which defect causes decrease in density of an ionic crystal, Schottky defect or Frenkel defect?

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17. Name a crystalline solid which is likely to develop both Schottky and Frenkel defects.

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18. Which defect in an ionic crystal is a combination of a vacancy defect and an interstitial defect?

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19. What type of defect arises in non-stoichiometric sodium chloride formed when NaCl is heated in an atmosphere of Na-vapour?

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20. What type of defect arises in non-stoichiometric zinc oxide formed when ZnO is heated?

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21. Arrange the following solids in order of their increasing electrical conductivities.

Metal, Semiconductor, Insulator.

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22. An n-type semiconductor is produced when pure Si or Ge is doped with an element. To which group of the periodic table does this element belong?

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23. What type of semiconductor (n-type or p-type) is formed when pure Ge is doped with a trace amount of group-13 element?

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24. Between a semiconductor and a metal, whose electrical conductivity decreases on increasing temperature?

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25. A substance when placed in a magnetic field in strongly attraceted by the field. The substance retains its magnetised state even when the magnetic field in removed. What type of magnetic substance is this?

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26. Rank the following magnetic substances in order of their magnetic moments in presence of a magnetic field: Ferrimagnetic, Ferromagnetic, Anti-ferromagnetic

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27. Name an ionic compound, a trace amount of which when added into the crystal structure of AgCl, results in cationic vacancies.

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28. What is the coordination number of a particle in a crystalline solid with rock-salt structure?

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29. How can you distinguish a metal and an ionic solid on the basis of their electrical conductance?

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30. What kind of intermolecular forces of attraction hold the molecules in a polar solid substance?

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31. "Crystalline solids are anisotropic" - What does this statement mean?

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32. Apart from the metallic lustre, mention one property by which one can distinguish a metal from an ionic solid.

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33. How is it possible to enhance the electrical conductivity to an intrinsic semiconductor?

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34. Which type of magnetism does the following arrangement of magnetic moments indicate?

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35. Why are gases and liquids considered as fluid?

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36. How can a crystalline solid be converted into an amorphous solid?

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37. What are voids or holes in a crystal?

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38. How one and two-dimensional lattices are formed?

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39. Identify the following unit cell: (1) $a = b \neq c, \alpha = \beta = \gamma = 90^{\circ}$ (2) $a \neq b \neq c, \alpha = \beta = \gamma = 90^{\circ}$

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40. Mention the constituent particles and kinds of forces holding the particles in the following crystalline solids. (1) Solid methane (2) Solid ammonia.

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41. Classify the following crystalline solids as molecular ionic, covalent and metallic solids: $CaCl_2$, Si, Ag, Glucose, Hg, HCl, BN, KOH

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42. Arrange the following cubic unit cells in increasing order of their particle number.

(1) Simple (2) Body-centred (3) Face-centred

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43. Arrange simple, body-centred and face-centred cubic unit cells in increasing order of their packing efficiencies.

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44. Which of the following defects are stoichiometric or non-stoichiometric?

(1) Metal excess defect (2) Schottky defect (3) Metal deficiency defect (4) Frenkel defect.

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45. Draw and mention the shape of the hole generated in a hexagonal close-packing of identical spheres in a plane.

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46. How many types of close-packing are possible when identical spheres pack together in a plane? Which one of these represents the highest efficiency in close-packing in two dimensions? Mention coordination number in each of these close-packing.

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47. Is the shape of a tetrahedral void tetrahedral? If not, why is it so called?

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48. Why does LiCl crystal containing excess lithium ions show pink colour?

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49. What types of magnetism are likely to be observed when magnetic moments align in the same direction, and when they align is opposite directions but in unequal numbers?

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50. What is the distance between two nearest neighbours in a bcc unit cell with an edge length of a?

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51. An element with atomic mass $Mg \cdot mol^{-1}$ crystallises in a cubical structure. W g of the element is found to contain n unit cells. How many atoms is its unit cell likely to have? (Assume : Avogadro's number = $N mol^{-1}$)

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52. In an ionic crystal, Schottky defect decreases the density of the crystal but Frenkel defect does not cause any change in density of the crystal. Explain.

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53. Write down two significances of radius ratio rule.

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54. Why does the electrical conductivity of a metal decrease with increase in temperature?

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55. Calculate the packing efficiency of the two-dimensional square unit cells as given in the figure.

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56. If the density and the dimension of unit cells of a metal are known, then how can you determine the atomic mass of the element?

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57. Under one experimental condition, an element crystallises in face-centred cubic structure with a unit-cell edge length of a_1, while under another experimental condition, it crystallises in body-centred cubic structure with a unit-cell edge length of a_2. Find the ratio of the densities of these structures.

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58. Have a look at the following defect in the crystal and answer the questions given below:

(1) What kind of stoichiometric defect does the crystal exhibit? (2) How does density of the crystal get affected by this defect? (3) What kind of ionic compounds are likely to show this defect?

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59. A solid with a formula AB has the rock-salt type of structure. If all the atoms touching one body-diagonal plane are removed, then what would the formula of the compound be?

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60. Explain the electrical non-conductivity of an insulator with the help of band theory.

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1. (i) Which type of semiconductor is sillicon having arsenic as impurity?

(ii) An elements (density = $7.2g \cdot cm^{-3}$) crystallises in a body-centred cubic structure having its cell edge length 2.88Å. Calculate the number of atoms and the number of unit cells present in 156g of the element.

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2. What is the number of unit cells in 6.4g of X (atomic mass = 64) (X crystallises in body centred cubic-lattice)

A. $\frac{N_A}{10}$

B. $\frac{N_A}{20}$

C. $\frac{N_A}{5}$

D. $2N_A$

Answer: B

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3. What is the number of particles per unit cell in a face-centred cubic lattice-

A. 1

B. 2

C. 3

D. 4

Answer: D

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4. Silver crystallises in face-centred cubic lattice. If edge length of the unit cell is $4.07 \times 10^{-8} cm$ and density of silver is $10.48 g \cdot cm^{-3}$, determine the relative atomic mass of silver.

or, (i) What is Schottky defect? (ii) Find out packing efficiency in a simple cubic lattice.

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5. Which of the following solids is a covalent crystal-

A. sodium chloride

B. quartz

C. sucrose

D. iodine

Answer: B

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6. (i) What is ferromagnetic substance?

(ii) KBr crystallises in face-centred cubic (fcc) crystals. The density and formula mass of KBr crystal are $2.65 g \cdot cm^{-3}$ and $119 g \cdot mol^{-1}$ respectively. Find the distance between K^{+} and Br^{-} ions in KBr crystal.

or, (i) Which kind of defect in ionic crystal does not alter the density?

(ii) An element X has atomic mass $60 g \cdot mol^{-1}$ and density $6.23 g \cdot cm^{-3}$. The edge length of its unit cell is 400 pm. Identify the type of the unit cubic cell. Calculate the radius of X atom.

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7. The number of Cl^{-} ions present around each Na^{+} ion in NaCl crystal lattice is-

A. 3

B. 4

C. 8

D. 6

Answer: D

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8. (i) What is the total number of voids in cubic close-packed lattice?

(ii) Metallic gold (Au) crystallises in face-centred cubic lattice. What is the number of unit cells in 2.0g of gold? [Au = 197]

or, (i) What is a p-type semiconductor?

(ii) A cubic crystal is made up of elements A and B. B is located at the corners of the unit cell and A is at the body-centre. What will be the probable formula of the compound?

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Solved Cbse Scanner

1. What is meant by 'doping' in a semiconductor?

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2. Tungsten crystallizes in body-centred cubic unit cell. If the edge of the unit cell is 316.5pm, what is the radius of tungsten atom?

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3. Iron has a body-centred cubic unit cell dimension of 286.65pm. The density of iron is $7.874 g \cdot cm^{-3}$. Use the information to calculate Avogadro's number [Atomic mass of Fe = 55.845u]

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4. An element with density $2.8 g \cdot cm^{-3}$ forms a fcc unit cell with edge length 4×10^{-8}cm.

Calculate the molar mass of the element. [Given: `N_(A)=6.022xx10^(23)mol^(-1)]

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5. (a) Write the type of magnetism observed when magnetic moments are aligned in parallel and anti-parallel directions in unequal numbers. (b) Which stoichiometric defect decreases the density of crystal?

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6. What is the formula of a compound in which the element Y forms ccp lattice and atoms of X occupy $\frac{1}{3}$rd of tedrahedral voids.

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7. An element with molar mass $27g\cdot mol^{-1}$ froms a cubic unit cell with edge length $4.05\times10^{-8}cm$. If its density is $2.7g\cdot cm^{-3}$, what is the nature of the cubic unit cell?

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8. What type of stoichiometric defect is shown by AgCl?

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9. Silver crystallises in fcc lattice. If edge length of the unit cell is 4.077×10^{-8}cm, then calculate the radius of silver atom.

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10. What type of magnetism is shown by a substance if magnetic moments of domains are arranged in the same direction?

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11. An element crystallises in a fcc lattice with cell edge of 250 pm. Calculate the density if 300 g of this element contain 2×10^{24} atoms.

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12. Give an example each of a molecular solid and an ionic solid.

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13. An element crystallises in a bcc lattice with cell edge of 500 pm. The density of the element is 7.5 $g \cdot cm^{-3}$. How many atoms are present is 300 g/mol of the element?

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14. (a) An element has atomic mass 93 $g \cdot mol^{-1}$ and density $11.5 g \cdot cm^{-3}$. If the edge length of its unit cell is 300 pm, identify the type of unit cell.

(b) Write any two differences between amorphous solids and crystalline solids.

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15. (a) Calculate the number of unit cell in 8.1g of aluminium if it crystallises in a fcc structure. (Atomic mass of Al = $27 g \cdot mol^{-1}$)

(b) Give reasons:

(i) In stoichiometric defects, NaCl exhibits Schottky defect and not Frenkel defect.

(ii) Silicon on doping with Phosphorous forms n-type semiconductor.

(iii) Ferrimagnetic substances show better magnetism than anti-ferromagnetic substances.

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16. Calculate the number of unit cells in 8.1 g of aluminium if it crystallises in face-centred cubic (fcc) structure. (Atomic mass of Al = 27 $g \cdot mol^{-1}$)

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17. (a) Based on the nature of intermolecular forces, classify the following solids: Silicon carbide, Argon.

(b) ZnO turns yellow on heating. Why?

(c) What is meant by groups 12-16 compounds? Give an example.

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18. (a) Based on the nature of intermolecular forces, classify the following solids: Benzene, Silver.

(b) AgCl shows Frenkel defect while NaCl does not. Give reason.

(c) What type of semiconductor is formed when Ge is doped with Al?

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19. (a) Based on the nature of intermolecular forces, classify the following solids: Sodium sulphate, Hydrogen.

(b) What happens when $CdCl_2$ is doppd with AgCl?

(c) Why do ferrimagnetic substances show better magnetism than antiferromagnetic substances?

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20. Analysis shows that FeO has a non-stoichiometric composition with formula $Fe_{0.95}O$. Give reason.

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21. An element 'X' (atomic mass = 40$g \cdot mol^{-1}$) having fcc structure, has unit cell edge length of 400 pm. Calculate the density of 'X' and the number of unit cell in 4g of 'X'. $(N_A = 6.022 \times 10^{23} mol^{-1})$

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Solved Ncert Textbook Problems

1. Why are solids rigid?

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2. Why do solids have a definite volume?

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3. Classify the following as amorphous or crystalline solids: Polyurethane, naphthalene, benzoic acid, teflon, potassium nitrate, cellophane, polyvinyl chloride, fibre glass, copper.

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4. Why is glass considered a super cooled liquid?

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5. Refractive index of a solid is observed to have the same value along all directions. Comment on the nature of this solid, would it show cleavage property?

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6. Classify the following solids based on the nature of intermolecular forces operating in them: Potassium sulphate, tin, benzene, urea, ammonia, water, zinc sulphide, graphite, rubidium, argon, silicon carbide.

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7. Solid A is a very hard electrical insulator in solid as well as in molten state and melts at extremely high temperature. What type of solid is it?

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8. Ionic solids conduct electricity in molten state but not in solid state. Explain.

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9. What type of solids are electrical conductors, malleable and ductile?

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10. Give the significance of a 'lattice point'.

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11. Name the parameters that characterise a unit cell.

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12. Distinguish between- (i) the hexagonal and monoclinic unit cells (ii) the face-centred and end-centred unit cells.

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13. Explain how much portion of an atom located (i) corner and (ii) body centre of a cubic unit cell is part of its neighbouring unit cell.

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14. What is the two dimensional coordination number of a molecule in square close-packed layer?

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15. A compound forms hexagonal close-packed structure. What is the total number of voids in 0.5 mol of it? How many of these are tetrahedral voids?

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16. A compound is formed by two elements, M and N. N forms ccp & atoms of M occupy $\frac{1}{3}$rd of tetrahedral voids. What is the formula of the compound?

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17. Which of the following lattice has the highest packing efficiency (i) simple cubic (ii) body-centred cubic (iii) hexagonal close-packed lattice.

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18. An element with molar mass $2.7 \times 10^{-2} kg \cdot mol^{-1}$ forms a cubic unit cell with edge length 405pm. If its density is $2.7 \times 10^3 kg \cdot m^{-3}$, what is the nature of the cubic unit cell?

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19. What type of defect can arise when a solid is heated? Which physical property is affected by it, in what way?

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20. What type of stoichiometric defect is shown by : (i) ZnS (ii) AgBr

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21. Ionic solids, which have anionic vacancies due to metal excess defect, develop colour. Explain.

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22. A group 14 element is to be converted into n-type semiconductor by doping it with a suitable impurity. To which group should this impurity belong?

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23. What type of substances would make better permanent magnets, ferromagnetic or ferrimagnetic? Justify.

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24. Define the term 'amorphous'. Give a few example of amorphous solids.

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25. What makes a glass different from a solid such as quartz? Under what conditions could quartz be converted into glass?

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26. Classify each of the following solids as ionic, metallic, molecular, network (covalent) or amorphous. (i) Tetraphosphorous decoxide (P_4O_{10}) (ii) Ammonium phosphate, $(NH_4)_3PO_4$ (iii) SiC (iv) I_2 (v) P_4 (vi) Plastic (vii) Graphite (viii) Brass (ix) Rb (x) LiBr (xi) Si

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27. (i) What is meant by the term 'coordination number'?

(ii) What is the coordination number of atom:

(a) in a cubic close-packed structure (b) in a body-centred cubic structure?

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28. How can you determine the atomic mass of an unknown metal having cubic crystal structure if you know its density and the dimension of its unit cell? Explain.

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29. Stability of a crystal is reflected in the magnitude of its melting points'. Comment. Collect melting points of solid water, ethyl alcohol, diethyl ether and methane from a data book. What can you say about the intermolecular forces between these molecules?

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30. How will you distinguish between the following pairs of terms?

(i) Hexagonal close-packing and cubic close-packing

(ii) Crystal lattice and unit cell

(iii) Tetrahedral void and octahedral void

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31. How many lattice points are there in one call of each of the following lattices? (i) Face-centred cubic (ii) Face-centred tetragonal (iii) Body-centred.

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32. Explain- (i) The basis of similarities and differences between metallic and ionic crystal (ii) Ionic solids are hard and brittle.

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33. Calculate the efficiency of packing in case of a metal crystal for (i) simple cubic (ii) body-centred cubic (iii) face-centred cubic (with the assumptions that atoms are touching each other)

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34. Silver crystallises in fcc lattice. If edge length of the cell is 4.07×10^{-8} cm and density is $10.5g \cdot cm^{-3}$, calculate the atomic mass of silver.

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35. A cubic solid is made of two elements P and Q. Atoms of Q are at the corners of the cube and P at the body centre. What is the formula of the compound? What are the coordination number of P and Q?

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36. Niobium crystallises in body-centred cubic structure. If density is $8.55 g \cdot cm^{-3}$, calculate atomic radius of nionium using its atomic mass 93 u.

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37. If radius of the octahedral void is r, radius of the atom in close packing is R, derive relation between r & R.

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38. Copper crystallises into a fcc lattice with edge length $3.61 \times 10^{-8} cm$. Show that the calculated density is in agreement with its measured value of $8.96 g \cdot cm^{-3}$.

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39. Analysis shows that nickel oxide has the formula $Ni_{0.98}O_{1.00}$. What fractions of nickel exist as Ni^{2+} and Ni^{3+} ions.

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40. What is a semiconductor? Describe two main types of semiconductor and contrast their conduction mechanism.

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41. Non-stoichiometric cuprous oxide, Cu_2O can be prepared in laboratory . In this oxide, copper to oxygen ratio is slightly less than $2:1$. Can you account for the fact that this substance is a p-type semiconductor?

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42. Ferric oxide crystallises in a hexagonal close-packed array of oxide ions with two out of every three octahedral holes occupied by ferric ions. Derive the formula of the ferric oxide.

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43. Classify each of the following as being either a p-type or a n-type semiconductor: (i) Ge doped with P (ii) Si doped with In

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44. Gold ($r = 0.144 nm$) crystallises in a face-centred unit cell. What is the length of a side of the cell?

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45. In terms of band theory, what is the difference (i) between a conductor and an insulator (ii) between a conductor and a semiconductor.

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46. Explain the following terms with suitable examples: (i) Schottky defect (ii) Frenkel defect (iii) Interstitials and (iv) F-centre.

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47. Aluminium crystallises in a cubic close-packed structure. Its metallic radius is 125 pm. (i) What is the length of the side of the unit cell? (ii) How many unit cells are there in $1.00 cm^3$ of aluminium?

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48. If NaCl is doped with 10^{-3} mol% $SrCl_2$, what is the concentration of cation vacancies?

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49. Explain the following with suitable examples: (i) Ferromagnetism (ii) Paramagnetism (iii) Ferrimagbetism (iv) Anti-ferromagnetism (v) 12-16 and 13-15 group compounds

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Higher Order Thinking Skill Hots Questions

1. The distance between the nearest neighbours of a body-centred cubic unit cell is equal to 0.866 times the edge length of the unit cell. What is the relation between the edge length and the radius of the constituent particle of this unit cell?

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2. In the crystal structure of metallic Zn, the layers of Zn atoms have stacking sequence

ABABAB... . What type of close-packed structure is formed in the crystal of Zn? How many Zn atoms are there in the unit cell of Zn crystal?

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3. Iron crystallises into a crystal structure in which the layer of Fe atoms form close-packed arrangement with stacking sequence ABCABC... . What is this close-packed arrangement called? How many Fe atoms are there in the unit cell of Fe crystal?

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4. Iron crystallises in a cubic close-packed (ccp) structure. How many voids or holes are there in 0.1 mol of iron?

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5. Determine the ratio of radii of particles in simple, body-centred and face-centred cubic unit cells. Assume the edge length of each type of unit cell is a.

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6. How many type of holes are generated in a hexagonal and a cubic close-packed arrangement of identical spheres?

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7. Determine the packing efficiency of the unit cell in hexagonal close-packed (hcp) structure of particles.

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8. Show that the radius of the particle that can be placed in a tetrahedral void of an hcp or a ccp structure of particles, without disturbing the close-packed structure, should not exceed 0.225 times the radius of the packed particles.

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9. Determine the percentages of Fe^{2+} and Fe^{3+} ions in the crystal of

$Fe_{0.88}O$.

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10. Why does CsCl adopt the crystal structure of NaCl when it is heated at - $480^{\circ} C$?

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11. In a crystalline solid having formula AB_2O_4, oxide ions are arranged in a cubic close-packed lattice while cations A and B are present in tetrahedral and octahedral voids respectively. What percentages of tetrahedral and octahedral voids are occupied by A and B ions respectively?

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12. What is piezoelectric crystal?

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13. Why is coordination number of 12 not found in ionic crystal?

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Advanced Level Numerical Bank

1. An element crystallises in a cubic crystal structure. The edge length of its unit cell is 3.15Å. The atomic mass and the density of the element are 96 amu and $10.2 g \cdot cm^{-3}$. Predict the crystal lattice possessed by the element.

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2. A unit call of NaCl has four formula units. In NaCl crystal, radius ratio (r_{+}/r_{-}) is 0.69 and edge-length of the unit cell is twice the sum of the radii of Na^{+} and Cl^{-} ions. If the radius of Na^{+} is 116 pm then find the density of NaCl crystal. Formula mass of NaCl = $58.5 g \cdot mol^{-1}$.

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3. An element having atomic radius 144 pm crystallises in a ccp structure. The density of the element is $10.6g \cdot cm^{-3}$. Identify the element.

Watch Video Solution

4. Crystal has face centred cubic structure, having atomic weight $6.023 ygmol^{-1}$. If the minimum distance between two atoms is $y^{1/3}$

nm and the observed density is $20 kg m^{-3}$ find type of defect in crystal lattice.

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5. An element crystallises in a body-centred cubic crystal structure with the unit cell edge length of 291pm. The density of the element is $7.54 g \cdot cm^{-3}$. How many unit cells are there in 168g of the element?

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6. An element crystallises in a body-centred cubic structure. The atomic radius of the element is 190pm. Calculate: (1) the distance between two nearest neighbours (2) the body diagonal and the edge length of the unit cell.

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7. Nickel crystallises in a cubic close-packed structure. In this structure, the distance between two nearest neighbours is 250pm. If the atomic mass of nickel is 58.7amu, then calculate the density of nickel crystal.

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8. Calcium fluoride (CaF_2) crystallises in a cubic crystal structure. Unit cell of this structure contains four Ca^{2+} ions and eight F^{-} ions. If density of CaF_2 is $3.2g \cdot cm^{-3}$, then calculate the edge length of the unit cell in pm.

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9. A compound consists of element A and B. It crystallises in a cubic crystal structure with unit cell having A atoms at the corners of the cell and B atom at the face centres of the cell. If the edge-length of the unit cell is 5Å, and the atomic masses of A and B are 60 and 90 respectively, then calculate the density of the compound.

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10. The density of CaO is $3.35 \times 10^3 kg \cdot m^3$. This oxide crystallises in one of the cubic system with a = 480pm. Calculate the number of formula units in the unit cell of the oxide. Which type of cubic system is it?

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11. KBr crystallises in a face-centred cubic crystal. The density of KBr crystal is $2.65 g \cdot cm^{-3}$. If formula mass of KBr is

$119g \cdot mol^{-1}$, then find the distance between K^{+} and Br^{-} in KBr crystal.

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12. From X-ray diffraction study it is observed that solid Ar possesses cubic close packed structure. If the density of solid Ar is $1.70g \cdot cm^{-3}$, then find (1) edge length of the unit cell of Ar crystal (2) the radius of Ar atom.

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13. Polonium crystallises in a primitive cubic structure. The radius of polonium atom and the density of polonium are 1.68Å and $9.27g \cdot cm^{-3}$ respectively. If the atomic mass of polonium is $210g \cdot mol^{-1}$, then find the value of Avogadro's number.

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14. Crystal structure of the oxide AB_2O_4 is bassed on the cubic close packed (ccp) array of O^{2-} ions, with A^{2+} ions occupying some tetrahedral voids and B^{3+} ions occupying some octahedral voids. If a crystal of this oxide contains 1 mol AB_2O_4 formula unit, then calculate (1) total number of voids in the crystal (2) total number of tetrahedral voids occupied by A^{2+} ions (3) total number of octahedral voids occupied by B^{3+} ions.

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15. The crystal structure of Zinc blende (ZnS) consists of cubic close-packed (ccp) array of

S^{2-} ions. If the radii of Zn^{2+} and S^{2-} ions are 0.74 and 1.84Å respectively, then which type of voids (tetrahedral or octahedral) formed in ccp array of S^{2-} ions are occupied by Zn^{2+} ions? What fraction of total number of this void remains unoccupied?

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16. An element has an fcc crystal structure with a unit cell edge length of 200 pm. If the element has a density of 10g/cm3, then what will its atomic mass be?

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17. Sodium crystallises in a bcc lattice having unit cell with an edge length of 4.29Å. Calculate the number of unit cells present in 2.3g of Na metal. Determine the number of atoms present in 1 cc of unit cell.

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1. Suppose the mass of a single Ag atom is 'm'. Ag metal crystallises in fcc lattice with unit cell of length 'a'. The density of Ag metal in terms of 'a' and 'm' is-

A. $\frac{4m}{a^3}$

B. $\frac{2m}{a^3}$

C. $\frac{m}{a^3}$

D. $\frac{m}{4a^3}$

Answer: A

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2. Ionic solids with Schottky defect may contain-

A. cation vacancies only

B. cation vacancies and interstitial cations

C. equal number of cation and anion vacancies

D. anion vacancies and interstitial anions

Answer: C

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3. In a close-packed body-centred cubic lattice of potassium, the correct relation between the atomic radius (r) of potassium and the edge length (a) of the cube is -

A. $r = \frac{a}{\sqrt{2}}$

B. $r = \frac{a}{\sqrt{3}}$

C. $r = \frac{\sqrt{3}}{2}a$

D. $r = \frac{\sqrt{3}}{4}a$

Answer: D

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4. A compound formed by elements X and Y crystallises in the cubic structure, where X - atoms are at the corners of a cube and Y -

atoms are at the centres of the body. The formula of the compound is-

A. XY

B. XY_2

C. X_2Y_3

D. XY_3

Answer: A

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5. In a face-centred cubic lattice, atom A occupies the corner and atom B occupies the face-centred positions. If one atom of B is missing from one of the face-centred points, the formula of the compound is-

A. A_2B_5

B. A_2B

C. AB_2

D. A_2B_3

Answer: A

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6. Lithium forms body-centred cubic structure. The length of the side of its unit cell is 351pm. Atomic radius of lithium will be-

A. 300pm

B. 240pm

C. 152pm

D. 75pm

Answer: C

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7. Which exists as covalent crystals in the solid state-

A. iodine

B. silicon

C. sulphur

D. phosphorus

Answer: B

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8. The correct statement for the molecule, CsI_3, is-

A. it contains Cs^+, I^- and lattice I_2 molecule

B. it is a covalent molecule

C. it contains Cs^+ and I_3^- ions

D. it contains Cs^{3+} and I^- ions

Answer: C

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9. CsCl crystallises in body-centred cubic lattice. If 'a' is its edge length then which of the following expressions is correct-

A. $r_{Cs^+} + r_{Cl^-} = \sqrt{3}a$

B. $r_{Cs^+} + r_{Cl^-} = 3a$

C. $r_{Cs^+} + r_{Cl^-} = \frac{3a}{2}$

D. $r_{Cs^+} + r_{Cl^-} = \frac{\sqrt{3}}{2}a$

Answer: D

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10. Sodium metal crystallises in a body-centreed cubic lattice with a unit cell edge of 4.29Å. The radius of sodium atom is approximately-

A. 1.86 Å

B. 3.22 Å

C. 5.72 Å

D. 0.93 Å

Answer: A

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11. Which of the following compounds is metallic and ferromagnetic-

A. TiO_2

B. CrO_2

C. VO_2

D. MnO_2

Answer: B

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12. A metal crystallises in a face-centred cubic structure. If the edge length of its unit cell is 'a', the closest approach between two atoms in metallic crystal will be-

A. $\sqrt{2}a$

B. $\frac{a}{\sqrt{2}}$

C. 2a

D. $2\sqrt{2}a$

Answer: B

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13. Which type of defect has the presence of cations in the interstitial sites-

A. Frenkel defect

B. metal deficiency defect

C. Schottky defect

D. vacancy defect

Answer: A

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14. A solid cmpound XY has NaCl structure. If the radius of the cation is 100pm, the radius of the anion (Y^{-}) will be-

A. 275.1pm

B. 322.5pm

C. 241.5pm

D. 165.7pm

Answer: C

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15. Structure of a mixed oxide is cubic close-packed (ccp). 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. A_2BO_2

B. $A_2B_3O_4$

C. AB_2O_2

D. ABO_2

Answer: C

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16. A metal crystallises with a face-centred cubic lattice. The edge of the unit cell is 408pm. The diameter of the metal atom is-

A. 114pm

B. 204pm

C. 288pm

D. 408pm

Answer: C

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17. The number of octahedral void(s) per atom present in a cubic close-packed structure is-

A. 2

B. 4

C. 1

D. 3

Answer: B

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18. The number of carbon atoms present per unit cell of diamond is-

A. 1

B. 4

C. 8

D. 6

Answer: C

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19. Which of the following statements about the interstitial compounds is incorrect-

A. they have higher melting points than the pure metal

B. they retain metallic conductivity

C. they are chemically reactive

D. they are much harder than the pure metal

Answer: C

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20. If a is the length of the side of a cube, the distance between the body-centred atom and one corner-atom in the cube will be-

A. $\frac{2}{\sqrt{3}}a$

B. $\frac{4}{\sqrt{3}}a$

C. $\frac{\sqrt{3}}{4}a$

D. $\frac{\sqrt{3}}{2}a$

Answer: D

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21. The correct statement regarding defects in the crystaline solid is-

A. Schottky defects have no effect on the density of crystalline solids

B. Frenkel defects decrease the density of crystalline solid

C. Frenkel defect is a dislocation defect

D. Frenkel defect is found in halides of alkaline metals

Answer: C

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22. The vacant space in bcc lattice cell is-

A. 0.26

B. 0.48

C. 0.23

D. 0.32

Answer: D

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23. In calcium fluoride, having the fluorite structure, the coordination number for calcium ion (Ca^{2+}) and fluoride ion (F^{-}) are-

A. 4 and 2

B. 6 and 6

C. 8 and 4

D. 4 and 8

Answer: D

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24. The ionic radii of A^{+} and B^{-} ions are $0.98 \times 10^{-10} m$ and $1.81 \times 10^{-10} m$. The coordination number of each ion in AB is-

A. 2

B. 6

C. 4

D. 8

Answer: B

Watch Video Solution

25. Lithium has bcc structure. Its density is $530 kg \cdot m^{-3}$ and its atomic mass is $6.94 g \cdot mol^{-1}$. Calculate the edge length of a unit cell of lithium metal

$(N_A = 6.02 \times 10^{23} mol^{-1})$

A. 527 pm

B. 264 pm

C. 154 pm

D. 352 pm

Answer: D

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26. Which is the incorrect statement-

A. density decreases in case of crystals with Schottky defect

B. $NaCl(s)$ is insulator, silicon is semiconductor, silver is conductor, quartz is piezo-electric crystal

C. Frenkel defect is favoured in those ionic compounds in which sizes of cation and anions are almost equal

D. $FeO_{0.98}$ has non-stoichiometric metal deficiency defect

Answer: C

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27. Iron exhibits bcc structure at room temperature. Above $900^{\circ}C$, it transforms to fcc structure. The ratio of density of iron temperature to that at $900^{\circ}C$ (assuming molar mass and atomic radii of iron remains constant with temperature) is-

A. $\frac{1}{2}$

B. $\frac{\sqrt{3}}{\sqrt{2}}$

C. $\frac{3\sqrt{3}}{4\sqrt{2}}$

D. $\frac{4\sqrt{3}}{3\sqrt{2}}$

Answer: C

Watch Video Solution

28. Schottky defect is-

A. vacancy of ions

B. delocalisation of ions

C. interstitial vacancy of ions

D. vacancy of only cations

Answer: A

Watch Video Solution

29. CsCl has bcc arrangement. Its unit cell edge length is 400 pm. Its inter-ionic distance is-

A. 400 pm

B. 800 pm

C. $\sqrt{3} \times 100\text{pm}$

D. $\frac{\sqrt{3}}{2} \times 400\text{pm}$

Answer: C

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30. If Si is doped with B-

A. n-type semiconductor is formed

B. p-type semiconductor is formed

C. insulator is formed

D. polymer is formed

Answer: B

Watch Video Solution

31. In bcc structure contribution of corner and central atom is-

A. $\frac{1}{8}, 1$

B. $\frac{1}{4}, \frac{1}{8}$

C. $\frac{1}{8}, \frac{1}{2}$

D. $1, \frac{1}{2}$

Answer: A

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32. In a solid, atom M occupies ccp lattice and 1/3rd of tetrahedral voids are occupied by atom N. Find the formula of solid formed by M and N-

A. M_3N_2

B. M_2N_3

C. M_4N_3

D. M_3N_4

Answer: A

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33. A forms hcp lattice and B are occupying 1/3rd of tetrahedral voids, then the formula of compound is-

A. AB

B. A_3B_2

C. A_2B_3

D. AB_4

Answer: B

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34. 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

Answer: A

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35. Addition of group-13 elements to intrinsic semiconductors result in-

A. creation of conduction band slightly above the valence band

B. creation of conduction band slightly below the valence band

C. creation of valence band slightly above the conduction band

D. overlapping of valence band and conduction band

Answer: A

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36. The yellow colour in NaCl crystals is due to-

A. excitation of electrons in F-centres

B. reflection of light from Cl^{-} ions on the surface

C. refraction of light from Na^{+} ions

D. all of the above

Answer: A

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37. Which of the following is an amorphous solid-

A. iron

B. graphite

C. diamond

D. glass

Answer: D

Watch Video Solution

38. If an atom crystallises in bcc lattice with r = 4Å then the edge length will be-

A. 2Å

B. 8Å

C. 2.39Å

D. 9.23Å

Answer: D

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39. ZnO is white when cold and yellow when heated. It is due to the development of-

A. Frenkel defect

B. metal excess defect

C. Schottky defect

D. metal deficiency defect

Answer: B

Watch Video Solution

40. A forms hcp lattice and B are occupying 1/3rd of tetrahedral voids, then the formula of compound is-

A. AB

B. A_3B_2

C. A_2B_3

D. AB_4

Answer: B

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41. F-centre is-

A. anion vacancy occupied by unpaired electron

B. anion vacancy occupied by paired electrons

C. cation vacancy occupied by electron

D. anion present in interstitial site

Answer: A

Watch Video Solution

42. What colour is observed when ZnO is heated-

A. yellow

B. violet

C. green

D. blue

Answer: A

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Solved Ncert Exemplar Problems

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

A. high temperature

B. low temperature

C. high thermal energy

D. weak cohesive forces

Answer: B

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

A. definite and characteristic heat of fusion

B. isotropic nature

C. a regular periodically repeated pattern of arrangement of constituent particles in the entire crystal

D. a true solid

Answer: B

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3. Which of the following is an amorphous solid-

A. graphite (C)

B. quartz glass (SiO_2)

C. chrome alum

D. silicon carbide (SiC)

Answer: B

Watch Video Solution

4. Which arrangements shows schematic alignment of magnetic moments of antiferromagnetic substances-

A.

B.

C.

D.

Answer: D

View Text Solution

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

A. same in all directions

B. different in different directions

C. cannot be measured

D. always zero

Answer: A

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6. Which of the following statements 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

Answer: D

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

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

B. a regular arrangement of constituent particles observed over a long distance in the crystal lattice

C. same arrangement of constituent particles in different directions

D. different arrangement of constituent particles in different directions

Answer: B

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8. Iodine molecules are held in the crystal lattice by-

A. London forces

B. dipole-dipole interactions

C. covalent bonds

D. coulombic forces

Answer: A

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9. Which of the following is a network solid-

A. $SO_2(s)$

B. I_2

C. diamond

D. H_2O(ice)

Answer: C

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10. Which of the given solids is not an electrical conductor-

(i) Mg(s) (ii) TiO(s) (iii) I_2(s) (iv) H_2O(s)

A. (i) only

B. (ii) only

C. (iii) and (iv)

D. (ii), (iii) and (iv)

Answer: C

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

A. very low electrical conductivity in the molten state

B. brittle nature

C. very strong forces of interactions

D. anisotropic nature

Answer: A

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

A. lone pair of electrons

B. free valence electrons

C. cations

D. anions

Answer: B

Watch Video Solution

13. Which of the following oxides behaves as conduator or insulator depending upon temperature-

A. TiO

B. SiO_2

C. TiO_3

D. MgO

Answer: C

Watch Video Solution

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

A. SiO_2

B. MgO

C. SO_2(s)

D. CrO_2

Answer: D

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

A. molecule

B. ion

C. electron

D. atom

Answer: C

Watch Video Solution

16. Graphite cannot be classified as-

A. conducting solid

B. network solid

C. covalent solid

D. ionic solid

Answer: D

Watch Video Solution

17. Cations are present in the interstitial sites in-

A. Frenkel defect

B. Schottky defect

C. vacancy defect

D. metal deficiency defect

Answer: A

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18. Schottky defect is observed in crystals when-

A. some cations move from their lattice site to interstitial sites

B. equal number of cations and anions are missing from the lattice

C. some lattice sites are occupied by electrons

D. some impurity is present in the lattice

Answer: B

Watch Video Solution

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

A. positive

B. neutral

C. negative

D. depends on concentration of p impurity

Answer: B

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

A. 2

B. 1

C. 3

D. 5

Answer: D

Watch Video Solution

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

A. 6

B. 8

C. 10

D. 12

Answer: B

Watch Video Solution

22. Which of the following point defect are shown by AgBr crystals: (i) Schottky defect (ii) Frenkel defect (iii) Metal excess defect (iv) Metal deficiency defect-

A. (i) and (ii)

B. (iii) and (iv)

C. (i) and (iii)

D. (ii) and (iv)

Answer: A

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23. In which pair most efficient packing is present-

A. hcp and bcc

B. hcp and ccp

C. bcc and ccp

D. bcc and simple cubic cell

Answer: B

Watch Video Solution

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

A. 74

B. 68

C. 32

D. 26

Answer: C

Watch Video Solution

25. Which of the following statements is not true about the hexagonal close packing-

A. the coordination number is 12

B. it has 74% packing efficiency

C. tetrahedral voids of the second layer are covered by the spheres of the third layer

D. in this arrangement spheres of the fourth layer are exactly aligned with those of the first layer

Answer: D

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26. 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

Answer: A

Watch Video Solution

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

A. 2

B. 3

C. 4

D. 6

Answer: C

Watch Video Solution

28. Which kind of defects are introduced by doping-

A. dislocation defect

B. Schottky defect

C. Frenkel defect

D. electronic defects

Answer: D

Watch Video Solution

29. Silicon doped with electron-rich impurity forms-

A. p-type semiconductor

B. n-type semiconductor

C. intrinsic semiconductor

D. insulator

Answer: B

Watch Video Solution

30. 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 anti-ferromagnetic substances are oppositely oriented with respect to each other

D. pairing of electrons cancels their magnetic moment in the diamagnetic substances

Answer: B

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31. Which of the given is not true about the ionic solids-

A. bigger ions form the close-packed structure

B. smaller ions occupy either the tetrahedral or the octahedral voids depending upon their size

C. occupation of all the voids is not necessary

D. the fraction of octahedral or tetrahedral voids occupied depends upon the radii of the ions occupying the voids

Answer: D

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

A. all the domains get oriented in the direction of magnetic field

B. all the domains get oriented in the direction opposite to the direction of magnetic field

C. domains get oriented randomly

D. domains are not affected by magnetic field

Answer: A

Watch Video Solution

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

A. fcc $<$ bcc $<$ simple cubic

B. fcc $>$ bcc $>$ simple cubic

C. fcc $<$ bcc $>$ simple cubic

D. bcc $<$ fcc $>$ simple cubic

Answer: B

Watch Video Solution

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

A. Frenkel defect

B. Schottky defect

C. non-stoichiometric defect

D. simple interstitial defect

Answer: A

Watch Video Solution

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

A. 4 tetrahedral voids each of which is shared by four adjacent unit cells

B. 4 tetrahedral voids within the unit cell

C. 8 tetrahedral voids each of the which is shared by four adjacent unit cells

D. 8 tetrahedral voids within the unit cells

Answer: D

Watch Video Solution

36. The edge lengths of the unit cells in terms of the radius of spheres constituting fcc, bcc and simple cubic unit cell 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. $2r, \frac{4r}{\sqrt{3}}, 2\sqrt{2}r$

Answer: A

Watch Video Solution

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

A.

$$K_{\text{metals}} > > K_{\text{insulators}} < K_{\text{semiconductors}}$$

B.

$$K_{\text{metals}} < < K_{\text{insulators}} < K_{\text{semiconductors}}$$

C. $K_{\text{metals}}, K_{\text{semiconductors}} > K_{\text{insulators}} = 0$

D.

$$K_{\text{metals}} < K_{\text{semiconductors}} > K_{\text{insulators}} \neq 0$$

Answer: A

Watch Video Solution

38. Which is not true about the voids formed in three dimensional hexagonal close-packed structure-

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

B. all the triangular voids are not covered by the spheres of the second layer

C. tetrahedral voids are formed when the triangular voids in the second layer lie above the triangular voids in the first layer and the triangular shapes of these voids do not overlap

D. octahedral voids are formed when the triangular voids in the second layer exactly overlap with similar voids in the first layer

Answer: C::D

Watch Video Solution

39. The value of magnetic moment is zero in the case of anti-ferromagnetic substances because the domains-

A. get oriented in the direction of applied magnetic field

B. get oriented opposite to the direction of the applied magnetic field

C. are oppositely oriented with respect to each other without the application of magnetic field

D. cannot out each other's magnetic moment

Answer: C::D

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40. Which of the following statements are not true-

A. vacancy defect results in a decrease in the density of the substance

B. interstitial defects results in an increase in the density of the substance

C. impurity defect has no effect on the density of the substance

D. Frenkel defect results in an increase in the density of the substance

Answer: C::D

Watch Video Solution

41. Which of the following are true about metals-

A. valence band overlaps with conductions band

B. the gap between valence band and conduction band is negligible

C. the gap between valence band and conduction band cannot be determined

D. valence band may remain partially filled

Answer: A::B::D

Watch Video Solution

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

A. electron will move towards the positvely charged plate through electron holes

B. holes will appear to be moving towards the negatively charged plate

C. both electrons and holes appear to move towards the positively charged plate

D. movement of electrons is not related to the movement of holes

Answer: A::B

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

A. silicon doped with electron rich impurity is a p-type semiconductor

B. silicon doped with an electron rich impurity is an a n-type semiconductor

C. delocalised electrons increase the conductivity of doped silicon

D. an electron vacancy increases the conductivity of n-type semiconductor

Answer: B::C

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

A. some anionic sites are occupied by an unpaired electron

B. some anionic sites are occupied by a pair of electrons

C. there are vacancies at some anionic sites

D. F-centres are created which impart colour to the crystals

Answer: A::D

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45. No. of tetrahedral voids per unit cell in NaCl crystal is-

A. 4

B. 8

C. twice the number of octahedral voids

D. four times the number of octahedral voids

Answer: B::C

Watch Video Solution

46. Amorphous solid can also be called-

A. pseudo solids

B. true solids

C. supper cooled liquids

D. super cooled solids

Answer: A::C

Watch Video Solution

47. A perfect crystal of silicon is doped with some elements as given in the options. Which of thses options show n-type semiconductors-

A. As

B. B

C. P

D. Al

Answer: A::C

Watch Video Solution

48. Which of the following statements are correct-

A. ferrimagnetic substances lose ferrimagnetism on heating and become paramagnetic

B. ferrimagnetic substances do not lose ferrimagnetism on heating and remain ferrimagnetic

C. antiferromagnetic substances have domain structures similar to ferromagnetic substances and their magnetic moments are not cancelled by each other

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

Answer: A::D

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

A. this is a crystalline solid

B. refractive index is same in all the directions

C. this has definite heat of fusion

D. this is also called super cooled liquid

Answer: A::C

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50. Which cannot be regarded as molecular solid-

A. SiC

B. AlN

C. diamond

D. I_2

Answer: A::B::C

Watch Video Solution

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

A. hcp

B. bcc

C. simple cubic

D. fcc

Answer: A::D

Watch Video Solution

52. Frenkel defect is also known as-

A. stoichiometric defect

B. dislocation defect

C. impurity defect

D. non-stoichiometric defect

Answer: A::B

Watch Video Solution

53. Which of the following defects decrease the density-

A. interstitial defect

B. vacancy defect

C. Frenkel defect

D. Schottky defect

Answer: B::D

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Short Answer Type

1. Why are liquids and gases categorised as fluids?

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2. Why are solids incompressible?

Watch Video Solution

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

Watch Video Solution

4. Why does table salt, some times appear yellow in colour?

Watch Video Solution

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

Watch Video Solution

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

Watch Video Solution

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

Watch Video Solution

8. Explain why does conductivity of germanium crystals increase on doping with galium.

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

Watch Video Solution

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

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Matching Type

1.

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2.

View Text Solution

3.

View Text Solution

4.

View Text Solution

5.

View Text Solution

Assertion Reason Type

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

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

A. (A) and (R) both are correct statements and (R) is correct explanation for (A).

B. (A) and (R) both are correct statements but (R) is not correct explanation for (A).

C. (A) is correct statement but (R) is wrong statement.

D. (A) is wrong statement but (R) is correct statement.

Answer: A

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2. Assertion(A) : Graphite is a good conductor of electricity however diamond belongs to the category of insulators.

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

A. (A) and (R) both are correct statements and (R) is correct explanation for (A).

B. (A) and (R) both are correct statements but (R) is not correct explanation for (A).

C. (A) is correct statement but (R) is wrong statement.

D. (A) is wrong statement but (R) is correct statement.

Answer: B

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3. Assertion(A) : Total number of octahedral voids present in unit cell of cubic close packing including the one that is present at the body centre, is four.

Reason (R) : Besides the body centre there is one octahedral void present at the centre of each of the six faces of the unit cell and each of which is shared between two adjacent unit cells.

A. (A) and (R) both are correct statements and (R) is correct explanation for (A).

B. (A) and (R) both are correct statements but (R) is not correct explanation for (A).

C. (A) is correct statement but (R) is wrong statement.

D. (A) is wrong statement but (R) is correct statement.

Answer: C

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4. Assertion(A) : The packing efficiency is maximum for the fcc structure.

Reason (R) : The coordination number is 12 in fcc structures.

A. (A) and (R) both are correct statements and (R) is correct explanation for (A).

B. (A) and (R) both are correct statements but (R) is not correct explanation for (A).

C. (A) is correct statement but (R) is wrong statement.

D. (A) is wrong statement but (R) is correct statement.

Answer: B

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5. Assertion(A) : Semiconductors are solids with conductivities in the intermediate range from $\left(10^{-6}-10^{4} ohm^{-1}\cdot m^{-1}\right)$.

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

A. (A) and (R) both are correct statements and (R) is correct explanation for (A).

B. (A) and (R) both are correct statements but (R) is not correct explanation for (A).

C. (A) is correct statement but (R) is wrong statement.

D. (A) is wrong statement but (R) is correct statement.

Answer: C

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Long Answer Type

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

Watch Video Solution

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

Watch Video Solution

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

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Mcq Hotspot

1. Crystalline quartz (SiO_2) is-

A. an ionic solid

B. a covalent solid

C. a polar molecular solid

D. a non-polar molecular solid

Answer: B

Watch Video Solution

2. In which of the following solids are the constituent particles held by London and dipole-dipole forces-

A. O_2

B. He

C. SO_2

D. graphite

Answer: C

Watch Video Solution

3. A crystalline solid has the given characteristics: (i) soft (ii) very low melting point (iii) non-conductor of heat and electricity both in solid and liquid states. Which of the following crystalline solids generally show these characteristics-

A. ionic

B. covalent

C. metallic

D. molecular

Answer: D

Watch Video Solution

4. Which of the following characteristics is true for an ionic crystalline solid-

A. the constituent particles are not arranged orderly

B. isotropic substance

C. the arrangement of particles has long range order

D. the arrangement of particles has short range order

Answer: C

Watch Video Solution

5. Boron nitride (BN) is-

A. an amorphous solid

B. ionic crystalline solid

C. covalent crystalline solid

D. molecular solid

Answer: C

Watch Video Solution

6. Which one of the following solids is a molecular solid-

A. silicon carbide

B. sodium fluoride

C. ice

D. diamond

Answer: C

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7. How many three dimentional crystal systems are possible from different types of crystals-

A. 5

B. 9

C. 14

D. 7

Answer: D

Watch Video Solution

8. The number of Bravais lattices is-

A. 12

B. 14

C. 7

D. 16

Answer: B

Watch Video Solution

9. The number of simple or primitive lattices among Bravais lattices is-

A. 7

B. 14

C. 8

D. 3

Answer: A

Watch Video Solution

10. Which of the following crystal systems does not have body-centred lattice-

A. orthorhombic

B. tetragonal

C. monoclinic

D. cubic

Answer: C

Watch Video Solution

11. Which of the following crystal systems has unit cell with $a = b \neq c$ (a, b & c are the edge lengths)-

A. orthorhombic

B. tetragonal

C. trigonal

D. triclinic

Answer: B

Watch Video Solution

12. Which of the following crystal systems has unit cell with $\alpha = \beta = 90^\circ, \gamma = 120^\circ$ (where $\alpha, \beta \text{ and } \gamma$ are interfacial angles)-

A. orthorhombic

B. triclinic

C. trigonal

D. hexagonal

Answer: D

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13. On crystallisation an element 'A' forms cubic crystal. The corners of the unit cell are occupied by A atoms. The coordination number of A in the unit cell-

A. 8

B. 6

C. 12

D. 10

Answer: B

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14. An element forms face-centred cubic lattice. Each atom in the lattice has a coordination number of-

A. 12

B. 8

C. 6

D. 10

Answer: A

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15. The edge length of body-centred cubic unit cell is $a\sqrt{3}$. The distance between two nearest neighbours in this unit cell is-

A. a

B. 0.5a

C. 1.5a

D. 2a

Answer: C

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16. The edge length of a face-centred cubic unit cell is $x\sqrt{2}$. The distance between two nearest neighbours in this unit cell is-

A. $\frac{x}{2\sqrt{2}}$

B. $\frac{x}{2}$

C. $x\sqrt{2}$

D. x

Answer: D

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17. The volume of a cubic unit cell is $x cm^3$ whose 26% remains unoccupied by the constituent particles. If the radius of each particle is $0.3535x^{1/3} cm$, then the number of particles per unit cell is-

A. 1

B. 2

C. 4

D. 3

Answer: C

Watch Video Solution

18. The number of unit cells in 1.08g of an element (atomic mass 108) forming cubic crystal, is 1.5057×10^{21}. The number of particles in the unit cell is-

A. 2

B. 4

C. 1

D. 3

Answer: B

Watch Video Solution

19. A crystalline solid consisting of elements A, B and C, crystallises in cubic crystal. The corners, body centre and edge centres of the unit cell of the crystal are occupied by atoms

A, B and C respectively. The chemical formula of the solid is-

A. $A_2B_2C_3$

B. AB_3C_2

C. A_2BC_3

D. ABC_3

Answer: D

Watch Video Solution

20. Which of the following statement is not true for a square close-packed arrangement of identical spheres-

A. unit cell is a square

B. coordination number of each sphere is 4

C. packing efficiency of the unit cell is = 68%

D. number of particles per unit cell is = 2

Answer: C

Watch Video Solution

21. A metal crystallises in bcc lattice structure with unit cell edge of 0.288nm. The density of the metal is $7.8 g \cdot cm^{-3}$. How many unit cells are present in 28g of it-

A. 2.7×10^{22}

B. 3.5×10^{24}

C. 6.7×10^{20}

D. 1.5×10^{23}

Answer: D

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22. An element (atomic mass = 31) crystallises in a cubic structure. The density of the metal is $5.4g \cdot cm^{-3}$. The number of unit cells is 3.1g of metal is 6.022×10^{22}. The number of atoms per unit cell is-

A. 6

B. 1

C. 4

D. 2

Answer: B

Watch Video Solution

23. The number of packed particles in a cubic close-packed structure is x. If the number of tetrahedral and octahedral holes in this structure are y and z, then-

A. x = y = z

B. x = y = 2z

C. x = 2y = 2z

D. $x = \frac{y}{2} = z$

Answer: D

Watch Video Solution

24. Which of the following statements is not true regarding hexagonal and cubic close-packed structures-

A. for both structures coordination number is the same

B. both structures have the same packing efficiencies

C. packing efficiency of hexagonal close-packed structure is less than that of cubic close-packed structure

D. the number of particles per unit cell in hexagonal close-packed structure is more than that in cubic close-packed structure

Answer: C

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25. In a ccp structure, the number of unit cell is N. The number of tetrahedral voids in this structure is-

A. 2N

B. 4N

C. 6N

D. 8N

Answer: D

Watch Video Solution

26. LiAg is an interstitial alloy with cubic crystalline structure. In the unit cell of the crystal both Li and Ag have coordination number of 8. The unit is-

A. simple cubic

B. body-centred cubic

C. face-centred cubic

D. unpredictable

Answer: B

Watch Video Solution

27. Metallic potassium (atomi mass = 39) has a body centred crystal structure. In the unit cell of this crystal, the distance between two nearest neighbour is 4.52Å. The density of potassium (in $kg \cdot m^{-3}$) is-

A. 887.34

B. 728.7

C. 910.87

D. 175.3

Answer: C

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28. Crystalline solid AB has face-centred cubic unit cell. Corners and the face centres of unit cell are occupied by atoms A. The edge centres and body centre of the unit cell are occupied by atoms B. If all the face-centred atoms along one of the axes are removed, then resulting chemical formula of the solid will become-

A. AB

B. A_4B_3

C. A_2B_3

D. A_3B_4

Answer: D

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29. An ionic crystal with Schottky defects has-

A. only anion vacancies

B. only cation vacancies

C. both cation and anion vacancies

D. anion vacancies as well as interstitial anions

Answer: C

Watch Video Solution

30. NaCl crystal is doped with $10^{-3} mol \%$ of $SrCl_2$. The concentration of cation vacancies in doped NaCl is-

A. $2 \times 10^{-3} mol \%$

B. $10^{-2} mol \%$

C. $4 \times 10^{-3} mol \%$

D. $10^{-3} mol \%$

Answer: D

Watch Video Solution

31. F-centres are created when KCl is heated in presence of potassium vapour. F-centre is-

A. an anion vacancy

B. an interstitial site filled with an unpaired electron

C. an anion vacancy filled with an unpaired electron

D. an anion vacancy filled with a pair of electrons

Answer: C

Watch Video Solution

32. Frenkel defects arise due to-

A. cation vacancies

B. anion vacancies

C. interstitial defects

D. both cation vacancies and interstitial defects

Answer: D

Watch Video Solution

33. Non-stoichiometric compound Fe_xO (where $0.84 < x < 0.96$) is formed due to metal deficiency defects in the crystal structure of FeO. The electrical neutrality of the crystal of Fe_xO is maintained because when one Fe^{2+} ion leaves the crystal-

A. one oxide ion in the form of $O_2(g)$ leaves the crystal

B. one Fe^{2+} ion and one Fe^{3+} ion get reduced

C. two Fe^{2+} ions and two Fe^{3+} ions get reduced

D. two Fe^{2+} ions oxidise to two Fe^{3+} ions

Answer: D

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34. Which of the following statements is true-

A. in hexagonal close-packed arrangement of spheres, the spheres of the first and fourth layers have the same vertical alignment

B. in cubic close-packed arrangement of spheres, the sphere of the first and third laters have the same vertical alignment

C. in cubic close-packed structure, the fifth layer repeats the second layer

D. hexagonal arrangement in three dimensions is less closely-packed than the cubic arrangement

Answer: C

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35. Which of the following statements is not true-

A. the valence band of Na metal is partially filled

B. in case of Mg metal, the conduction band overlaps with the valence band

C. the electrical conductivity of a semiconductor increases with rise in temperature

D. the electrical conductivity of a metal increases with rise in temperature

Answer: D

Watch Video Solution

36. The magnetic substance that can be converted into a permanent magnetic substance is-

A. paramagnetic substance

B. ferromagnetic substance

C. anti-ferromagnetic substance

D. diamagnetic substance

Answer: B

Watch Video Solution

37. The magnetic moments of the domains in a ferromagnetic substance-

A. are not influenced by applied magnetic field

B. are aligned in parallel and anti-parallel directions in equal numbers in presence of applied magnetic field

C. are aligned in parallel and anti-parallel directions in unequal numbers in presence of applied magnetic field

D. are aligned parallel to the direction of applied magnetic field

Answer: D

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38. If radii of particles in simple cubic, body-centred cubic and face-centred cubic unit cell are $r_1, r_2, \text{ and } r_3$ respectively, and each of this unit cell has an edge length of 0.16nm, then the ratio of $r_1, r_2, \text{ and } r_3$ is-

A. $1 : 1.414 : 1.224$

B. $1.414 : 1.224 : 1$

C. $1.414 : 1.732 : 1$

D. $1.732 : 1.414 : 1$

Answer: B

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39. The coordination number of a particle in a bcc unit cell is-

A. 4

B. 6

C. 8

D. 12

Answer: C

Watch Video Solution

40. Sodium chloride with density 2.165 $g \cdot cm^{-3}$ has unit cell with an edge length of 564 pm. The number of formula units per unit cell is-

A. 2

B. 3

C. 4

D. 6

Answer: C

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41. The number of particles is a unit cell of hexagonal close-packed structure is-

A. 4

B. 6

C. 12

D. 14

Answer: B

Watch Video Solution

42. The percent of empty space in a unit cell of hexagonal close-packed structure is-

A. 0.74

B. 0.486

C. 0.32

D. 0.26

Answer: D

Watch Video Solution

43. NaCl has face-centred unit cell. In its crystal, the number of Cl^{-} ions present in contact with a Na^{+} ion is-

A. 4

B. 6

C. 8

D. 10

Answer: B

Watch Video Solution

44. The number of nearest neighbours and that of next nearest neighbours of an atom of a metal with face-centred cubic crystal structure, respectively, are-

A. 6, 8

B. 8, 12

C. 12, 6

D. 8, 6

Answer: C

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45. NaCl crystal possesses a crystal structure having face-centred cubic unit cell. If the radii of Na^{+} and Cl^{-} ions are 95 and 181 pm, respectively, then the edge length of its unit cell is-

A. 371 pm

B. 552 pm

C. 276 pm

D. 457 pm

Answer: B

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46. NaCl has a crystal structure containing face-centred cubic unit cells. The number of unit cell in $1.0g$ of NaCl is-

A. 2.56×10^{21}

B. 1.85×10^{22}

C. 2.37×10^{23}

D. 3.49×10^{20}

Answer: A

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47. An ionic crystal XY crystallises in body-centred cube with unit cell edge length of 300 pm. The nearest distance between two oppositely charged ions is-

A. 221.7 pm

B. 198.3 pm

C. 259.8 pm

D. 210.5 pm

Answer: C

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48. Which of the following ranges of $\frac{r_+}{r_-}$ does imply a tetrahedral structure of an ionic crystal-

A. 0.414 - 0.732

B. 0.225 - 0.414

C. 0.732 - 1.000

D. 0.155 - 0.225

Answer: B

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49. The number of nearest neighbour and the next neighbour of Na^+ ion in a crystal of NaCl are respectively-

A. $6Na^+, 12Cl^-$

B. $6Cl^{-}, 12Na^{+}$

C. $12Cl^{-}, 12Na^{+}$

D. $6Cl^{-}, 6Na^{+}$

Answer: B

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50. 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_2 molecules and I_2 molecules

Answer: A

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51. In an antifluorite structure, cations occupy-

A. octahedral voids

B. centre of cube

C. tetrahedral voids

D. corner of cube

Answer: C

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52. An organic compound crystallises in an orthorhombic cell in the ratio of 2 : 1. The dimensions of cell are 12.05, 15.05 and 2.69Å and density is $1.419g/cm^3$. Molar mass of the compound is-

A. $207g \cdot mol^{-1}$

B. $209g \cdot mol^{-1}$

C. $308g \cdot mol^{-1}$

D. $317g \cdot mol^{-1}$

Answer: B

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53. The radius ratio in CsCl is 0.93. The expected lattice structure is-

A. tetrahedral

B. square planar

C. octahedral

D. body-centred cubic

Answer: D

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54. The radius ratio (r_{+}/r_{-}) of an ionic solid $(A^{+}B^{-})$ is 0.69. What is the coordination number of B^{-}

A. 6

B. 8

C. 2

D. 10

Answer: A

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55. Which of the following solids belong to the class of network solids-

A. BN

B. ice

C. graphite

D. Se_8

Answer: A::C::D

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56. A crystalline solid is made up of elements A, B & C. It has a cubical crystal structure. Unit cell of the solid has atoms of A at its corners, an atom of B at its body centre, and atoms of C at its edge centres. In the unit cell-

A. number of A atoms = number of B atoms

B. number of B atoms = number of C atoms

C. ratio of number of atoms of A, B and C = 1 : 1 : 1

D. ratio of number of atoms of A, B and C = 1 : 1 : 3

Answer: A::D

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57. In a metallic crystal with hexagonal close-packed arrangement of N atoms, the numbers of tetrahedral and octahedral voids are T and O, respectively, then-

A. T = N

B. O = N

C. T = 2N

D. O = 2N

Answer: B::C

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58. Crystal systems with a = b = c are-

A. cubic

B. trigonal

C. orthorhombic

D. tetragonal

Answer: A::B

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59. Crystal systems with $\alpha = \beta = \gamma = 90^{\circ}$ -

A. cubic

B. tetragonal

C. triclinic

D. orthorhombic

Answer: A::B::D

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60. Which of the following statements are true for a simple cubic unit cell-

A. the coordination number of constituent particles is 6

B. the distance between the two nearest neighbours = edge length of the unit cell

C. 50% of the total volume of the unit cell is occupied by the constituent particles

D. this type of unit cell is usually observed in almost all metallic crystals.

Answer: A::B

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61. Which of the following statements are not true regarding Schottky and Frenkel defects-

A. these defects are called non-stoichiometric defects

B. the density of a crystal decreases if Schottky defects arise in the crystal

C. the density of a crystal decreases if Frenkel defects arise in the crystal

D. both types of defects in a crystal result in cation and anion vacancies simultaneously

Answer: A::C::D

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62. Which of the following comments are not true for hcp and ccp structures? In both cases-

A. unit cells have the same number of particles

B. unit cells have the same packing efficiency

C. particles have the same coordination number

D. layers formed by particles have the same packing sequence

Answer: A::D

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Exercise

1. How can a crystalline solid be converted into an amorphous solid?

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2. How many classes are crystals divided into? How many Bravais lattice are there?

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3. Between crystalline and amorphous solids which one does not have a fixed melting point and which is anisotropic?

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4. What type of solid is called a supercooled liquid with high viscosity and why?

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5. Give an example of a non-polar and a polar molecular solid?

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6. Given an example of a network solid.

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7. What is metallic bond?

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8. Which of the compounds will develop Frenkel defect, CsCl or AgCl?

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9. What are the causes of electrical conductivity of a semiconductor?

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10. What happens when a ferromagnetic substance is heated at very high temperature?

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11. What is point defect? Give an example.

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12. What is F-centre? Why is a solid with F-centres paramagnetic?

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13. Of the following crystalline solids which one is molecular solid, and which one is network solid? (i) P_4 (ii) Se

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14. What is the coordination of an atom of a metal with bcc structure?

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15. Which crystal system does have all four types of unit cell, i.e., simple, body-centred, face-centred and end-centered?

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16. Radius of particle in a fcc unit cell is 0.3535 times the edge length of the unit cell. What is the distance between two nearest neighbours in this unit cell?

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17. What type of unit cell do ccp and hcp structures possess?

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18. A simple cubic unit cell with edge length 'a' contains particle with radius 'r'. What is the relation between 'a' and 'r'.

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19. What are the percentages of empty space in body-centred and face-centred cubic unit cells?

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20. What is an impurity defect?

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21. What are the coordination numbers of each particles in square and hexagonal close packing of particles in two dimensions?

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22. What is space lattice?

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23. What is lattice point?

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24. What do you understand by unit cell of a crystal?

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25. What is impurity or extrinsic semiconductor? Give an example.

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26. What is the coordination number of a particle in an hcp or a ccp structure of particles?

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27. What is a ferromagnetic substance? Give an example.

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28. What is a ferrimagnetic substance? Give an example.

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29. The constiuent particle in solid H_2 _______ and the attractive forces holding the particles in solid H_2 are _______ .

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30. Silicon is a ________ solid.

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31. Packing efficiency of body-centred cubic unit cell is ________ and that of face-centred cubic unit cell is ______.

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32. If equal number of cations and anions are missing from an ionic crystal of the type MX, then the defect that arises in the crystal is called ______ defect.

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33. Number of Bravais lattices in cubic crystal system is _______.

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34. _______ substance can be converted into a permanent magnetic substance.

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35. If pure Si is doped with a trace amount of As, _______ semiconductor is formed.

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36. A unit cell having $a = b \neq c$ and $\alpha = \beta = \gamma = 90^\circ$ belongs to _____ system.

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37. The unit cell in a three-dimensional close-packed structure with sequance ABAB... is __________.

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38. In the crystal lattice of non-stoichiometric NaCl, the anion vacancies are occupied by ________.

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39. Number of particles in the unit cells of ccp and hcp structures are ______ and _______, respectively.

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40. Amount of empty space in ccp structure is _______ %.

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41. Crystals are classified into ________ crystal system.

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42. Number of Bravais lattices are _______.

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43. A hcp structure contains N atoms. Number of tetrahedral and octahedral holes in this structure are _______ and ________, respectively.

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44. Number of octahedral holes per particle in a fcc lattice (is/are) _______

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45. A crystal with F-centres is associated with _______ defect.

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46. Defect that is found to occur in the crystal of $Fe_{0.88}O_{1.00}$ is called ________.

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47. Why are crystalline substances anisotropic?

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48. Classify the solid that has the given characteristics: (i) very hard, brittle (ii) very high melting point and heat of fusion (iii) non-conductor of electricity and heat in solid state.

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49. Mention the differences between a molecular solid and a network solid with regard to their constituent particles and the forces holding the particles in the solids.

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50. Identify the crystal system whose unit cell parameters are $a \neq b \neq c$ and $\alpha = \beta = \gamma = 90^\circ$. How many Bravais lattices are possible for this crystal system? What are they?

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51. How much portion of a corner particle of cubic unit cell does lie within the unit cell?

Give reason.

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52. How much portion of an edge-centred particle of a cubic unit cell does lie within the unit cell? Give reason.

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53. An ionic solid M_xA_y has a cubic unit cell with M^{y+} ions at its corners and A^{x-} ions at its centres. Determine the values of x and y.

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54. Mention two differences between Schottky and Frenkel defects.

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55. Arrange simple, body-centred and face-centred cubic unit cells in order of their increasing packing efficiencies, and give reasons.

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56. What are non-stoichiometric defects? Give two example of such defects.

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57. Why aren't Frenkel defects observed in pure halides of alkali metals?

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58. Why does KCl become violet in colour when it is heated in presence of potassium vapour?

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59. What do you understand by a tetrahedral void in a close-packed structure of a crystal? What is the relation between the number of tetrahedral voids and the number of packed particles in a close-packed structure of particles?

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60. What do you understand by an octahedral void in a close-packed crystal structure? What is the relation between the number of octahedral voids and the number of packed particles in a close-packed structure of particles?

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61. Metallic Zn has a hexagonal close-packed array of Zn atoms. How many voids are present in 0.5mol of Zn?

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62. What type of semiconductor (n-or p-type) is formed when pure Ge is doped with a trace amount of As, and why?

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63. What type of semiconductor (n- or p-type) is formed when pure Si is doped with a trace amount of B, and why?

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

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65. Why is the electrical conductivity of metals found to decrease with rise in temperature?

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66. Why does the electrical conductivity of germanium crystal increase when it is doped with gallium?

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67. Write the differences between crystalline and amorphous solids.

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68. On the basis of the nature of constituent particles, how are crystalline solids classified? Give an example of each type.

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69. Between square and hexagonal close packing in two dimensions, which one represents the most effective packing, and why?

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70. Define: (i) Cubic close-packed structure (ii) Hexagonal close-packed structure (iii) Non-stoichiometric defect.

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71. Show that 26% of the total volume of a face-centred cubic unit cell remains unoccupied.

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72. Show that the number of octahedral voids in a ccp or an hcp structure is equal to the number of packed particles.

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73. Explain how the electrical neutrality of an ionic crystal is maintained when metal excess defects occur in the crystal.

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74. Table salt (NaCl), which is essentially white in colour, is found yellow in colour at times. Why this happens?

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75. ZnO is white in colour, but when it is heated its colour turns yellow. Why does this change occur?

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76. Why is ferrous oxide hard to be prepared with ideal stoichiometric composition?

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77. Calculate the number of particles in unit cells of ccp and hcp structures with identical particles.

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78. Show with a diagram that a unit cell in a ccp structure has a total of four octahedral holes.

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79. The actual formula derived from the analysis of a sample of ferrous oxide is $Fe_{0.93}O_{1.00}$. What fraction of iron in this sample does exist in the form of Fe^{2+} ions?

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80. Show that if the radius of tetrahedral holes in a ccp or a hcp structure be r and that of packed particles be R, $r = 0.225 \times R$.

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81. Show that if the radius of octahedral holes be r in a ccp or hcp structure be r and that of packed particles be R, then $r = 0.414 \times R$.

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82. Calculate the packing fraction in a hexagonal close-packed structure with similar particles.

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83. With the help of band theory explain (i) inability of an insulator to conduct electricity and (ii) the electrical conductivity of a semiconductor.

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84. What is an impurity defect? What kind of impurity defect is generated in a NaCl crystal when it is doped with a small amount of $SrCl_2$? Calculate the number of cation vacancy per Sr^{2+} ions is this crystal?

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85. What is stoichiometric defect? What kind of defects are Schottky and Frenkel defects? Which one of these two defects is associated with decrease in density of the crystal, and which one is associated with no change in density? Give reasons.

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Numerical Problems

1. A metal has face-centred cubic unit cell. The radius of an atom of the metal is 1.28Å. What is the edge length of the unit cell?

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2. Potassium metal has body-centred cubic crystal. The edge length of the unit cell of the crystal is 0.542 nm. Determine the radius of K atom and the volume occupied by the atoms in the unit cell.

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3. The total volume occupied by the particles in a cubic unit cell is $5 \times 10^{-23} cm^3$. The edge length of the unit cell is 0.407 nm. How many particles are present in the unit cell?

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4. Sodium (atomic mass = 23) forms face-centred cubic crystal. What is the density of sodium crystal if the radius of sodium atom is 1.91Å?

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5. A metal (atomic mass = 63.5) forms cubic crystal. Its density is $8.92 \times 10^3 kg \cdot m^{-3}$. Edge length of the unit cell is 0.362 nm. How many atoms are present in the unit cell?

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6. A metal has cubic close-packed crystal structure. Its density is $2.7 g \cdot cm^{-3}$. The radius of the metal atom is 1.43Å. Determine the atomic weight of the metal.

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7. Ag (atomic weight = 108) forms cubic close-packed crystal structure. What is the length of the unit cell of Ag crystal if the density of Ag is $10.6 g \cdot cm^{-3}$?

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8. An element crystallises in cubic structure. Its density is $2.41 g \cdot cm^{-3}$. The edge length of the unit cell of the crystal is 1.8Å. How many number of unit cells are present in 250g of element?

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9. The unit cell of NaCl crystal has $4Na^{+}$ and $4Cl^{-}$ ions. The edge length of the

unit cell is 5.64Å. What is the density of NaCl crystal?

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10. A metal (atomic weight = 75) has cubic crystal structure. Its density is $2g \cdot cm^{-3}$. The edge length of the unit cell of the crystal is 5Å. What is the radius of the metal atom?

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11. Chromium metal (atomic weight = 52) has body-centred cubic structure. The unit cell of the crystal of chromium is 287pm. Calculate the radius of chromium atom and the density of chromium metal.

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12. The density of copper metal is $8.95g \cdot cm^{-3}$. If the radius of copper atom is 127.8 pm, is the copper unit cell a simple cube, a body-centred or a face-centred cubic structure?

[Given: Atomic mass of copper: $63.54 g \cdot mol^{-1}, N_A = 6.022 \times 10^{23} mol^{-1}$]

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13. The density of lead is $11.35 g \cdot cm^{-3}$ and the metal crystallises with fcc unit cell. Estimate the radius of lead atom. [Given: Atomic mass of lead = 207 $g \cdot mol^{-1}, N_A = 6.022 \times 10^{23}$]

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14. Iron has a body-centred cubic unit cell with a cell dimension of 286.65 pm. The density of iron is $7.874g \cdot cm^{-3}$. Use the information to calculate Avogadro's number. (At. Mass of Fe = 55.845 u).

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15. An element crystallises is a fcc lattice with cell edge of 250 pm. Calculate the density of

300 g of this element containing 2×10^{24} atoms.

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Practice Set 1

1. The unit cell with crystallographic dimensions,

$a \neq b \neq c, \alpha = \gamma = 90^\circ, \beta \neq 90^\circ$ is-

A. monoclinic

B. tetragonal

C. triclinic

D. orthorhombic

Answer:

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2. In zinc blende structure, the coordination number of cation is-

A. 4

B. 6

C. 8

D. 12

Answer:

Watch Video Solution

3. Number of tetrahedral voids in a face-centred cubic unit cell is-

A. 4

B. 6

C. 8

D. 12

Answer:

Watch Video Solution

4. To prepare n-type semiconductor from silicon the valency of doping substance will be-

A. 2

B. 1

C. 3

D. 5

Answer:

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5. Sodium metal crystallises in a body-centreed cubic lattice with a unit cell edge of 4.29Å. The radius of sodium atom is approximately-

A. 5.72 Å

B. 0.93 Å

C. 1.86 Å

D. 3.22 Å

Answer:

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6. The number of two dimensional lattice is-

A. 4

B. 5

C. 7

D. 14

Answer:

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7. The crystal of dry ice is held by-

A. London forces

B. covalent bonds

C. coulombic forces

D. dipole-dipole interactions

Answer:

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8. (a) A crystalline compound formed by element A and B has face-centred cubic unit cell. The corners and the face centres are occupied by A and B atoms respectively. If one of the corner atoms is found missing then what would be the formula of the compound?

(b) Give an example of a compound which exhibits both Schottky and Frenkel defects.

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9. (a) Analysis shows that a metal oxide has the empirical formula $M_{0.96}O_{1.00}$. Calculate the percentage of M^{2+} and M^{3+} ions in this crystal? (b) What type of defect is found in this crystal?

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10. (a) An element crystallises in a cubic crystal structure with unit cell's edge length of 3.15Å. The atomic mass and the density of the element are 96 amu and $10.2g \cdot cm^{-3}$. Predict the crystal lattice possessed by the element. (b) What type of stoichiometric defects is shown by AgCl?

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11. An element crystallises in simple cubic structure. Its density is $8g/cm^3$ and its 200g contains 24×10^{24} atoms. Calculate the edge length of the unit cell. (b) What is meant by 'doping' in a semiconductor?

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12. (a) Why does the colour of NaCl turn yellow when it is heated in an atmosphere of sodium vapour? (b) What is curie temperature?

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13. (a) Why does the old glass object appear slightly milky instead of being transparent? (b) What do you meant by unit cell of crystal lattice?

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