CLASS : CC -AD

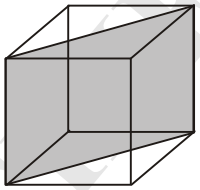
Revision Work-sheet Solid State

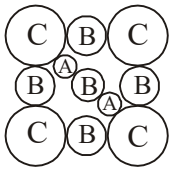
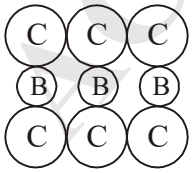
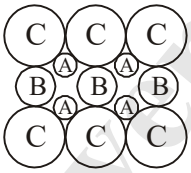
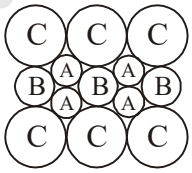
Single correct

Q.1 A solid is formed and it has three types of atoms X, Y, Z. X forms a FCC lattice with Y atoms occupying all the tetrahedral voids and Z atoms occupying half the octrahedral voids. The formula of the solid is:
(A) X_2Y_4Z (B) XY_2Z_4 (C) X_4Y_2Z (D) X_4YZ_2

Q.2 Which one of the following schemes of ordering closed packed sheets of equal sized spheres do not generate close packed lattice.
(A) ABCABC (B) ABACABAC (C) ABBAABBA (D) ABCBCABCBC

Q.3 In a hypothetical solid 'C' atoms are found to form cubical close packed lattice. 'A' atoms occupy all tetrahedral voids & 'B' atoms occupy all octahedral voids. 'A' and 'B' atoms are of appropriate size i.e. there is no distortion in ccp lattice of C atoms. Now if a plane as shown in the following figure is cut, then the cross section of this plane will look like.



(A)  (B)  (C)  (D) 

Q.4 A solid element (monoatomic) exist as cubic crystal. If its atomic radius is 1.0 Å and the ratio of packing fraction and density is 0.1 cm^3/gm, then the atomic mass of the element is ($N_A = 6 \times 10^{23}$)
(A) 8 π (B) 16 π (C) 80 π (D) 4 π

Q.5 In FCC unit cell, what fraction of edge is not covered by atoms?
(A) 0.134 (B) 0.24 (C) 0.293 (D) None of these

Q.6 In a hypothetical solid, 'C' atoms are found to form cubical closed packed lattice. 'A' atoms occupy all tetrahedral void and 'B' atoms occupy all octahedral voids. There is no distortion in **ccp** lattice. Fraction of body diagonal not covered up by atoms is :
(A) 0.76 (B) 0.24 (C) 0.68 (D) 0.32

Q.7 An ionic solid consists of A^{+2} and B^- ion and the radius ratio of $\frac{r_{A^{+2}}}{r_{B^-}}$ is 0.8. Identify the **correct** statements regarding unit cell and location of ions.
(A) Simple cubic of B^- ions and A^{+2} occupying all the body centered voids or cubic voids.
(B) Face centered cubic of B^- ions and A^{+2} occupying all tetrahedral voids.
(C) Face centered cubic of B^- ions and A^{+2} occupying 50% tetrahedral voids.
(D) Face centered cubic of A^{+2} ions and B^- occupying all tetrahedral voids.

Assertion Reason

Q.8 **Statement-1 :** KCl is more likely to show schottky defect, while LiI is more likely to show Frenkel defect.

Statement-2 : Schottky defect is more likely in ionic solids in which cations and anions are of comparable size while Frenkel defect is more likely is which cations and anions have large differences in their ionic sizes.

(A) Statement-1 is true, statement-2 is true and statement-2 is correct explanation for statement-1

(B) Statement-1 is true, statement-2 is true and statement-2 is NOT the correct explanation for statement-1.

(C) Statement-1 is true, statement-2 is false.

(D) Statement-1 is false, statement-2 is true.

Comprehension

Paragraph for Question No. 9 to 11

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

Q.9 The number of atoms in this HCP unit cells is

(A) 4 (B) 6 (C) 12 (D) 17

Q.10 The volume of this HCP unit cell is

(A) $24\sqrt{2}\,r^3$ (B) $16\sqrt{2}\,r^3$ (C) $12\sqrt{2}\,r^3$ (D) $\frac{64}{3\sqrt{3}}\,r^3$

Q.11 The empty space in this HCP unit cell is

(A) 74% (B) 47.6 % (C) 32% (D) 26%

Paragraph for question No. 12 & 13

Silicon carbide (SiC) and diamond are covalent solids which crystallize in cubic strucures. In SiC, carbon atoms occupy points of the face centred cubic lattice (FCC positions) and silicon atoms occupy half of the tetrahedral voids available. In diamonds, same position of the tetrahedral voids are occupied by other carbon atoms.

Also the density of SiC and diamond are 3.2 and 3.6 g/cc respectively. Answer the following four questions based on the above information: (M : Si = 28)

Q.12 The radius of silicon atom is

(A) 0.76 Å (B) 1.12 Å (C) 3.54 Å (D) 4.75 Å

Q.13 Which of the following will not change the density of SiC solid?

(A) Substitution of some Si atoms by some carbon atoms

(B) Schottky defects

(C) Interchange of some Si atom by some C atom

(D) None

More than one correct:

Q.14 Which of the following statements regarding crystal defects is / are **not correct**?
(A) Schottky defects are dislocation defects.
(B) 3 cationic vacancies are created per ion of Al^{+3} inserted if NaCl crystals are doped with Al^{+3} ion.
(C) Addition of As in Si results in formation of n-type semiconductors.
(D) Packing fraction remains unaffected in vacancy defect.

Q.15 Select the correct statement(s).
(A) Distance between two consecutive hexagonal layers in hcp & fcc is same.
(B) Conductivity (K) is extensive property as it is additive.
(C) magnitude of enthalpy of combustion for thermodynamically more stable allotropic from of a substance is less.
(D) Vapour pressure of ideal liquid solution always lie in between vapour pressure of two liquids.

Q.16 The correct statement(s) regarding defects in solid is (are)
(A) Frenkel defect is usually favoured by a very small difference in the sizes of cation and anion.
(B) Frenkel defect is a dislocation defect
(C) Trapping of an electron in the lattice leads to the formation of F-center.
(D) Schottky defects have no effect on the physical properties of solids.

Q.17 Which of the following statements is/are **incorrect** regarding defects in solid?
(A) AgBr(s) crystals show both schottky and frenkel defects.
(B) Impurity defect by doping Arsenic in Silicon yields 'P' type semiconductor.
(C) Doping in crystal introduces dislocation defects.
(D) Metal deficient defect can occur with extra anions present in the interstitial voids.

Q.18 80.0 gm salt of weak base & strong acid XY is dissolved in water and formed 2 litre of aqueous solution. The pH of the resultant solution was found to be 5 at 298 K. If XY forms CsCl type crystal having r_{X^+} (radius of X^+) = 1.6 Å & r_{Y^-} (radius of Y^-) = 1.864 Å then select correct statement(s).
(Given : K_b (XOH) = 4×10^{-5} ; $N_A = 6 \times 10^{23}$)
(A) Molar mass of salt is 100 g/mol
(B) % Degree of hydrolysis of salt is 0.25
(C) Edge length of XY is 4Å
(D) Density of solid salt XY is 2 in gm/cc

Match the column :

Q.19 Match the crystal system / unit cells mentioned in Column I with their characteristic features mentioned in Column II. Indicate your answer by darkening the appropriate bubbles of the 4 × 4 matrix given in the ORS.

	Column I	**Column II**
(A)	simple cubic and face-centred cubic	(P) have these cell parameters a = b = c and $\alpha = \beta = \gamma$
(B)	cubic and rhombohedral	(Q) are two crystal systems
(C)	cubic and tetragonal	(R) have only two crystallographic angles of 90°
(D)	hexagonal and monoclinic	(S) belong to same crystal system.

Q.20

Column I [Distance in terms of edge length of cube (a)]		Column II	
(A)	0.866 **a**	(P)	Shortest distance between cation & anion in CsCl structure.
(B)	0.707 **a**	(Q)	Shortest distance between two cation in CaF_2 structure.
(C)	0.433 **a**	(R)	Shortest distance between carbon atoms in diamond.
		(S)	Shortest distance between two cations in rock salt structure.

Subjective :

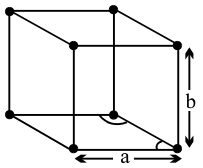
Q.21 AgCl has the same structure as that of NaCl. The edge length of unit cell of AgCl is found to be 555 pm and the density of AgCl is 5.561 g cm^{-3}. Find the percentage of sites that are unoccupied.

Q.22 A non stoichiometric compound Fe_7S_8 consist of iron in both Fe^{+2} and Fe^{+3} form and sulphur is present as sulphide ions. Calculate cation vacancies as a percentage of Fe^{+2} initially present in the sample.

[Express your answer as $\frac{100}{x}\%$ & fill x in the OMR sheet]

Q.23 Silver has an atomic radius of 144 pm and the density of silver is 10.6 g cm^{-3}. To which type of cubic crystal, silver belongs?

Q.24 Ice crystallizes in a hexagonal lattice. At the low temperature at which the structure was determined, the lattice constants were a = 4.53 Å, and b = 7.60 Å(see figure). How many molecules are contained in a given unit cell? [density (ice) = 0.90 gm/cm^3)]



Q.25 The density of KBr is 2.75 g cm^{-3} . The length of the edge of the unit cell is 654 pm. Show that KBr has face centered cubic structure. (N = 6.023 $\times 10^{23}$ mol^{-1} , At. mass : K = 39, Br = 80)

Q.26 If NaCl is dopped with 10^{-3} mol % $SrCl_2$, what is the numbers of cation vacancies?

Q.27 If the radius of Mg^{2+} ion, Cs^{+} ion, O^{2-} ion, S^{2-} ion and Cl^{-} ion are 0.65 Å , 1.69 Å, 1.40 Å, 1.84 Å, and 1.81 Å respectively. Calculate the co-ordination numbers of the cations in the crystals of MgS, MgO and CsCl.

Q.28 Spinel is a important class of oxides consisting of two types of metal ions with the oxide ions arranged in CCP pattern. The normal spinel has one-eight of the tetrahedral holes occupied by one type of metal ion and one half of the octahedral hole occupied by another type of metal ion. Such a spinel is formed by Zn^{2+}, Al^{3+} and O^{2-}, with Zn^{2+} in the tetrahedral holes. Give the formulae of spinel.

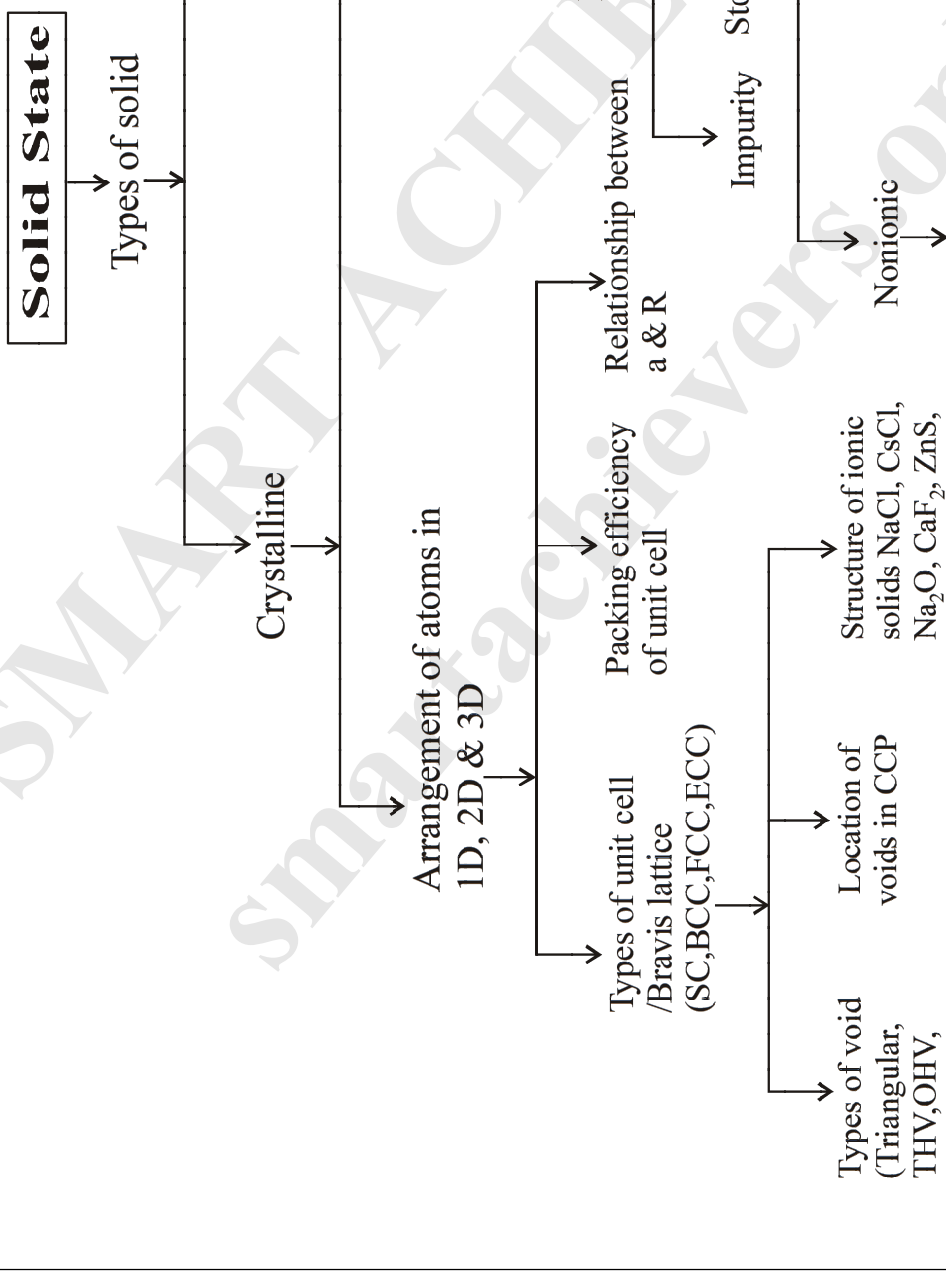
Q.29 $BaTiO_3$ crystallizes in the prevoskite structure. This structure may be described as a cubic lattice with barium ions occupying the corner of the unit cell, oxide ions occupying the face-centers and titanium ion occupying the center of the unit cell.

(a) If titanium is described as occupying holes in BaO lattice, what type of holes does it occupy?

(b) What fraction of this type hole does it occupy?

Q.30 A substance AB crystallizes in cubic closest packing (C.C.P.) with B occupying half the tetrahedral voids. One litre of the crystal is doped with 1 mole atoms of C some of which replace the B atoms and remaining occupy few interstitial voids without affecting the dimensions of cubic crystal lattice. If density of crystal before doping is 4.8 gm/millilitre and density after doping is 4.795 gm /ml then calculate % of C added with replace B atoms. **(Given : Atomic weight : A, B and C : 40, 30, 15)**

REVISION FLOW CHART



LIST OF IMPORTANT FORMULAS

* For SC $a = 2R$
* For BCC $\sqrt{3}\ a = 4R$
* For CCP / FCC $\sqrt{2}\ a = 4R$

$$\text{Packing efficiency}\ (\eta) = \frac{Z \times \text{Mass of 1 atom}}{\text{Volume of unit cell}} = \frac{Z \times M}{N_A \times a^3}$$

* **Limiting radius ratio**

S.No.	$\frac{r^+}{r^-}$	Type of void	CN	Structure	eg
1.	$\frac{r^+}{r^-} < 0.155$	Linear	2	Linear	
2.	$0.155 \le \frac{r^+}{r^-} < 0.225$	Trigonal	3	Planar	
3.	$0.255 \le \frac{r^+}{r^-} < 0.414$	Tetrahedral	4	FCC or HCP	Zns
4.	$0.414 \le \frac{r^+}{r^-} < 0.732$	Octahedral	6	FCC or HCP	NaCl
5.	$0.732 \le \frac{r^+}{r^-} < 1$	Cubic	8	SC	CsCl

* For NaCl $Z = 4$ & $r_{Na^+} + r_{Cl^-} = \frac{a}{2}$
* For CsCl $Z = 1$ & $\sqrt{3a} = (r_{Cs^+} + r_{Cl^-}) \times 2$
* For ZnS (Sphlerite) $Z = 4$ & $\frac{\sqrt{3}}{4} a = r_{Zn^{2+}} + r_{S^{2-}}$
* For CaF_2 $Z = 4$ & $\frac{\sqrt{3}}{4} a = r_{Ca^{2+}} + r_{F^-}$

$$\%\ \text{of missing units} = \left(\frac{d_{Theo} - d_{exp}}{d_{Theo}} \right) \times 100$$

LAST MOMENT REVIEW

SOLID STATE

Theory : .....

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Exercise - 1 : Question .....

Exercise - 2 : Question .....

Exercise - 3 : Question .....

Exercise - 4 : Question .....

DPPs : ....

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Other Sources : .....

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CLASS : CC -AD

Revision Work-sheet Solid State

Single correct

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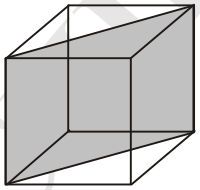
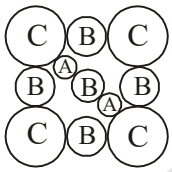
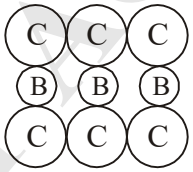
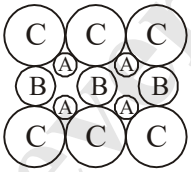
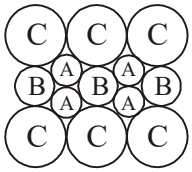


(A)  (B)  (C*)  (D) 

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(A) Simple cubic of B^- ions and A^{+2} occupying all the body centered voids or cubic voids.
(B) Face centered cubic of B^- ions and A^{+2} occupying all tetrahedral voids.
(C) Face centered cubic of B^- ions and A^{+2} occupying 50% tetrahedral voids.
(D*) Face centered cubic of A^{+2} ions and B^- occupying all tetrahedral voids.

Assertion Reason

Q.8 **Statement-1 :** KCl is more likely to show schottky defect, while LiI is more likely to show Frenkel defect.

Statement-2 : Schottky defect is more likely in ionic solids in which cations and anions are of comparable size while Frenkel defect is more likely is which cations and anions have large differences in their ionic sizes.

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(B) Statement-1 is true, statement-2 is true and statement-2 is NOT the correct explanation for statement-1.

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Comprehension

Paragraph for Question No. 9 to 11

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

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Also the density of SiC and diamond are 3.2 and 3.6 g/cc respectively. Answer the following four questions based on the above information: (M : Si = 28)

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(B) Schottky defects

(C*) Interchange of some Si atom by some C atom

(D) None

More than one correct:

Q.14 Which of the following statements regarding crystal defects is / are **not correct**?
(A*) Schottky defects are dislocation defects.
(B*) 3 cationic vacancies are created per ion of Al^{+3} inserted if NaCl crystals are doped with Al^{+3} ion.
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Q.18 80.0 gm salt of weak base & strong acid XY is dissolved in water and formed 2 litre of aqueous solution. The pH of the resultant solution was found to be 5 at 298 K. If XY forms CsCl type crystal having

r_{X^+} (radius of X^+) = 1.6 Å & r_{Y^-} (radius of Y^-) = 1.864 Å then select correct statement(s).

(Given : K_b (XOH) = 4×10^{-5} ; $N_A = 6 \times 10^{23}$)

(A*) Molar mass of salt is 100 g/mol
(B) % Degree of hydrolysis of salt is 0.25
(C*) Edge length of XY is 4Å
(D) Density of solid salt XY is 2 in gm/cc

Match the column :

Q.19 Match the crystal system / unit cells mentioned in Column I with their characteristic features mentioned in Column II. Indicate your answer by darkening the appropriate bubbles of the 4 × 4 matrix given in the ORS.

	Column I	**Column II**
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(C)	cubic and tetragonal	(R) have only two crystallographic angles of 90°
(D)	hexagonal and monoclinic	(S) belong to same crystal system.

[Ans. (A) P, S (B) P,Q (C) Q (D) Q,R]

Q.20

Column I [Distance in terms of edge length of cube (a)]		Column II	
(A)	0.866 **a**	(P)	Shortest distance between cation & anion in CsCl structure.
(B)	0.707 **a**	(Q)	Shortest distance between two cation in CaF_2 structure.
(C)	0.433 **a**	(R)	Shortest distance between carbon atoms in diamond.
		(S)	Shortest distance between two cations in rock salt structure.

[Ans. (A) P (B) Q,S (C) R]

Subjective :

Q.21 AgCl has the same structure as that of NaCl. The edge length of unit cell of AgCl is found to be 555 pm and the density of AgCl is 5.561 g cm^{-3}. Find the percentage of sites that are unoccupied.

Ans. 0.25%

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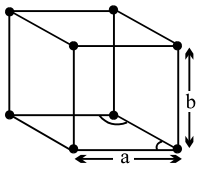
[Express your answer as $\frac{100}{x}$% & fill x in the OMR sheet] [Ans. 8]

Q.23 Silver has an atomic radius of 144 pm and the density of silver is 10.6 g cm^{-3}. To which type of cubic crystal, silver belongs?

Ans. FCC

Q.24 Ice crystallizes in a hexagonal lattice. At the low temperature at which the structure was determined, the lattice constants were a = 4.53 Å, and b = 7.60 Å(see figure). How many molecules are contained in a given unit cell? [density (ice) = 0.90 gm/cm^3)]



Ans. 4 molecules of H_2O

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(N = 6.023 $\times 10^{23}$ mol^{-1} , At. mass : K = 39, Br = 80)

Q.26 If NaCl is dopped with 10^{-3} mol % $SrCl_2$, what is the numbers of cation vacancies?

Ans. 6.02×10^{18} mol^{-1}

Q.27 If the radius of Mg^{2+} ion, Cs^{+} ion, O^{2-} ion, S^{2-} ion and Cl^{-} ion are 0.65 Å , 1.69 Å, 1.40 Å, 1.84 Å, and 1.81 Å respectively. Calculate the co-ordination numbers of the cations in the crystals of MgS, MgO and CsCl.

Ans. 4, 6, 8

Q.28 Spinel is a important class of oxides consisting of two types of metal ions with the oxide ions arranged in CCP pattern. The normal spinel has one-eight of the tetrahedral holes occupied by one type of metal ion and one half of the octahedral hole occupied by another type of metal ion. Such a spinel is formed by Zn^{2+}, Al^{3+} and O^{2-}, with Zn^{2+} in the tetrahedral holes. Give the formulae of spinel.

Ans. $ZnAl_2O_4$

Q.29 $BaTiO_3$ crystallizes in the prevoskite structure. This structure may be described as a cubic lattice with barium ions occupying the corner of the unit cell, oxide ions occupying the face-centers and titanium ion occupying the center of the unit cell.

(a) If titanium is described as occupying holes in BaO lattice, what type of holes does it occupy?

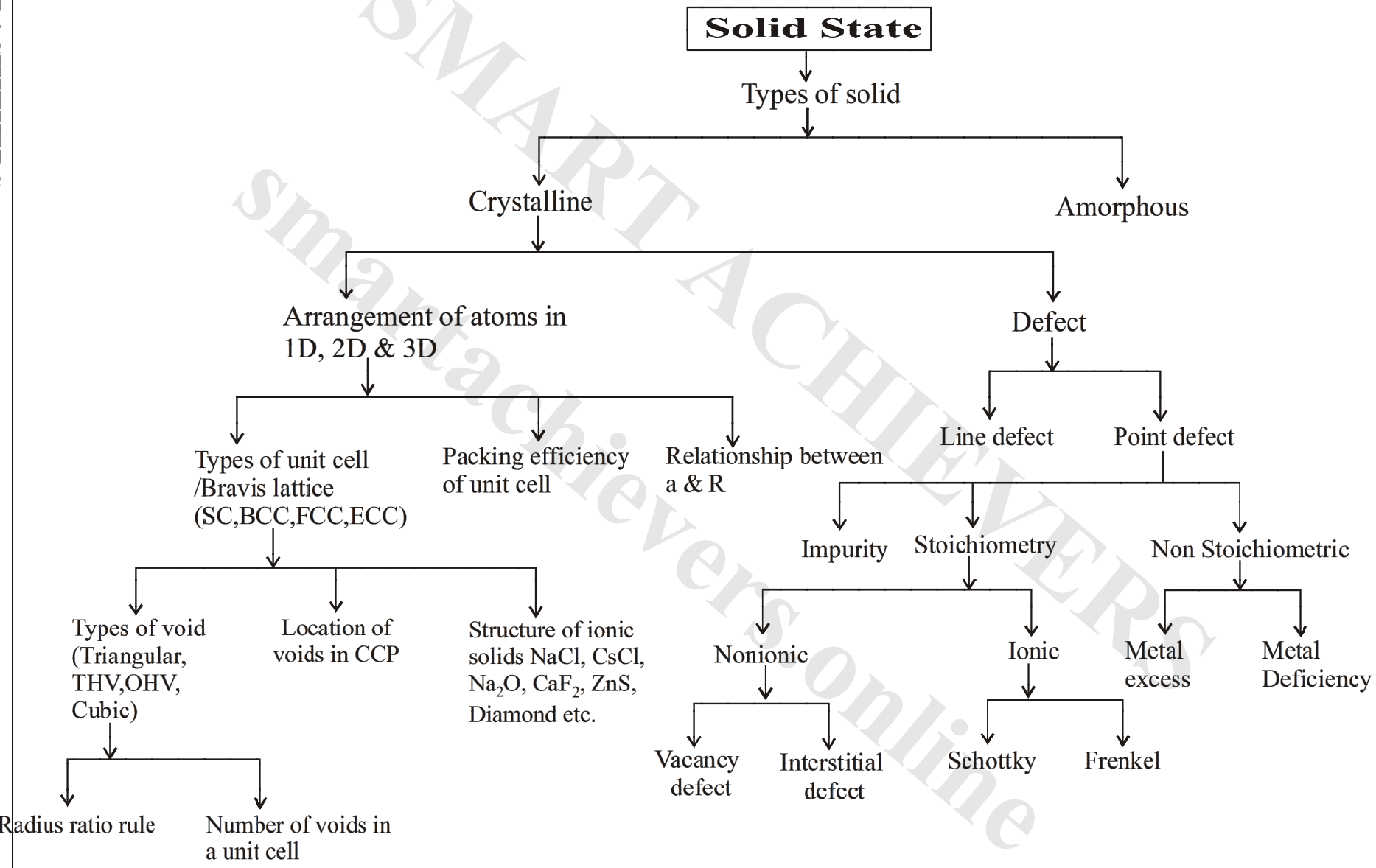
(b) What fraction of this type hole does it occupy?

Ans. **(a)** octahedral, **(b)** 1/4

Q.30 A substance AB crystallizes in cubic closest packing (C.C.P.) with B occupying half the tetrahedral voids. One litre of the crystal is doped with 1 mole atoms of C some of which replace the B atoms and remaining occupy few interstitial voids without affecting the dimensions of cubic crystal lattice. If density of crystal before doping is 4.8 gm/millilitre and density after doping is 4.795 gm /ml then calculate % of C added with replace B atoms. **(Given : Atomic weight : A, B and C : 40, 30, 15)**

[Ans 0067]

REVISION FLOW CHART



LIST OF IMPORTANT FORMULAS

* For SC $a = 2R$

* For BCC $\sqrt{3}\ a = 4R$

* For CCP / FCC $\sqrt{2}\ a = 4R$

$$\text{Packing efficiency}\ (\eta) = \frac{Z \times \text{Mass of 1 atom}}{\text{Volume of unit cell}} = \frac{Z \times M}{N_A \times a^3}$$

* **Limiting radius ratio**

S.No.	$\frac{r^+}{r^-}$	Type of void	CN	Structure	eg
1.	$\frac{r^+}{r^-} < 0.155$	Linear	2	Linear	
2.	$0.155 \le \frac{r^+}{r^-} < 0.225$	Trigonal	3	Planar	
3.	$0.255 \le \frac{r^+}{r^-} < 0.414$	Tetrahedral	4	FCC or HCP	Zns
4.	$0.414 \le \frac{r^+}{r^-} < 0.732$	Octahedral	6	FCC or HCP	NaCl
5.	$0.732 \le \frac{r^+}{r^-} < 1$	Cubic	8	SC	CsCl

* For NaCl $Z = 4$ & $r_{Na^+} + r_{Cl^-} = \frac{a}{2}$

* For CsCl $Z = 1$ & $\sqrt{3a} = (r_{Cs^+} + r_{Cl^-}) \times 2$

* For ZnS (Sphlerite) $Z = 4$ & $\frac{\sqrt{3}}{4} a = r_{Zn^{2+}} + r_{S^{2-}}$

* For CaF_2 $Z = 4$ & $\frac{\sqrt{3}}{4} a = r_{Ca^{2+}} + r_{F^-}$

$$\%\ \text{of missing units} = \left(\frac{d_{Theo} - d_{exp}}{d_{Theo}} \right) \times 100$$

LAST MOMENT REVIEW

SOLID STATE

Theory : .....

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Exercise - 1 : Question .....

Exercise - 2 : Question .....

Exercise - 3 : Question .....

Exercise - 4 : Question .....

DPPs : ....

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Other Sources : .....

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