# CHEMISTRY

## BOOKS - KALYANI CHEMISTRY (ENGLISH)

## SOLID STATE

### Worked Out Example

**1.** Find out the number of atoms per unit cell in a face-centred cubic structure having only single atoms at its lattice points.

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**2.** Calculate the number of atoms in a cube based unit cell having one atom on each corner and two atoms on each body diagonal.

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

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**4.** In a cubic type unit cell, A atoms are at one half faces, while B atoms are at the corners of the cube. Calculate the formula of the compound.

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**5.** A solid is made up of two elements A and B. Atoms A occupy all the tetrahedral sites while atoms B are in ccp arrangement. Derive

the formula of the compound.

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**6.** Ferric oxide crystallizes 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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**7.** In a cubic type unit cell, atoms of A are at centre and corners of the cube. Atoms of B are at one half faces of the cube. What is the simplest formula of the compound?

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**8.** A unit cell consists of a cube in which there are A atoms at the corners and B atoms at the face centres and A atoms are missing from two corners in each unit cell. What is the simplest formula of the compound ?

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**9.** Potassium crystallizes in a body centred cubic lattice. Calculate the number of unit cells in 1 g potassium. Atomic mass of potassium=39 u.

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**10.** Xenon is crystallized in the fcc lattice and the edge of unit length is 620 pm. What is the nearest neighbour distance and radius of xenon atom ?

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**11.** Aluminium crystallizes in an fcc structure. Atomic radius of the metal is 125 pm.

What is the length of the edge of the unit cell ?

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**12.** Aluminium crystallizes in an fcc structure. Atomic radius of the metal is 125 pm.

How many such unit cells are there in 1 $m^3$ of aluminium?

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**13.** $Br^-$ ions form close packed structure. If the radius of $Br^-$ ion is 195 p, calculate the radius of the cation that just fits in the

tetrahedral hole. Can a cation $A^+$ having a radius of 82 pm be slipped into the octahedral hole of the crystal $A^+Br^-$?

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

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**15.** Predict the structure of MgO crystal and coordination number of its cation in which the cation and anion radii are equal to 65 pm and 140 pm respectively.

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**16.** A solid AB has NaCl structure. If the radius of cation $A^+$ is 160 pm, calculate the maximum possible value of radius of the anion $B^-$?

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

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**18.** Analysis shows that nickel oxide has formula $Ni_{0.98}O_{1.0}$. What fractions of the nickel exist as $Ni^{2+}$ and $Ni^{3+}$ ions ?

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## Worked Out Example Type I Calculation Of Density Of Unit Cell

**1.** Calculate the density of silver which crystallizes in face- centred cubic form. The distance between nearest metal atoms is 287 pm (Molar mass of $Ag = 107.87 gmol^{-1}$, $N_A = 6.022 \times 10^{23} mol^{-1}$).

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## Worked Out Example Type Ii Calculation Of Edge Length Interionic Distances And Volume Of Unit Cell From Density

**1.** Niobium crystallizes in body centred cubic structure. If its density is 8.55 g $cm^{-3}$, calculate the atomic radius of niobium. (Atomic mass of Nb = 93u , $N_A = 6.02 \times 10^{23} mol^{-1}$)

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**2.** Silver metal crystallizes with a face centred cubic lattice. The length of the unit cell is found to be $4.077 \times 10^{-8}$ cm. Calculate atomic radius and density of silver. (Atomic mass of Ag = 108 u, $N_A = 6.02 \times 10^{23} mol^{-1}$)

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**3.** Lithium metal has a body centred cubic structure. Its density is 0.53g $cm^{-3}$ and its molar mass is 6.94g $mol^{-1}$. Calculate the volume of a unit cell of lithium metal.

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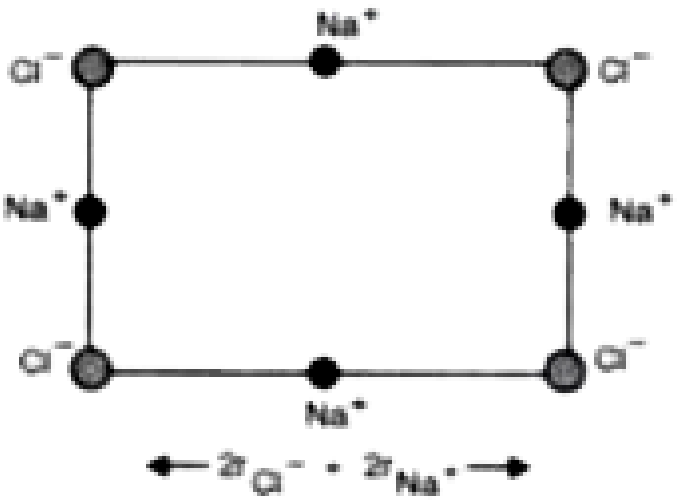
**4.** What is the distance between $Na^+$ and $Cl^-$ ions in NaCl crystal if its density is 2.165g $cm^{-3}$ ? NaCl crystallizes in fcc lattice.

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## Worked Out Example Type Iii Calculation Of Avogadro S Number

**1.** Sodium chloride crystallizes in face-centred cubic (f.c.c.) structure. Its density is 2.165 g $cm^{-3}$. If the distance between $Na^{+}$ and its nearest $Cl^{-}$ ions is 281 pm, find out the Avogadro's number (Na = 23 g $\mathrm{mol}^{-}$, $Cl = 35.5 g \mathrm{mol}^{-}$).

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## Worked Out Example Type Iv Calculation Of Atomic Mass And Number Of Atoms In A Given Mass

**1.** An element crystallizes into structure which may be described by a cube type of unit cell having one atom on each corner of the cube and two atoms on one of its diagonals. If the volume of this unit cell is $24 \times 10^{-24} cm^3$ and density of the element is 7.2 g $cm^{-3}$, calculate the number of atoms present in 200 g of the element.

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**2.** Anelement has a body-centred cubic (bec) structure with cell edge of 288 pm. The density of the element is 7.2 $g/cm^3$. How many atoms are present in 208 g of the element ?

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## Worked Out Example Type V Determination Of The Nature Of The Unit Cell And Number Of Atoms Per Unit Cell

**1.** Sodium crystallizes in the cubic lattice and the edge of the unit cell is 430 pm. Calculate the number of atoms in a unit cell. (Atomic mass of Na = 23.0 density = 0.9623g $cm^{-3}$, $N_A = 6.023 \times 10^{23} mol^{-1}$).

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**2.** An element with molar mass 27 g $mol^{-1}$ forms a cubic unit cell with edge length $4.05 \times 10^{-8}$ cm. If its density is 2.7g $cm^{-3}$, what is the nature of the cubic unit cell?

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**3.** The density of chromium metal is 7.2 g $cm^{-3}$. If the unit cell has edge length of 289 pm, determine the type of unit cell. Also, calculate the radius of an atom of chromium. (Atomic mass of chromium = 52 a.m.u.)

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## Intext Questions

**1.** What are the two factors which decide the physical state of a substance?

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**2.** Why solids have definite shape and volume ?

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**3.** Why are solids hard and rigid ?

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**4.** Why is glass regarded as an amorphous solid ?

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**5.** Classify each of the following solids as molecular, ionic, network (covalent), metallic or amorphous :

(i) $I_2$ (ii) Tetraphosphorus decaoxide $(P_4O_{10})$ (iii) $P_4$ (iv) $S_8$ (v) Plastic (vi) Brass (vii) SiC (viii) Graphite (ix) Rb (x)Si (xi) Ammonium phosphate (xii) LiBr (xiii) Wax (xiv) Ice (xv) Solid $CO_2$ (xvi) Al (xvii) Naphthalene (xviii) CsCl (rir) Sugar (xx) $SiO_2$, (xxi) Glass

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**6.** Why the window glass panes of the old buildings are thick at the bottom ?

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**7.** Some glass objects from ancient civilisations look milky instead of being transparent. Explain.

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**8.** Calculate the number of atoms present in the unit cell of a monoatomic element of (i) simple cubic (ii) body-centered cubic and (iii) face-centered cubic lattices.

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**9.** How many unit cells are shared by an atom on the face of a unit cell?

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**10.** What is the two dimensional coordination number of a molecule in (i) square close-packed layer (ii) hexagonal close-packed layer.

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**11.** Why uncharged atoms or molecules never crystallize in simple cubic lattice ?

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**12.** Noble gases and metals both have closed packed structures, yet the melting point of noble gases are exceptionally low. Why?

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**13.** Explain why a hexagonal close-packed structure and a cubic close packed structure for a given element would be expected to have the same density ?

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**14.** What is the advantage of heating a germanium semiconductor with silver or gold instead of indium or boron?

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**15.** Why sodium chloride on heating with sodium vapours acquires yellow colour?

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**16.** Why cation vacancies in some crystals make them good catalysts?

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**17.** Why solids with F-centres are paramagnetic?

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**18.** Schottky defect lowers the density of ionic crystals while Frenkel defect does not. Why?

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**19.** $Fe_3O_4$ is ferrimagnetic at room temperature but becomes paramagnetic at 850K. Explain.

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## Follow Up Problems

**1.** Copper crystallizes in a face centred cubic lattice. Calculate the number of unit cells in 1.2g of copper. Atomic mass of copper = 63.54.

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**2.** A unit cell consists of a cube in which there are anions Y at each corner and cations X at the centres of alternate faces of unit cell. What is the simplest formula of the compound?

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**3.** In aluminium oxide, the oxide ions are arranged in hexagonal close packed (hcp) arrangement and the aluminium occupy $2/3$ of octahedral voids. What is the formula of oxide ?

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**4.** A compound is formed by two elements A and B. Atoms of the element B (as anions) are in ccp arrangement and those of the element A as cations occupy all the octahedral voids. What is the formula of the compound?

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**5.** What is the formula of the compound formed by elements X and Y if atoms of element Y are in hcp arrangement and those of the element X occupy $2/3$rd of tetrahedral voids?

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**6.** A compound formed by elements A and B crystallizes in the cubic arrangement in which atoms A are at the corners of the cube and atoms B at the face centres. What is the formula of the compound?

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**7.** An element crystallizes in face centred cubic lattice. Calculate the length of the side of the unit cell if the radius of atom is 200 pm.

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**8.** Silver crystallizes in face-centred cubic unit cell. Each side of this unit cell has a length of 400 pm. Calculate the radius of the silver atom. (Assume the atoms touch each other on the diagonal across the face of the unit cell. That is each face atom is touching the four corner atoms).

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**9.** Chromium metal crystallizes in a body centred cubic lattice. The length of the unit cell edge is found to be 287 pm. Calculate the atomic radius of chromium.

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**10.** If the radius of the bromide ion is 0.182 nm, how large a cation can fit in each of the tetrahedral holes ?

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**11.** CsCl has bec arrangement and its unit cell edge length is 400 pm. Calculate the inter-ionic distance in CsCl.

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**12.** The atomic radius of an ion which crystallizes in fcc structure is $\frac{9}{7}$ Å. Calculate the lattice constant.

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**13.** The radius of $Na^+$ ion is 95 pm and that of $Cl^-$ ion is 181 pm. Predict the structure of $Na^+Cl^-$ and the coordination number of cation.

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**14.** Calculate the radius ratio $(r_+ / r_-)$ and coordination number of $Li^+$ and $F^-$ ion in LiF crystal structure from the following data : $r_{Li^+}$ = 60 pm , $r_{F^-}$ = 136 pm

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**15.** A solid AB has the NaCl structure. If the radius of the cation $A^+$ is 150 pm, calculate the maximum possible value of the radius of the anion $B^-$.

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**16.** 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 the sample.

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**17.** If NaCl is doped with $10^{-2}$ mol % $SrCl_2$, what is the concentration of cation vacancies?

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**18.** Composition of sample wurtzite is $Fe_{0.93}O_{1.0}$. What percentage of iron is present in the form of Fe(III) ?

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## Follow Up Problems Type 1 Calculation Of Density Of Unit Cell

**1.** An element crystallizes in a structure having fee unit cell of an edge 200 pm. Calculate the density if 200 g of this element contains $24 \times 10^{23}$ atoms.

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**2.** Silver forms ccp lattice and X-ray studies of its crystals show that the edge length of its unit cell is 408.6 pm. Calculate the density of silver (Atomic mass = 107.9u).

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## Follow Up Problems Type Ii Calculation Of Edge Length Interionic Distances And Volume Of Unit Cell

**1.** An element (at. mass = 60) having face centred cubic unit cell has a density of 6.23g $cm^{-3}$. What is the edge length of the unit cell? (Avogadro's constant = $6.023 \times 10^{23} mol^{-1}$)

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**2.** The density of aluminium (atomic mass = 27) is 2700 kg $m^{-3}$. If Al has feestructure, calculate its atomic radius.

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**3.** A metal (atomic mass = 50) has a body centred cubic crystal structure. The density of the metal is 5.96 g $cm^{-3}$. Find the volume of this unit cell.

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**4.** KF has NaCl structure. What is the distance between $K^{+}$ and $F^{-}$ in KF, if its density is 2.48 g $cm^{-3}$ ?

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## Follow Up Problems Type Iii Calculation Of Avogadro S Number

**1.** Chromium crystallizes in a body centred cubic lattice, whose density is 7.20 $g/cm^3$. The length of the edge of unit cell is 288.4 pm. Calculate Avogadro's number.

(Atomic mass of chromium=52)

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**2.** An element of atomic mass 90 occurs in fce structure with cell edge of 500 pm. Calculate the Avogadro's number if the density is 4.2g $cm^{-3}$

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## Follow Up Problems Type Iv Calculation Of Atomic Mass And Number Of Atoms In A Given Mass

**1.** X-ray diffraction studies show that copper crystallizes in an fcc unit cell with cell edge of $3.608 \times 10^{-8}$ cm. In a separate experiment, copper is determined to have a density of $8.92 g / cm^3$ calculate the atomic mass of copper.

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**2.** An element occurs in bcc structure with cell edge 288 pm. Its density is 7.2 g $cm^{-3}$. Calculate the atomic mass of the element.

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**3.** Tungsten has bcc lattice. Each edge of the unit cell is 316 pm and the density of the metal is 19.35g $cm^{-3}$. How many atoms are present in 50 g of this element?

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**4.** A body centred cubic element of density, 10.3 g $cm^{-3}$ has a cell edge of 314 pm. Calculate the atomic mass of the element. ( $N_A = 6.023 \times 10^{23} mol^{-1}$)

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## Follow Up Problems Type V Determination Of The Nature Of Unit Cell And Number Of Atoms Per Unit Cells

**1.** The density of KBr is 2.75g $cm^{-3}$. The length of the edge of the unit cell is 654 pm. Show that KBr has a face centred cubic structure. ($N_A = 6.023 \times 10^{23} mol^{-}$ at. mass : K=39, Br = 80]

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**2.** Determine the type of cubic lattice to which the iron crystal belongs if its unit cell has an edge length of 286 pm and the density of iron crystals is 7.86g $cm^{-3}$.

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## Exercise Part I Objective Questions

**1.** Fill in the blanks by choosing the appropriate word from those given in the brackets. (isotropic, anisotropic, 0.255–0.414, 0.414–0.732, unit cell AB AB, .... ABC ABC ..., ...., 52.4, 60.4, F-centres, V-centres, 4, 2, hexagonal close packing, square close packing, 6, 8 glass, plastics, lead zirconate, barium titanate)

Amorphous solids are .....

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**2.** Fill in the blanks by choosing the appropriate word from those given in the brackets. (isotropic, anisotropic, 0.255–0.414, 0.414–0.732, unit cell AB AB, .... ABC ABC ..., ...., 52.4, 60.4, F-centres, V-centres, 4, 2, hexagonal close packing, square close packing, 6, 8 glass, plastics, lead zirconate, barium titanate)

For tetrahedral coordination, the radius ratio should be.....

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**3.** Fill in the blanks by choosing the appropriate word from those given in the brackets. (isotropic, anisotropic, 0.255–0.414, 0.414–0.732, unit cell AB AB, .... ABC ABC ..., ...., 52.4, 60.4, F-centres, V-centres, 4, 2, hexagonal close packing, square close packing, 6, 8 glass, plastics, lead zirconate, barium titanate)

A crystal lattice, a built of repititive units called.....

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**4.** Fill in the blanks by choosing the appropriate word from those given in the brackets. (isotropic, anisotropic, 0.255–0.414, 0.414–0.732, unit cell AB AB, .... ABC ABC ..., ...., 52.4, 60.4, F-centres, V-centres, 4, 2, hexagonal close packing, square close packing, 6, 8 glass, plastics, lead zirconate, barium titanate)

The type of symmetry present in hcp arrangement is called.....

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**5.** Fill in the blanks by choosing the appropriate word from those given in the brackets. (isotropic, anisotropic, 0.255–0.414, 0.414–0.732, unit cell AB AB, .... ABC ABC ..., ...., 52.4, 60.4, F-centres, V-centres, 4, 2, hexagonal close packing, square close packing, 6, 8 glass, plastics, lead zirconate, barium titanate)

The electrons trapped in anion vacancies in metal excess defects are called.....

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**6.** Fill in the blanks by choosing the appropriate word from those given in the brackets. (isotropic, anisotropic, 0.255–0.414, 0.414–0.732, unit cell AB AB, .... ABC ABC ..., ...., 52.4, 60.4, F-centres, V-centres, 4, 2, hexagonal close packing, square close packing, 6, 8 glass, plastics, lead zirconate, barium titanate)

A crystal lattice, a built of repititive units called.....

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**7.** Fill in the blanks by choosing the appropriate word from those given in the brackets. (isotropic, anisotropic, 0.255–0.414, 0.414–0.732, unit cell AB AB, .... ABC ABC ..., ...., 52.4, 60.4, F-centres, V-centres, 4, 2, hexagonal close packing, square close packing, 6, 8 glass, plastics, lead zirconate, barium titanate)

In square close packing pattern of spheres of identical size in one layer, the coordination number of each sphere will be.....

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**8.** Fill in the blanks by choosing the appropriate word from those given in the brackets. (isotropic, anisotropic, 0.255–0.414, 0.414–0.732, unit cell AB AB, .... ABC ABC ..., ...., 52.4, 60.4, F-centres, V-centres, 4, 2, hexagonal close packing, square close packing, 6, 8 glass, plastics, lead zirconate, barium titanate)

The available space filled by identical spheres in hcp pattern in one layer is.....

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**9.** Fill in the blanks by choosing the appropriate word from those given in the brackets. (isotropic, anisotropic, 0.255–0.414, 0.414–0.732, unit cell AB AB, .... ABC ABC ..., ...., 52.4, 60.4, F-centres, V-centres, 4, 2, hexagonal close packing, square close packing, 6, 8 glass, plastics, lead zirconate, barium titanate)

In cop arrangement of identical spheres, the pattern of the successive layers will be designated as.....

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**10.** Fill in the blanks by choosing the appropriate word from those given in the brackets. (isotropic, anisotropic, 0.255–0.414, 0.414–0.732, unit cell AB AB, .... ABC ABC ..., ....., 52.4, 60.4, F-centres, V-centres, 4, 2, hexagonal close packing, square close packing, 6, 8 glass, plastics, lead zirconate, barium titanate)

In the sodium chloride structure each Na+ ion is surrounded by six $Cl^-$ ions nearest neighbours and ..... $Na^+$ ions next nearest neighbours.

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**11.** Fill in the blanks by choosing the appropriate word from those given in the brackets. (isotropic, anisotropic, 0.255–0.414, 0.414–0.732, unit cell AB AB, .... ABC ABC ..., ....., 52.4, 60.4, F-centres, V-centres, 4, 2, hexagonal close packing, square close packing, 6, 8 glass, plastics, lead zirconate, barium titanate)

A liquid which is permanently supercooled is frequently called a .....

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**12.** The amorphous solid among the following is

A. Diamond

B. Graphite

C. Glass

D. Common salt.

**Answer: C**

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**13.** The property not attributed to crystalline solids is

A. Isotropic

B. Sharp melting point

C. A definite and regular geometry

D. High intermolecular forces.

**Answer: A**

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**14.** Basic crystal systems known are:

A. 7

B. 8

C. 6

D. 4

**Answer: B**

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**15.** Systems which $\text{has/have}$ not been correctly characterised is

A. cubic, a = b = c, $\alpha = \beta = \gamma = 90^\circ$

B. cubic, a = b =c, $\alpha = \beta = \gamma \neq 90^\circ$

C. monoclinic , $a \neq b \neq c, \alpha = \gamma = 90^\circ \ \beta \neq 90^\circ$

D. tetragonal, $a = b \neq c, \alpha = \beta = \gamma = 90^\circ.$

**Answer: B**

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**16.** In a sodium chloride crystal, each chloride ion is surrounded by

A. 6 sodium ions

B. 6 chloride ions

C. 8 sodium ions

D. 4 sodium ions.

**Answer: A**

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**17.** An ionic solid is a poor conductor of electricity, because

A. the charge on the ions is unequally distributed

B. ions do not conduct electricity

C. ions are rigidly held in solid

D. none of the above.

**Answer: C**

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**18.** The crystal having highest melting point is

A. Ionic crystal

B. Molecular crystal

C. Covalent crystal

D. Metallic crystal

**Answer: C**

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**19.** The crystal very soft in nature is

A. Ionic crystal

B. Molecular crystal

C. Covalent crystal

D. Metallic crystal

**Answer: C**

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**20.** Covalent molecules are usually held in a crystal structure by

A. dipole-dipole interactions

B. electrostatic attraction

C. hydrogen bonds

D. van der Waals' attraction.

**Answer: D**

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**21.** 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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**22.** 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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**23.** Which of the following is an amorphous solid ?

A. Graphite ©

B. Quartz glass $(SiO_2)$

C. Chrome alum

D. Silicon carbide (SiC)

**Answer: B**

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

A. 

B. 

C. 

D. 

**Answer: D**

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**25.** 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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**26.** 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 on heating.

D. They are anisotropic in nature.

**Answer: D**

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**27.** 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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**28.** Iodine molecules are held in the crystals lattice by

A. London forces

B. dipole-dipole interactions

C. covalent bonds

D. coulombic forces

**Answer: A**

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**29.** Which of the following is a network solid

A. $SO_2$ (Solid)

B. $I_2$

C. Diamond

D. $H_2O$ (ice)

**Answer: C**

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

(I)$Mg_{(s)}$ , (II)$TiO_{(s)}$ , (III)$I_{2(s)}$ , (IV)$H_2O_{(s)}$

A. (A) only

B. (B) only

C. (C) and (D)

D. (B), (C) and (D)

**Answer: C**

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**31.** which of the following is not the characteristic of ionic solids?

A. Very low value of electrical conductivity in the molten state

B. Brittle nature

C. Very strong forces of interactions

D. Anisotropic nature

**Answer: A**

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**32.** 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**

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

A. TiO

B. $SiO_2$

C. $TiO_3$

D. MgO

**Answer: C**

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**34.** 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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**35.** The lattice site in a pure crystal cannot be occupied by

A. molecule

B. ion

C. electron

D. atom

**Answer: C**

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**36.** Graphite cannot be classified as

A. conducting solid

B. network solid

C. covalent solid

D. ionic solid

**Answer: D**

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**37.** 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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**38.** 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**

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**39.** 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-type impurity

**Answer: B**

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

A. 2

B. 1

C. 3

D. 5

**Answer: D**

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**41.** The total number of tetrahedral voids in the face centred unit cell is

A. 6

B. 8

C. 10

D. 12

**Answer: B**

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**42.** Which of the following point defects are shown by AgBr(s) crystals ?

(A) Schottky defect (B) Frenkel defect

(C) Metal excess defect (D) Metal deficiency defect.

A. (A) and (B)

B. (C) and (D)

C. (A) and (C)

D. (B) and (D)

**Answer: A**

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**43.** 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**

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

A. 74

B. 68

C. 32

D. 26

**Answer: C**

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

A. $Cl^-$ ions form fcc lattice and $Na^+$ ions occupy all octahedral voids of the unit cell

B. $Ca^{2+}$ ions form fcc lattice and $Fi^{-}$ ons 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::D**

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

A. 2

B. 3

C. 4

D. 6

**Answer: C**

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**48.** Which kind of defects are introduced by doping ?

A. Dislocation defects

B. Schottky defects

C. Frenkel defects

D. Electronic defects

**Answer: D**

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**49.** Silicon doped with electron-rich impurity forms

A. p-type semiconductor

B. n-type semiconductor

C. intrinsic semiconductor

D. insulator

**Answer: B**

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**50.** Which of the following statements is not true

A. Paramagnetic substances are weakly attracted by magnetic field

B. Ferromagnetic substances cannot be magnetised permanently

C. The domains in antiferromagnetic substances are oppositely oriented with respect to each other

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

**Answer: B**

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**51.** Which of the following 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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**52.** A ferromagnetic substance becomes the permanent magnet when it is placed in the 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**

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**53.** The correct order of the packing efficiency in different types of unit cells is

A. $\text{fcc} < \text{bcc} < \text{simple cubic}$

B. $\text{fcc} > \text{bcc} > \text{simple cubic}$

C. $\text{fcc} < \text{bcc} > \text{simple cubic}$

D. $\text{bcc} < \text{fcc} > \text{simple cubic}$

**Answer: B**

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**54.** 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**

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**55.** 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 cach of which is shared by four adjacent unit cells

D. 8 tetrahedral voids within the unit cells

**Answer: D**

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

A. $2\sqrt{2}r, \frac{4r}{\sqrt{3}}, 2r$

B. $\frac{4r}{\sqrt{3}}, 2\sqrt{2}r, 2r$

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

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

**Answer: A**

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**57.** 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. $K_{\text{metals}} = K_{\text{semiconductors}} > K_{\text{insulators}} = \text{zero}$

D. $K_{\text{metals}} < K_{\text{insulators}} > K_{\text{semiconductors}} \neq \text{zero}$

**Answer: A**

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**58.** Correct the following statement by changing the underlined part of the sentence.

In a hexagonal closest packing of identical spheres in two layers,

one above the other, the coordination number of each sphere will be $\underline{12}$.

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**59.** Correct the following statement by changing the underlined part of the sentence.

In bcc arrangement, the space filled by identical spheres is $\underline{60.4\,\%}$.

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**60.** Correct the following statement by changing the underlined part of the sentence.

If R is the radius of spheres forming closest packing arrangement, then radius r of the tetrahedral void will be $\underline{0.732R}$.

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**61.** Correct the following statement by changing the underlined part of the sentence.

In a close packed lattice, the number of tetrahedral sites formed will be equal to that of the number of spheres.

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**62.** Correct the following statement by changing the underlined part of the sentence.

Amorphous solids have sharp melting points.

Watch Video Solution

**63.** Correct the following statement by changing the underlined part of the sentence.

Graphite is an amorphous solid.

Watch Video Solution

**64.** Correct the following statement by changing the underlined part of the sentence.

Three spheres of the first layer and three of the second layer enclose a site at the centre in a closest packing arrangement, the site is called tetrahedral site.

Watch Video Solution

**65.** Correct the following statement by changing the underlined part of the sentence.

W(tungsten) crystallises in fcc structure If the edge length is 316.5 pm.

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**66.** Correct the following statement by changing the underlined part of the sentence.

If R is the radius of the spheres forming closest packing arrangement, then radius r of the octahedral void will be $\underline{0.225\ \mathrm{R}}$.

Watch Video Solution

**67.** Correct the following statement by changing the underlined part of the sentence.

Non-stoichiometric NaCl is $\underline{\mathrm{pink}}$.

Watch Video Solution

**68.** Match the following :

| | | | |
|---|---|---|---|
| (*i*) | Ionic solid | (*a*) | Ice |
| (*ii*) | Metallic solid | (*b*) | Graphite |
| (*iii*) | Covalent solid | (*c*) | $I_2$ |
| (*iv*) | Non-polar molecular solid | (*d*) | Cu |
| (*v*) | Hydrogen bonded molecular solid | (*e*) | NaCl |

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**69.** Match the following :

| | Compound | | Magnetic property |
|---|---|---|---|
| (*i*) | NaCl | (*a*) | Ferrimagnetic |
| (*ii*) | MnO | (*b*) | Paramagnetic |
| (*iii*) | $CrCl_3$ | (*c*) | Ferromagnetic |
| (*iv*) | $CrO_2$ | (*d*) | Diamagnetic |
| (*v*) | $MgFe_2O_4$ | (*e*) | Antiferromagntic |

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## Exercise Part Ii Descriptive Questions Very Short Answer Questions

**1.** Define space lattice.

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**2.** Define unit cell.

Watch Video Solution

**3.** Define void.

Watch Video Solution

**4.** Which of the following lattices has the highest packing efficiency (i) simple cubic (ii) body-centred cubic and (iii) hexagonal close-

packed lattice ?

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**5.** Name the type of structure possessed by unit cell of CsCl

Watch Video Solution

**6.** A compound $AB_2$ possesses the $CaF_2$ type crystal structure. Write the coordination number of $A^{2+}$ and $B^-$ ions in its crystals.

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**7.** What is the number of atoms in a unit cell of a face-centred cubic crystal ?

Watch Video Solution

**8.** How many octahedral voids are present in 1 mole of a compound having cubic close packed structure ?

Watch Video Solution

**9.** What is 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)

Watch Video Solution

**10.** What is the coordination number of octahedral voids?

Watch Video Solution

**11.** What is the coordination number of

(i) sodium in sodium oxide $(Na_2O)$?

(ii) oxide ion in sodium oxide $(Na_2O)$?

(iii) calcium in calcium fluoride $(CaF_2)$?

(iv) zinc in zinc blende (ZnS)?

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**12.** What is the non-stoichiometry defect in the crystals ?

Watch Video Solution

**13.** Why does Frenkel defect not change the density of AgCl crystals?

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## Exercise Part Ii Descriptive Questions Short Answer Questions

**1.** Do you agree with the statement that in hep and ccp structures, there is no difference in the arrangement of atoms? Explain.

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**2.** Will hcp or ccp for the given element gives the same density? Explain.

Watch Video Solution

**3.** What do you mean by the term coordination number? What is the coordination of each sphere in hcp strucutre

Watch Video Solution

**4.** What do you mean by the term coordination number? What is the coordination of each sphere in ccp structures

Watch Video Solution

**5.** What do you mean by the term coordination number? What is the coordination of each sphere in bcc packed structure ?

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**6.** When atoms are placed at the corners of all 12 edges of a cube in a unit cell, how many atoms are present per unit cell? Also name this unit cell.

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**7.** Write the name of two important kinds of holes normally encountered in a closed packed structure. How many such holes are present per sphere in a close packed arrangement?

Watch Video Solution

**8.** Mention three differences between crystalline and amorphous solids.

Watch Video Solution

**9.** How does amorphous silica differs from quartz?

Watch Video Solution

**10.** Explain with the help of diagram, the structural difference between three types of cubic crystals.

Watch Video Solution

**11.** Explain the Schottky defects in stoichiometric crystals.

Watch Video Solution

**12.** What are the consequences of Schottky and Frenkel defects?

Watch Video Solution

**13.** What are point defects in crystals ? Describe the Schottky defects in crystals.

Watch Video Solution

**14.** What do you understand by imperfections in ionic crystals? Name the types of imperfections which generally occur in ionic crystals.

Watch Video Solution

**15.** What are the types of lattice imperfection found in crystals?

Watch Video Solution

**16.** The radius of an octahedral void is 'r' and the radius of an atom is 'R' when these are in close packing. Derive the relation between the two.

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**17.** If the radius of a tetrahedral void is 'r' and radius of atom in close packing is 'R', derive the relation between r and R.

Watch Video Solution

**18.** What is radius ratio ? What is its significance in case of ionic crystals?

Watch Video Solution

**19.** Briefly describe the radius ratio rules.

Watch Video Solution

**20.** Explain briefly the superconductivity.

Watch Video Solution

**21.** Explain each of the following with a suitable example: Paramagnetism .

Watch Video Solution

**22.** Explain each of the following with a suitable example: Piezoelectric effect.

Watch Video Solution

**23.** Explain the nature of the crystal defect produced when NaCl is doped with $AlCl_3$ assuming $AlCl_3$ to be an ionic compound.

Watch Video Solution

**24.** Prove that the actual volume occupied by a bcc arrangement is 68% only.

Watch Video Solution

**25.** How much is the empty space present in a primitive unit cell? Also calculate the total volume occupied.

Watch Video Solution

**26.** Addition of $CdCl_2$ to the crystals of AgCl will produce Schottky defects but the same is not produced when NaCl crystals are added. Explain.

Watch Video Solution

**27.** Distinguish between crystal lattice and unit cell.

Watch Video Solution

**28.** Give reasons Silicon doped with phosphorus, gives an n-type semiconductor, while p-type semiconductor is obtained when silicon is doped with gallium.

Watch Video Solution

**29.** Give reasons The electrical conductivity of a metal decreases with rise in temperature, while that of a semiconductor increases.

Watch Video Solution

**30.** Account for the Silicon is an insulator but silicon doped with phosphorus acts as a semiconductor.

Watch Video Solution

**31.** Account for the Some of the very old glass objects appear slightly milky instead of being transparent.

Watch Video Solution

**32.** State the difference between Schottky and Frenkel defects. Which of these two changes the density of the solid ?

Watch Video Solution

**33.** What are molecular crystals ? Name the forces which are holding the constituent particles in molecular crystals.

Watch Video Solution

**34.** What are metallic crystals ?

Watch Video Solution

**35.** Describe briefly the structure of copper metal.

Watch Video Solution

**36.** Draw a neat diagram for NaCl structure.

Watch Video Solution

**37.** Discuss the structure of diamond.

Watch Video Solution

## Exercise Part Ii Descriptive Questions Long Answer Questions

**1.** Briefly explain the packing of the constituent particles in a crystal.

Watch Video Solution

**2.** Derive an expression for the density of a cubic crystal whose edge is 'a' pm and contains z atoms per unit cell. The atomic mass of substance may be taken as M.

Watch Video Solution

**3.** Show that the density of a cubic crystal is given by the expression:

$$d = \frac{ZM}{a^3 N_A}$$

where Z is the number of atoms/molecules/ions present per unit cell, M is molecular weight, $N_A$ is Avogadro's number and $a^3$ is the volume of unit cell.

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**4.** How Schottky and Frenkel defects occur in ionic crystals? How does the density of a crystal gets affected by the presence of these defects ?

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**5.** How will you distinguish between ferromagnets, antiferromagnets and ferrimagnets with the help of electron spins ?

Watch Video Solution

**6.** Discuss briefly the point defects in ionic crystals.

Watch Video Solution

**7.** Discuss briefly the following property of solid :

Magnetic properties

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**8.** Discuss briefly the following property of solid :

Electrical properties

Watch Video Solution

**9.** Discuss briefly the following property of solid :

Dielectric properties.

Watch Video Solution

**10.** Classify the crystals on the basis of nature of bonds existing between the constituent particles forming the crystal.

Watch Video Solution

**11.** What are ionic crystals ? Discuss the crystal structure of sodium chloride.

Watch Video Solution

**12.** Explain why ionic solids are quite hard and rigid.

Watch Video Solution

**13.** Explain why ionic solids have high melting and boiling points.

Watch Video Solution

**14.** Explain why ionic solids do not conduct electricity but are good conductors in molten state.

Watch Video Solution

**15.** Explain why ionic solids are more soluble in polar solvents.

Watch Video Solution

**16.** Explain why solids have high density.

Watch Video Solution

**17.** Explain why ionic solids are highly brittle.

Watch Video Solution

**18.** What are atomic solids ? Discuss the structures of diamond and graphite.

Watch Video Solution

**19.** Explain why the covalent solids have high melting and boiling points.

Watch Video Solution

**20.** Explain why the covalent solids are hard.

Watch Video Solution

**21.** Explain why the covalent solids are bad conductors of electricity.

Watch Video Solution

**22.** Explain why the covalent solids are usually soluble in non-polar solvents but are insoluble in polar solvents.

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**23.** How will you account for the following:

Diamond is extremely hard and has high melting point.

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**24.** How will you account for the following:

Diamond is a non-conductor of electricity.

Watch Video Solution

**25.** How will you account for the following:

Diamond has high density.

Watch Video Solution

**26.** How will you account for the following:

Graphite is soft and is used as a solid lubricant.

Watch Video Solution

**27.** How will you account for the following:

Graphite is a good conductor of electricity.

Watch Video Solution

**28.** Mention three differences between crystalline and amorphous solids.

Watch Video Solution

**29.** For diamond, state the element present at the lattice sites, the number of nearest neighbours for each atom and the type of unit cell.

Watch Video Solution

**30.** For sodium chloride crystal, state:

the type of unit cell.

Watch Video Solution

**31.** For sodium chloride crystal, state:

the nature of forces holding the particles together.

Watch Video Solution

**32.** For sodium chloride crystal, state:

the number of nearest neighbours around each sodium ion.

Watch Video Solution

**33.** For sodium chloride crystal, state:

the geometry of the sodium ions which are arranged around a chloride ion.

Watch Video Solution

**34.** Graphite is anisotropic to electrical conduction. Discuss.

Watch Video Solution

**35.** Diamond is hard and a bad conductor of electricity while graphite is soft and a good conductor of electricity. Explain. State the hybridization of carbon in both substances.

Watch Video Solution

**36.** Describe the unit cell of sodium chloride with a neat diagram stating.

Type of unit cell

Watch Video Solution

**37.** Describe the unit cell of sodium chloride with a neat diagram stating.

Type of unit cell

Watch Video Solution

**38.** Describe the unit cell of sodium chloride with a neat diagram stating.

Number of nearest neighbours around sodium and chloride ions.

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## Isc Examination Questions Part I Objective Question

**1.** Fill in the blanks choosing appropriate words given in brackets : (Sodium chloride, Caesium chloride, copper, diamond, graphite, ions, atoms, close, 74%, 68%.

Crystals of ..... and ..... have face centred cubic lattices.

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**2.** Fill in the blanks choosing appropriate words given in brackets : (Sodium chloride, Caesium chloride, copper, diamond, graphite, ions, atoms, close, 74%, 68%.

The crystal of diamond is made of ..... while that of calcium chloride is made of .....

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**3.** Fill in the blanks choosing appropriate words given in brackets : (Sodium chloride, Caesium chloride, copper, diamond, graphite, ions, atoms, close, 74%, 68%.

The crystal of diamond is made up ..... while that of sodium chloride is made up of .....

Watch Video Solution

**4.** Fill in the blanks choosing appropriate words given in brackets : (Sodium chloride, Caesium chloride, copper, diamond, graphite, ions, atoms, close, 74%, 68%.

Both cop and hcp are ..... packings and occupy about ..... % of the available space.

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**5.** Match the following :

| Compound | Magnetic property |
|---|---|
| (*i*) NaCl | (*a*) Ferrimagnetic |
| (*ii*) MnO | (*b*) Paramagnetic |
| (*iii*) $CrCl_3$ | (*c*) Ferromagnetic |
| (*iv*) $CrO_2$ | (*d*) Diamagnetic |
| (*v*) $MgFe_2O_4$ | (*e*) Antiferromagntic |

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## Isc Examination Questions Part I Objective Question Complete The Following Statements By Selecting The Correct Alternative From The Choices Given

**1.** Copper has the face centred cubic structure. The coordination number of each ion is:

a) 4

b) 12

c) 14

d) 8

A. 4

B. 12

C. 14

D. 8

**Answer: B**

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## Isc Examination Questions Part I Objective Question Correct The Following Statement

**1.** Graphite has a two dimensional sheet-like structure in which each carbon atom is $sp^3$ hybridized .

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## Isc Examination Questions Part I Descriptive Question

**1.** State the main characteristics of an ionic and a network type of crystal citing a suitable example for each.

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**2.** Name the crystal structure of copper metal.

Watch Video Solution

**3.** What is the coordination number of copper in its crystalline state ?

Watch Video Solution

**4.** How many sodium ions and chloride ions are present in a unit cell of sodium chloride ?

Watch Video Solution

**5.** What is the coordination number of sodium and chloride ions in sodium chloride crystals?

Watch Video Solution

**6.** For diamond, state the element present at the lattice sites, the number of nearest neighbours for each atom and the type of cell. State the hybridization of the carbon atom in diamond.

Watch Video Solution

**7.** In a body-centred and face-centred arrangement of atoms of an element, what will be the number of atoms present in respective unit cells ?

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**8.** Explain why graphite is soft and can be used as a lubricant.

Watch Video Solution

**9.** Compare the crystals of copper and diamond giving one similarity and one difference.

Watch Video Solution

**10.** Define piezoelectricity and give one use of piezoelectric crystals.

Watch Video Solution

**11.** What are semiconductors ? What is the effect of increasing temperature on the conductivity of a semiconductor ?

Watch Video Solution

**12.** For a crystal of diamond, state :

The hybridization of the carbon atom.

Watch Video Solution

**13.** For a crystal of diamond, state :

The coordination number of each carbon atom.

Watch Video Solution

**14.** For a crystal of diamond, state :

The type of lattice in which it crystallizes.

Watch Video Solution

**15.** For a crystal of diamond, state :

The number of carbon atoms present per unit cell.

Watch Video Solution

**16.** What is Schottky defect in a solid ?

Watch Video Solution

**17.** An ionic compound is made up of A cations and B anions. if A cations are present at the alternate corners and B anion is present

on the body of the diagonal, what is the formula of the ionic compound ?

Watch Video Solution

**18.** Define Frenkel defect in solid crystal.

Watch Video Solution

**19.** Explain giving reasons why ionic solids conduct electricity in molten state, but not in solid state.

Watch Video Solution

**20.** For a crystal of diamond, state :

The number of carbon atoms present per unit cell.

Watch Video Solution

**21.** For a crystal of diamond, state :

The type of lattice in which it crystallizes.

Watch Video Solution

**22.** In a crystal of diamond :

How many carbon atoms surround each carbon atom

Watch Video Solution

**23.** For a crystal of diamond, state :

The type of lattice in which it crystallizes.

Watch Video Solution

**24.** Describe briefly the structure of copper metal.

Watch Video Solution

**25.** Why sodium chloride on heating with sodium vapours acquires yellow colour?

Watch Video Solution

**26.** Describe the unit cell of sodium chloride with a neat diagram stating.

Type of unit cell

Watch Video Solution

**27.** What is the coordination number of sodium and chloride ions in sodium chloride crystals?

Watch Video Solution

**28.** How many sodium ions and chloride ions are present in a unit cell of sodium chloride ?

Watch Video Solution

**29.** For a crystal of sodium chloride, state :

The structural arrangement of the sodium chloride crystal.

Watch Video Solution

**30.** Graphite is anisotropic with respect to conduction of electric current. Explain.

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## Isc Examination Questions Part I Numerical Problems

**1.** Lead sulfide has fcc structure. The edge length of the unit cell of PbS crystal is 500 pm What is its density ?

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**2.** A compound AB has a cubic structure and molecular mass 99. Its density is $3 \cdot 4 gcm^{-3}$ . What is the length of the edge of the unit cell?

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**3.** A bcc element (atomic mass 65) has cell edge of 420 pm. Calculate its density in $gcm^{-3}$.

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**4.** Chromium metal crystallizes with a body-centred cubic lattice. The edge length of the unit cell is found to be 287 pm. Calculate the atomic radius. What would be the density of chromium in g $cm^{-3}$ ? (atomic mass of Cr = 52.99)

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**5.** The edge length of unit cell of a body-centred cubic (bcc) crystal is 352 pm. Calculate the radius of the atom.

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**6.** In a body-centred and face-centred arrangement of atoms of an element, what will be the number of atoms present in respective unit cells. Justify your answer with calculation.

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