5. SOLID STATE

SYNOPSIS

I. TYPES OF SOLID AND CRYSTAL STRUCTURES

Types of crystalline solids:

Type of solid	Intermolecular forces	Properties	Examples
Ionic	Ion-ion forces	Brittle, hard high melting	NaCl, KCl, $MgCl_2$
Molecular	Dispersion forces/Dipole-Dipole, H-bond	Soft, low melting non-conducting	H_2O, Br_2, CO_2, CH_4
Covalent network	Covalent bonds	Hard : High melting	C-(Diamond), SiO_2
Metallic	Metallic bonds	Variable hardness and melting point conducting	Na, Zn, Cu, Fe

Crystal System

Crystal Systems	Bravais Lattice	Unit Cell Parameters	
		Intercepts	Crystal Angles
1. Cubic	Primitive, face centered, body centered	$a = b = c$	$\alpha = \beta = \gamma = 90^0$
2. Orthorhombic	Primitive, FCC,BCC, end centered	$a \neq b \neq c$	$\alpha = \beta = \gamma = 90^0$
3. Rhombohedral	Primitive	$a = b = c$	$\alpha = \beta = \gamma \neq 90^0$
4. Monoclinic	Primitive, end centered	$a \neq b \neq c$	$\alpha = \gamma = 90^0, \beta \neq 90^0$
5. Triclinic	Primitive	$a \neq b \neq c$	$\alpha \neq \beta \neq \gamma \neq 90^0$
6. Tetragonal	Primitive, body centered	$a = b \neq c$	$\alpha = \beta = \gamma = 90^0$
7. Hexagonal	Primitive	$a = b \neq c$	$\alpha = \beta = 90^0, \gamma = 120^0$

Density of the crystal : $d = \frac{ZM}{N_0 a^3}$

II. CLOSED PACKED STRUCTURES AND VOIDS

Types of Voids

S.No.	Name of Void	rVoid/rSphere	Co-ordination Number (C.No.)
1.	Triangular void	0.155	3
2.	Tetrahedral void	0.225	4
3.	Octahedral void	0.414	6
4.	Cubic void	0.732	8

Types of Ionic Structure

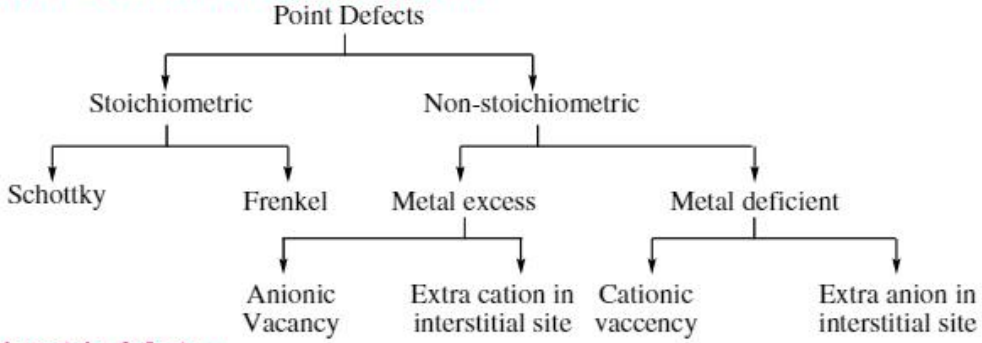
S.No.	Name of Structure	Location of Particle
1.	Rock Salt (AB) NaCl	B^- : CCP lattice; A^+ : Octahedral void
2.	Zinc blende (ZnS)	S^{2-} : CCP lattice; Zn^{2+} : Alternate tetrahedral void
3.	CsCl	Cs^+ : Cube centre ; Cl^- : Corner of cube
4.	Fluorite structure (CaF_2)	Ca^{2+} : FCC lattice; F^- : Tetrahedral void
5.	Antifluorite structure Na_2O	O^{2-} : FCC lattice; Na^+ : Tetrahedral void

Bragg's Equation : $2d\sin\theta = n\lambda$

n = 1 First order reflection ; n = 2 Second order reflection ; θ = angle of reflection.

d = distance between planes; λ = wavelength of x-ray

III. DEFECTS AND PROPERTIES OF SOLIDS



1) Stoichiometric defects :

Vacancy : When constituent particle is missing, then vacancy defects occurs.

Frenkel : The defect in which an ion is displaced from its regular position to an interstitial position creating a vacancy. Such defect is known as Frenkel defects or dislocation defect.

Schottky : Defect in which a pair of cation and anion of equal valence are missing from an ionic crystal leading to a pair of vacant sites. Such defect is known as schottky defect.

2) Non-Stoichiometric defects :

Metal excess defect : The defect occurs due to anionic vacancies or due to the presence of extra cations at the interstital site.

Metal deficiency defect : The defect occurs due to absence of positive ions from lattice site or extra interstitial negative ions.

Electrical Properties : The solids can be conductors, insulators or semiconductors.

* Conductors conduct electricity through movement of electrons (metals) or ions (electrolytes).
* If the gap between the filled valence band the next higher unoccupied conduction band overlaps, the electrons can jump and are called conductors. If this gap is more, the electrons can not jump and the substance behaves as an insulator.
* In semiconductors, this gap is small. For example, silicon and germanium. Their conductivity can be increased by adding impurity (doping) which can be electron rich or electron deficient.
* When increase in conductivity is due to the electron-rich impurity, it is called n-type semiconductor.
* When the increase in conductivity is due to electron-deficient impurity, the conductors are called p-type semiconductors.

Magnetic Properties:

* **Paramagnetic :** Substances weakly attracted in magnetic field and magnetized in same direction are known as paramagnetic substances.
* **Diamagnetic :** Substances weakly repelled in magnetic field are known as diamagnetic substances.
* **Ferromagnetic :** Substances attracted very strongly by magnetic field are known as ferromagnetic substances.
* **Antiferromagnetic :** Substances in which oppositely located domains cancel out each other's magnetic moment are known as Antiferromagnetic substances.
* **Ferrimagnetic :** Substances in which magnetic moment of domains are arranged in parallel and antiparallel directions in unequal numbers are known as ferrimagnetic substances.

LECTURE SHEET

EXERCISE-I

(Types of solids and Crystal Structures)

LEVEL-I (MAIN)

Straight Objective Type Questions

1. Covalent solid among the following is
   1) solid Ar 2) MgO 3) Fe 4) BN

2. **(A) :** Glass possess sharp melting point.
   (R) : Glass is a pseudo solid.
   1) Both (A) and (R) are true and (R) is the correct explanation of (A)
   2) Both (A) and (R) are true and (R) is not the correct explanation of (A)
   3) (A) is true but (R) is false 4) (A) is false but (R) is true

3. Graphically the total number of fundamental spatial arrangements possible are
   1) 3 2) 7 3) 10 4) 14

4. In case of a cubic system, the number of types of space lattices are
   1) 3 2) 7 3) 14 4) 12

5. How many kinds of primitive unit cells are possible
   1) 23 2) 7 3) 230 4) 14

6. | (Unitcell) | (no of atoms per unitcell) |
   |---|---|
   | A) Simple cube | 1) 4 |
   | B) fcc | 2) 2 |
   | C) bcc | 3) 1 |

   The correct match is

	A	B	C		A	B	C		A	B	C		A	B	C
1)	2	3	1	2)	2	1	3	3)	3	1	2	4)	1	2	3

7. The crystal system without any element of symmetry is
   1) monoclinic 2) hexagonal 3) triclinic 4) cubic

8. White Sn belongs to one of the seven crystal systems. The number of Bravais lattices possible for that crystal system
   1) 2 2) 1 3) 4 4) 3

9. In $KMnO_4$ the crystallographic parameters are
   1) $\alpha=\beta=\gamma\neq 90^0$ 2) $\alpha=\beta=\gamma=90^0$ 3) $\alpha\neq\beta\neq\gamma\neq 90^0$ 4) $\alpha=\gamma=90^0;\ \beta>90^0$

10. Copper metal belongs to a crystal system represented by the crystal dimensions as
    1) $\alpha=\beta=\gamma=90^0$; $a=b=c$ 2) $\alpha\neq\beta\neq\gamma$; $a=b=c$
    3) $\alpha=\beta=90^0, \gamma\neq 90^0$; $a=b=c$ 4) $\alpha=\beta=\gamma=90^0$; $a\neq b\neq c$

11. For a covalent solid, the units which occupy lattice points are
    1) Atoms 2) Ions 3) Molecules or atoms 4) Electrons

12. Which of the following does not give any diffraction bands with X-rays ?
    1) $BaSO_4$ 2) Graphite 3) Diamond 4) Plastic

13. The ratio of 'd' values in NaCl crystal is
1) 0.703 : 1 : 1.134 2) 1 : 0.703 : 1.134 3) 1 : 1.134 : 0.703 4) 0.703 : 1.134 : 1

14. In *x*-ray diffraction experiment at which one of the following path difference between the two waves, destructive interference is observed (λ = wavelength of x – rays)
1) λ 2) 2λ 3) 3λ 4) 1.5λ

15. A match box exhibits
1) Cubic geometry 2) monoclinic geometry
3) orthorhombic geometry 4) tetragonal geometry

Numerical Value Type Questions

16. For a crystal the angle of diffraction (2θ) is 90^0 and the second order line has a 'd' value of $2.28A^0$. The wave length (in A^0) of x-rays used for Bragg's diffraction is :

17. The number of space lattices possible for the crystallographic dimensions $\alpha \neq \beta \neq \gamma$.

18. At what angle for a first order diffraction, the distance between two adjacent planes of crystal is equal to the wavelength of x-rays used

LEVEL-II (ADVANCED)

Straight Objective Type Questions

1. At very low temperature, oxygen O_2, freezes and forms a crystal. Which term best describes the solid
a) Covalent network b) Molecular crystals c) Metallic d) Ionic

2. As it cools, olive oil slowly solidifies and forms a solid over a wide range of temperature. Which term best describes the solid?
a) Ionic b) Covalent network c) Metallic d) Amorphous

3. Metals are good conductors of electricity because they contain
a) ionic bonds b) a network structure
c) very few valence electrons d) free electrons

4. In a metallic crystal
a) the valence electrons constitute a sea of mobile electrons
b) the valence electrons are localised in between the kernels
c) the valence electrons remain within the field of influence of their own kernels
d) none of the above

5. Triclinic crystal has the following unit cell parameters:
a) $a = b = c$; $\alpha = \beta = \gamma = 90^0$ b) $a = b \neq c$; $\alpha = \beta = \gamma = 90^0$
c) $a \neq b \neq c$; $\alpha \neq \beta \neq \gamma \neq 90^0$ d) $a = b \neq c$; $\alpha = \beta = 90^0$, $\gamma = 120^0$

6. The unit cell with parameters $\alpha = \beta = \gamma = 90^0$ and $a = b \neq c$ is
a) Cubic b) Triclinic c) Hexagonal d) Tetragonal

7. In a hexagonal crystal:
a) $\alpha = \beta = \gamma \neq 90^0$; $a = b = c$ b) $\alpha = \beta = \gamma = 90^0$; $a = b \neq c$
c) $\alpha = \beta = \gamma = 90^0$; $a \neq b \neq c$ d) $\alpha = \beta = 90^0$, $\gamma = 120^0$; $a = b \neq c$;

8. Orthorhombic crystal has the following unit cell parameters:
a) $a = b = c$; $\alpha = \beta = \gamma = 90^0$ b) $a = b \neq c$; $\alpha = \beta = \gamma = 90^0$
c) $a \neq b \neq c$; $\alpha = \beta = \gamma = 90^0$ d) $a = b \neq c$; $\alpha = \beta = 90^0$, $\gamma = 120^0$

9. The crystal system of a compound with unit cell parameters, a = 0.328 nm, b = 0.328 nm, c = 0.527 nm and $\alpha = \beta = \gamma = 90^0$ is
a) Cubic b) Tetragonal c) Monoclinic d) Rhombohedral

More than One correct answer Type Questions

10. Glasses and plastics are
a) amorphous solids b) supercooled liquids c) anisotropic d) ferromagnetic

11. If the three interaxial angles defining the unit cell are all equal in magnitude, the crystal cannot belong to the
a) monoclinic system b) cubic system c) hexagonal system d) triclinic system

12. Which of the following solids fuse at moderate temperature?
a) Ga_2 b) SiO_2 c) Solid CO_2 d) SiC

13. Which systems have more than one unit cell?
a) Triclinic b) Hexagonal c) Monoclinic d) Orthorhombic

Linked Comprehension Type Questions

Passage :

When a metallic element combines with a non-metallic element, generally an electrovalent substance is formed. Metal atom loses electron or electrons to form cations. Non metal atom gains electrons to form anion. The oppositely charged ions are held together in an ionic solid by electrostatic attraction forces.

An example of formation of electrovalent substance: K(s) + 1/2 Br_2(l) → KBr(s)

14. During melting of potassium bromide
a) Ions are formed b) Ions are separated
c) ions are made volatile d) Molecules are separated

15. Potassium bromide in its native state does not conduct electricity because
a) It has no electrons b) It has no ions
c) Positive charge of cation is nullified by negative charge of anions
d) Ions do not move in the systematic lattice of the solid

Matrix Matching Type Questions

16.

Column-I (Crystaline solids)	Column-II (Type)
A) Solid CO_2	p) Hydrogen bonded structure
B) Silica	q) Conducting covalent solid
C) Graphite	r) Non-conducting covalent solid
D) Ice	s) Molecular crystalline solid

17.

Column-I (Nature of bonding)	Column-II (Material)
A) Metallic	p) Carborundum, silicon
B) Covalent	q) MgO
C) Vanderwaal's	r) Solid N_2
D) Ionic	s) Sodium

Integer Type Questions

18. How many unit crystal systems contain only one unit cell?

19. What is the maximum number of unit cells may be present in any crystal system?

EXERCISE-II

(Close Packed Structures and Voids)

LEVEL-I (MAIN)

Straight Objective Type Questions

1. Coordination number for Cu is
   1) 1 2) 6 3) 8 4) 12

2. Which of the following is an example of body centred cube?
   1) Mg 2) Zinc 3) Copper 4) Potassium

3. The co-ordination number of a metal crystallising in a hexagonal close packed structure is
   1) 12 2) 4 3) 8 4) 6

4. In a cubic close packed structure the number of nearest neighbours for a given lattice point is
   1) 6 2) 8 3) 12 4) 14

5. Which of the following structure is most uncommon for metals?
   1) simple cubic 2) B.C.C. 3) C.C.P. 4) H.C.P.

6. A point that is located at the corner of a unit cell is shared by how many unit cells?
   1) 2 2) 4 3) 6 4) 8

7. The number of lattice points per unit cell in B.C.C and end centered lattice respectively
   1) 6, 6 2) 9, 10 3) 6, 8 4) 6, 10

8. A body centered cubic solid is made up of two elements A and B. Atoms of 'A' occupy two corners of the cube. Remaining positions of the unit cell are occupied by the atoms of 'B'. The formula of the compound is :
   1) A_4B_7 2) A_7B_4 3) AB_7 4) A_7B

9. A compound formed by elements X and Y crystallizes in a cubic structure in which the X atoms are at the corners of a cube and the Y atoms are at the face-centres. The formula of the compound is
   1) X_3Y 2) XY 3) XY_2 4) XY_3

10. The void between two oppositely directed planar triangles of spheres in adjacent layers is called
    1) Cubic void 2) Tetrahedral void
    3) Octahedral void 4) Tetrahedral (or) Octahedral void

11. How many Cl^- ions are there around Na^+ ion in NaCl crystal
    1) 3 2) 4 3) 6 4) 8

12. Which of the following has hcp crystal structure?
    1) NaCl 2) $CaCl_2$ 3) Zn 4) RbCl

13. How many atoms are there in a cube based unit cell having one atom on each corner and two atoms on each body diagonal?
    1) 8 2) 6 3) 9 4) 4

14. A solid has a structure in which W atoms are located at the corners of the cubic lattice, O atoms at the centre of the edges and Na atom at the centre of the cube. The formula of the compound is
    1) $NaWO_2$ 2) Na_2WO_3 3) $NaWO_3$ 4) $NaWO_4$

15. The number of octahedral voids in a unit cell of cubic close packed structure is
1) 1 2) 2 3) 4 4) 8

16. **(A) :** A void surrounded by a triangle of spheres capped by another sphere is called tetrahedral void.
(R) : Tetrahedral voids are in tetrahedral arrangement.
1) Both (A) and (R) are true and (R) is the correct explanation of (A)
2) Both (A) and (R) are true and (R) is not the correct explanation of (A)
3) (A) is true but (R) is false 4) (A) is false but (R) is true

17. In a face centred cubic arrangement of A and B atoms whose A atoms are at the corner of the unit cell and B atoms at the face centred. One of the A atom is missing from one corner in unit cell. The simplest formula of compound is :
1) A_7B_3 2) AB_3 3) A_7B_{24} 4) $A_{\frac{8}{7}}B_3$

18. Lithium selenide can be described as a cubic closest-packed array of selenide ions with lithium ions in all of the tetrahedral holes. Formula of lithium selenide is
1) Li_2Se 2) LiSe 3) $LiSe_2$ 4) Li_3Se

19. In the closest packing of atom A, the radius of atom B that can be fitted into tetrahedral void is
1) $r_B = 0.155r_A$ 2) $r_B = 0.225r_A$ 3) $r_B = 0.414r_A$ 4) $r_B = 0.732r_A$

20. What is the co-ordination number of sodium in Na_2O?
1) 6 2) 4 3) 8 4) 2

21. Total volume of atoms present in a face centered cubic unit cell of a metal is
1) $\frac{24}{3}\pi r^3$ 2) $\frac{12}{3}\pi r^3$ 3) $\frac{16}{3}\pi r^3$ 4) $\frac{20}{3}\pi r^3$

Numerical Value Type Questions

22. The minimum radius ratio that can give a specific coordination number to the compound is

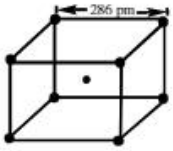
23. Sodium metal crystallises in a body-centred cubic lattice with the cell edge, 'a' = 4.29 $\overset{o}{A}$. The radius of the Na-atom will be ($\overset{o}{A}$)

24. For an octahedral arrangement the lowest radius ratio limit is

LEVEL-II (ADVANCED)

Straight Objective Type Questions

1. The crystal structure adopted by iron is shown below. The distance between the nearest iron atoms is



a) 286 pm b) 124 pm c) 143 pm d) 247.6 pm

2. The body centred cubic cell of chromium has a length of 0.288 nm. Calculate the density of chromium (g/cm^3) : (Atomic weight : Cr = 52.0)
a) 6.80 b) 7.60 c) 6.60 d) 7.26

3. First three nearest neighbour distance for body centered cubic lattice are
a) $\sqrt{2}a, a, \sqrt{3}a$ b) $\frac{a}{\sqrt{2}}, a\sqrt{3}, a$ c) $\frac{\sqrt{3}a}{2}, a, \sqrt{2}a$ d) $\frac{\sqrt{3}a}{2}, a, \sqrt{3}a$

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

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

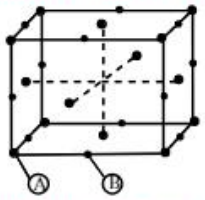
5. For a solid with the following structure, the coordination number of the point B is

a) 3

b) 4

c) 5

d) 6



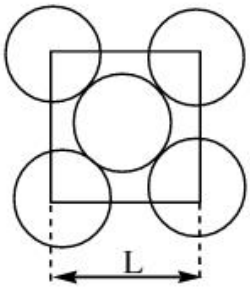
6. In rock salt structure, what percentage of the octahedral sites are occupied by cations?

a) 50% b) 33% c) 75% d) 100%

7. Determine the simplest formula of an ionic compound in which cations present at the corners and anions occur at the centre of each face

a) A_2B_3 b) AB_3 c) AB_2 d) AB_4

8. The packing efficiency of the two-dimensional square unit cell shown below is

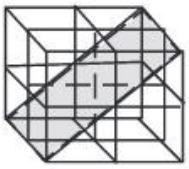


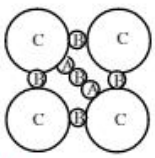
a) 39.27 % b) 68.02% c) 74.05% d) 78.54%

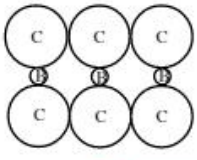
9. Calculate the number of ZnS units in a unit cell of zinc blende.

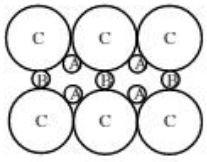
a) 6 b) 2 c) 4 d) 8

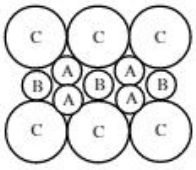
10. In a hypothetical solid C atoms are found to form cubical close packed lattice, A atoms occupy all tetrahedral voids while B atoms occupy all octahedral voids. A and B atoms are of appropriate size, so that there is no distortion in ccp lattice of C atoms. Now if a plane as shown in the following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



a) 

b) 

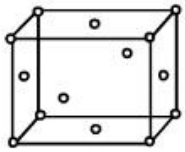
c) 

d) 

11. The intermediate compound LiAg crystallises in a cubic lattice in which both Li and Ag atoms have co-ordination number of 8. To what crystal class does the unit cell belong
a) NaCl b) CsCl c) ZnS d) CsF_2

12. AgI crystallises in the cubic close-packed zinc blend structure. Assuming that the iodide ions occupy the lattice points, fraction of the tetrahedral sites occupies by sliver ions are
a) 50% b) 75% c) 100 % d) 33.3%

13. For the structure of solid given below if the lattice points represent A^+ ions and the B^- ions occupy the tetrahedral voids then coordination number of A and B may be



a) 2, 4 b) 4, 6
c) 6, 4 d) 8, 4

More than One correct answer Type Questions

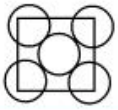
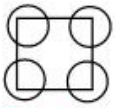
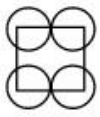
14. The two types of holes which occur in any close-packed structures are
a) tetrahedral, octahedral b) trigonal, octahedral
c) trigonal, tetrahedral d) only octahedral

15. In face centered cubic structure, the octahedral voids are located at :
a) edge centres b) body centre c) face centres d) corners

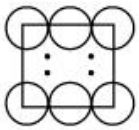
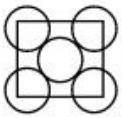
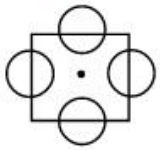
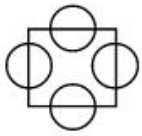
16. Select the correct statements among following: (a = edge length of unit cell)
a) Nearest neighbour distance in NaCl = $\frac{a}{2}$
b) Nearest neighbour distance in CaF_2 = $\frac{a\sqrt{3}}{4}$
c) Nearest neighbour distance in Na_2O = $\frac{a\sqrt{3}}{4}$
d) Nearest neighbour distance in CsCl = $\frac{a\sqrt{3}}{2}$

17. Which of the following statements are correct?
a) The co-ordination number of each type of ions in CsCl crystals is 8.
b) A metal which crystallizes in bcc structure has co-ordination number of 12.
c) The length of a unit cell in NaCl is 552 pm. ($r_{Na^+} = 95pm, r_{Cl^-} = 181pm$)
d) A unit cell of an ionic crystals shares some of its ions with other unit cells.

18. Which of the following statment(s) is (are) correct?
a) When the radius ratio is in the range 0.414 - 0.732, a B.C.C arrangement with co-ordination no. 8
b) When the radius ratio is in the range 0.225 - 0.414, a tetrahedral arrangement with co-ordination no. 4.
c) When the radius ratio is in the range 0.155 - 0.225, an octahedral arrangement with co-ordination no. 6.
d) In B_2O_3, smaller cations occupy triangular voids and a planar trigonal arrangement with co-ordination no. 3

19. Which planes can be found in a bcc unit cell?
a)  b)  c)  d) 

20. Which planes can be found in fluorite structure (unit cell)?

a)  b)  c)  d) 

21. Which of the following statements is or are true?

a) two ions A^+ and B^- have radii 88 pm and 200 pm respectively. In the close packed crystal of compound AB, the coordination number of A^+ is 6

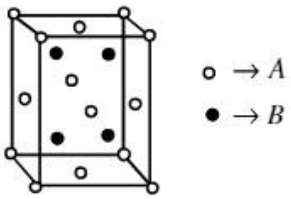
b) in CsCl crystal, edge length is 404 pm. The distance between the nearest neighbours is 350 pm.

c) due to Frenkel defect, the density of the ionic solids does not changes

d) the volume of atoms present in a face centered cubic unit cell of a metal (r is atom radii) is $\frac{16}{3}\pi r^3$

Linked Comprehension Type Questions

Passage-I :



Answer the following questions for the above unit cell

22. If the molar mass of AB is 100g mol^{-1} and 'a' is edge length then the density of the crystal will be

a) $\frac{4N_A}{a^3 \times 100}$ b) $\frac{4\times100}{a^3N_A}$ c) $\frac{2N_A}{a^3100}$ d) $\frac{2\times100}{a^3N_A}$

23. The given unit cell belongs to

a) CsCl type b) TiCl type c) rock salt type d) zinc blende type

24. The coordination number of 'B' will be

a) 8 b) 6 c) 4 d) 12

Passage-II :

O^{-2} : CCP

B^{3+} : Half of octahedral Voids

A^{2+} : 1/8th of tetrahedral Voids

25. The space lattice described refers to

a) fluorite structure b) rock salt structure c) spinel structure d) inverse spinel structure

26. The formula of the compound is

a) ABO_2 b) A_2BO_3 c) AB_2O_4 d) A_2BO_4

27. Which of the following is an example of this structure

a) $ZnAl_2O_4$ b) Zn_2AlO_4 c) $ZnAlO_2$ d) Zn_2AlO_3

Passage-III :

Following is the fact about the newly discovered superconductor of C_{60}(fullerene). The alkali metal fulleride superconductor M_3C_{60} has a cubic closest-packed (face-centered cubic) arragement of nearly spherical C_{60}^{3-} anions with M^+ cations in the holes between the larger C_{60}^{3-} ions. The holes are of two types-octahedral holes, which are surrounded octahedrally by six C_{60}^{3-} ions, and tetrahedral holes, which are surrounded tetrahedrally by four C_{60}^{3-} ions.

28. How many C_{60}^{3-} ions, octahedral holes, and tetrahedral holes are present per unit cell

a) 5,4,4 b) 3,8,4 c) 4,4,8 d) 2,1,2

29. Specify fractional coordinates for the tetrahedral holes (Fractional coordinates are fractions of the unit cell edge lengths. For example, a hole at the centre of the cell has fractional coordinates $\frac{1}{2},\frac{1}{2},\frac{1}{2}$)

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

30. The ionic radii of Na^+, K^+ and Rb^+ are 97, 133 and 147 pm, respectively. Which of these ions will fit into the octachedral holes? (radius of C_{60}^{3-} is about 350 pm)

a) Na^+ b) K^+ c) Rb^+ d) all of these

Matrix Matching Type Questions

31. Match the following closest packing of identical spheres listed in Column-I with the characteristics listed in Column-II.

Column-I	Column-II
A) AAAA packing	p) CCP, CN = 12
B) ABAB packing	q) HCP, CN = 12
C) ABCABC packing	r) BCC, CN = 8
D) Square close packing	s) Primitive cubic, CN = 6

32. Match the elements (in Column-I) with the shape of the crystal (in Column-II)

Column-I	Column-II
A) Be	p) Body-centred cubic
B) Ca	q) Simple cubic
C) Ba	r) Face-centred cubic
D) Po	s) Hexagonal close-packed

33.

Column-I	Column-II
A) 50% 'Tetrahedral' voids filled	p) CsCl
B) 100% 'octahedral' voids	q) NaCl
C) 100% 'Tetrahedral' voids filled	r) ZnS
D) No 'Tetrahedral' voids present	s) Na_2O

Integer Type Questions

34. Number of atoms per unit cell for body centered cubic system is ____

35. How many effective Cl^- ions are present in the rock salt NaCl if ions along one axis joining opposite faces are removed?

36. A spinel is an important class of oxides consisting of two types of metal ions with oxide ions arranged in CCP layers. The normal spinel has 1/8th of the tetrahedral void occupied by one type of metal and one half of the octahedral voids occupied by another type of metal ions such a spinel is formed by Zn^{2+}, Al^{3+} and O^{2-} with Zn^{2+} in tetrahedral void. Then the simplest formula of that spinel is $Zn_xAl_yO_z$ then $x + y + z$ is

37. A metal crystallizes in f.c.c. Then, the ratio of number of its first nearest neighbours to the second nearest neighbours is

38. Find the co-ordination number of sodium in Na_2O.

EXERCISE-III

(Defects and Properties of Solids)

LEVEL-I (MAIN)

Straight Objective Type Questions

1. **(A) :** Thermodynamically all solids possess a tendency to acquire defects
   (R) : During defects the entropy of the system increases in solids.
   1) Both (A) and (R) are true and (R) is the correct explanation of (A)
   2) Both (A) and (R) are true and (R) is not the correct explanation of (A)
   3) (A) is true but (R) is false
   4) (A) is false but (R) is true

2. At zero kelvin, most of the ionic crystals possess
   1) Frenkel defect 2) Schottky defect 3) Metal excess defect 4) No defect

3. In stoichiometric defects, the ratio of positive and negative ions as indicated by chemical formula of the compound
   1) Decreases 2) Increases 3) Remains same 4) Cannot be predicted

4. In a solid lattice the cation has left a lattice site and is located at an interstitial position, the lattice defect is
   1) Metal excess defect 2) Vacancy defect 3) Frenkel defect 4) Schottky defect

5. Non stoichiometric solid among the following
   1) MgO 2) CaO 3) Na_2O 4) TiO

6. Which of the following has both Schottky and Frenkel defects.
   1) AgBr 2) ZnO 3) NaCl 4) KCl

7. On doping Ge metal with a little of gallium one gets
   1) p-type 2) n-type 3) Insulator 4) Rectifier

8. Which substance will conduct the current in the soild state
   1) Diamond 2) Graphite 3) Iodine 4) Sodium chloride

9. An example for metallic conductor and semiconductor is
   1) TiO 2) FeO 3) V_2O_3 4) NiO

10. Molten sodium chloride conducts electricity due to the presence of
    1) Free electrons 2) Free ions
    3) Free molecules 4) Atoms of sodium and chlorine

11. Which of the following is ferromagnetic?
1) Ni 2) Co 3) CrO_2 4) All

12. The oxide that is insulator is
1) VO 2) MnO 3) ReO_3 4) Ti_2O_3

13. In which of the following the conductivity would be in the order of 10^{-4} ohm^{-1} cm^{-1}
1) $NaCl_{(s)}$ 2) $Na_{(s)}$ 3) diamond 4) Ge

14. **(A)** : Schottky and Frenkel defects are also called as 'thermo dynamic defects'.
(R) : Both Schottky and Frenkel defects increase with increase in temperature.

15. Schottky defect causes
1) Increase in the density of solid
2) Decrease in the density of solid
3) No change in the density of solid
4) Decrease in the conductivity of solid

16. Which among the following is likely to have Schottky defect?
1) AgCl 2) NaCl 3) TiCl 4) $MgCl_2$

Numerical Value Type Questions

17. Metals have conductivity in the order of 10^x to 10^y then $(x + y)$ = ___ $(ohm^{-1}\ cm^{-1})$

18. To get n-type semiconductor, impurity to be added to silicon should have the how many number of valence electrons?

LEVEL-II (ADVANCED)

Straight Objective Type Questions

1. Schottky-Wagner defects are mostly found in
a) Ionic compounds with high co-ordination number
b) Ionic compound with low co-ordination number
c) Covalent compounds with low coordination number
d) Covalent compound with high coordination number

2. Germanium can be made n-type semi conductor by doping with
a) silicon b) arsenic c) gallium d) either As (or) Ga

3. **(A)** : Metals are generally good conductors of electricity.
(R) : Electrical conductivity of metals is due to Schottky type defects.
a) Both (A) and (R) are true and (R) is the correct explanation of (A)
b) Both (A) and (R) are true and (R) is not the correct explanation of (A)
c) (A) is true but (R) is false
d) (A) is false but (R) is true

4. **(A)** : Antiferromagnetic substances possess almost zero magnetic moment.
(R) : There are no unpaired electrons in anti-ferromagnetic substances.
a) Both (A) and (R) are true and (R) is the correct explanation of (A)
b) Both (A) and (R) are true and (R) is not the correct explanation of (A)
c) (A) is true but (R) is false
d) (A) is false but (R) is true

5. **(A) :** Fe_3O_4 is ferrimagnetic at room temperature but becomes paramagnetic at 850 K.
(R) : The magnetic moments in Fe_3O_4 are aligned equally in parallel and antiparallel directions which on heating randomise.
a) Both (A) and (R) are true and (R) is the correct explanation of (A)
b) Both (A) and (R) are true and (R) is not the correct explanation of (A)
c) (A) is true but (R) is false
d) (A) is false but (R) is true

6. Frenkel defect appears in
a) AgI b) ZnS c) AgBr d) all of these

7. An electron trapped in an anion vacancy within the crystal is called
a) n-type conductor b) p-type conductor c) F-centre d) insulator

8. The p-type semiconductor is obtained when Si is doped with
a) Sn b) Ge c) Ga d) As

9. The substance whose resistance gets reduced to virtually zero at very low temperature is called
a) electrical conductor b) hyper conductor c) semiconductor d) super conductor

10. The allignment of magnetic dipoles in antiferro-magnetism is
a) ↑↑↑↑↑ b) ↑↓↑↓ c) both (a) and (b) d) none of these

11. The formula of an oxide of iron is $Fe_{0.93}O_{1.00}$. If the compound has hundred O^{-2} ions, then it contains
a) $93Fe^{+2}$ions b) $93Fe^{+3}$ions c) $79Fe^{+2}, 14Fe^{+3}$ d) $93Fe^{+2}, 14Fe^{+3}$

More than One correct answer Type Questions

12. Which is true?
a) Piezoelectricity is due to net dipole moment
b) Some electric current is produced on heating polar crystals, this is pyroelectricity
c) Ferroelectricity is due to alignment of dipoles in same direction
d) Ferroelectricity is due to alignment of dipoles in opposite direction

13. The presence of F-centres in a crystal makes it
a) conducting b) colourless c) coloured d) non-conducting

14. Which of the following is/are correct about the point defects?
a) In Frenkel defect, the dielectric constant of solid increases
b) In Schottky defect, the density of solid decreases
c) In Frenkel defect, the density of solid decreases
d) In Schottky defect, the dielectric constant of solid increases

15. Which of the following statements are correct about the diamagnetic solids?
a) They have only paired electrons
b) They are weakly repelled in magnetic field
c) They have large number of unpaired electrons
d) Chromium is diamagnetic

16. Which of the following statement(s) is/are correct?
a) Frenkel defects occur when difference in size of cations and anions are bigger
b) Schottky defects occur when cations and anions have similar ionic size
c) An ionic crystal can have both Frenkel and Schottky defects
d) Pure alkali metals do not have Frenkel defects

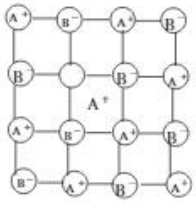
Linked Comprehension Type Questions

Passage-I :

Ionic lattice has two major point defects, (1) Schottky (2) Frenkel defects, Schottky defects occurs due to the cation - anion pairs missing from the lattice sites, Frenkel defects occur when an ion leaves its lattice site and fits into an interstitial space. The neutrality of the crystals is being maintained and we consider all losses from interstitial postions

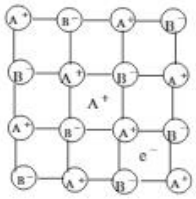
17. Which defect decreases density of the crystal?
a) Frenkel defect b) Schottky defect c) Both (a) and (b) d) None of these

18. Structure shown here represents



a) Schottky defect
b) Frenkel defect
c) Metal excess defect
d) None of these

19. Structure shown here represents :



a) Schottky defect
b) Frenkel defect
c) Both defects
d) None of these

Passage-II :

When a silicon crystal is doped with a group-15 element (with five valence electrons) such as P, As, Sb or Bi, the structure of the crystal lattice remains unchanged. Out of the five valence electrons of group-15 doped element, four electrons are used in normal covalent bonding with silicon and fifth electron is delocalised and thus conducts electricity. Doping a silicon crystal with a group-13 element (with three valence electrons) such as B, Al, Ga or In produces a semiconductor with three electrons in dopant. The place where fourth electron is missing is called as electron vacancy or hole.

20. Silicon that has been doped with group-15 elements is called
a) p-type semiconductor b) n-type semiconductor
c) electron vacancy or hole d) e-type semiconductor

21. Silicon that has been doped with group-13 elements is called
a) p-type semiconductor b) n-type semiconductor
c) electron vacancy or hole d) e-type semiconductor

22. If NaCl is doped with 10^{-3} mol% $SrCl_2$, then concentration of cation vacancies is
a) 6.02×10^{23} b) 6.02×10^{20} c) 6.02×10^{18} d) 6.02×10^{15}

Matrix Matching Type Questions

23.

Column-I (Electrical Properties)	Column-II (Materials)
A) Pure crystal of silicon at 0 K	p) Semi conductor – p-holes carry current
B) Pure crystal of silicon at 400 K	q) Semi conductor – electrons carry current
C) Silicon crystal doped with arsenic impurity	r) Insulator
D) Silicon crystal dopped with gallium	s) Semiconductor-equal number of p-holes and electrons carry current

24.

Column-I (Solids)	Column-II (Characteristics)
A) Piezoelectric	p) Electric dipoles spontaneously aligned in one direction
B) Antipiezoelectric	q) Heating causes electric field
C) Ferroelectric	r) Mechanical stress causes electric field
D) Pyroelectric	s) Electric field causes elastic deformation

25.

Column-I	Column-II
A) 'Na' vapour blown into NaCl	p) Doping
B) $Fe_{(1-x)}O$	q) F-centres
C) Hot ZnO	r) Variable metal valency
D) Mixture of NaCl, $SnCl_2$	s) Metal excess

Integer Type Questions

26. Analysis shows that nickel oxide has formula $Ni_{0.98}O_{1.00}$, the % of Ni^{3+} is x%. Then '*x*' is

27. In $Fe_{0.96}O$, per one Avogadro number of oxide ions, $x \times 10^{-2}$ Avagadro number of cation vacancies are present *x* value is

KEY SHEET (LECTURE SHEET)

EXERCISE-I

LEVEL-I

1) **4** 2) **4** 3) **4** 4) **1** 5) **2** 6) **3** 7) **3** 8) **1**
9) **1** 10) **1** 11) **1** 12) **4** 13) **2** 14) **4** 15) **3** 16) **1.61**
17) **1** 18) **30**

LEVEL-II

1) **b** 2) **d** 3) **d** 4) **a** 5) **c** 6) **d** 7) **d** 8) **c**
9) **b** 10) **ab** 11) **acd** 12) **ac** 13) **cd** 14) **b** 15) **d**
16) **A-s; B-r; C-q; D-p** 17) **A-s; B-p; C-r; D-q** 18) **3** 19) **4**

EXERCISE-II

LEVEL-I

1) **4** 2) **4** 3) **1** 4) **3** 5) **1** 6) **4** 7) **2** 8) **3**
9) **4** 10) **3** 11) **3** 12) **3** 13) **3** 14) **3** 15) **3** 16) **3**
17) **3** 18) **1** 19) **2** 20) **2** 21) **3** 22) **0.15** 23) **1.86** 24) **0.41**

LEVEL-II

1) **d** 2) **d** 3) **c** 4) **c** 5) **d** 6) **d** 7) **b** 8) **d**
9) **c** 10) **c** 11) **b** 12) **a** 13) **d** 14) **abc** 15) **ab** 16) **abcd**
17) **acd** 18) **bd** 19) **abc** 20) **abd** 21) **abcd** 22) **b** 23) **d** 24) **c**
25) **c** 26) **c** 27) **a** 28) **c** 29) **c** 30) **c**
31) **A-s; B-qr; C-p; D-s** 32) **A-s; B-r; C-p; D-q**
33) **A-r; B-q; C-s; D-p** 34) **2** 35) **3** 36) **7** 37) **2** 38) **4**

EXERCISE-III

LEVEL-I

1) **1** 2) **4** 3) **3** 4) **3** 5) **4** 6) **1** 7) **1** 8) **2**
9) **3** 10) **2** 11) **4** 12) **2** 13) **4** 14) **1** 15) **2** 16) **2**
17) **7** 18) **5**

LEVEL-II

1) **a** 2) **b** 3) **c** 4) **c** 5) **c** 6) **d** 7) **c** 8) **c**
9) **d** 10) **b** 11) **c** 12) **abc** 13) **ac** 14) **ab** 15) **ab** 16) **abcd**
17) **b** 18) **b** 19) **d** 20) **b** 21) **a** 22) **c**
23) **A-r; B-s; C-q; D-p** 24) **A-r; B-s; C-p; D-q**
25) **A-qs; B-r; C-qs; D-p** 26) **4** 27) **4**

PRACTICE SHEET

EXERCISE-I

(Types of solids and Crystal Structures)

LEVEL-I (MAIN)

Straight Objective Type Questions

1. How many unit cells are possible for the crystallographic dimensions as $a \neq b \neq c$; $\alpha = \gamma = 90^0$; $\alpha \neq \beta$
   1) 2 2) 1 3) 4 4) 3

2. Which of the following systems is not correctly characterised?
   1) cubic : $a = b = c$; $\alpha = \beta = \gamma = 90^0$
   2) tetragonal : $a = b \neq c$; $\alpha = \beta = \gamma = 90^0$
   3) orthorhombic : $a \neq b \neq c$; $\alpha = \beta = \gamma = 90^0$
   4) rhombohedral : $a = b \neq c$; $\alpha = \beta = \gamma = 90^0$

3. The consitutent particles in carborundum
   1) atoms
   2) molecules
   3) +ve ions
   4) +ve ions in a sea of electrons

4. The unit cell of highest symmetry is
   1) Cubic 2) Triclinic 3) Hexagonal 4) Monoclinic

5. The unit cell of lowest symmetry is
   1) Cubic 2) Triclinic 3) Hexagonal 4) Monoclinic

6. If the three inter-axial angles defining the unit cell are all equal in magnitude, the crystal can not belong to the ____ system
   1) Orthorhombic 2) Hexagonal 3) Tetragonal 4) Cubic

7. TiO_2 is well known example of
   1) Triclinic system 2) Tetragonal system 3) Monoclinic system 4) Cubic system

8. For a certain crystal, the unit cell axial lengths are found to be $a = 5.62A^0$, $b = 7.41A^0$ and $c = 10.13A^0$. The three coordinate axes are mutually perpendicular. The crystal system to which the crystal belongs is
   1) Tetragonal 2) Orthorhombic 3) Monoclinic 4) Cubic

9. Amorphous solids
   1) do not have sharp melting points 2) are isotropic
   3) have same mechanical strength electrical and crystal properties in any direction
   4) All of these

10. Glasses and plastics are
   1) amorphous solids 2) supercooled liquids
   3) Both (1) and (2) 4) none of these

11. Metals are good conductors of electricity because they contain
   1) ionic bonds 2) a network structure
   3) very few valence electrons 4) free electrons

Straight Objective Type Questions

12. The total number of crystal forms possible is around :

13. The first order diffraction of x-rays from a certain set of crystal planes occurs at an angle of 11.8^0 from the planes. If the planes are 0.281 nm apart, the wavelength of x-rays (nm) is $(\sin 11.8^0 = 0.2, \sin 5.9^0 = 0.103)$

LEVEL-II (ADVANCED)

Straight Objective Type Questions

1. Which of the following is amorphous in nature?
   a) Quartz b) $CuSO_4 . 5H_2O$ c) Dry ice d) fused silica glass

2. Which of the following is covalent solid?
   a) Fe b) Diamond c) NaCl d) Cu

3. Which of the following melts below 298 k?
   a) NaCl(s) b) Si(s) c) Ar (s) d) Na(s)

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

5. Among solids, the highest melting point is exhibited by
   a) Amorphous solids b) Ionic solids c) Pseudo solids d) Molecular solids

6. Which of the following is not a correct statement?
   a) Any material can be made amorphous by quenching its melt (or) freezing its vapour
   b) The melt of an amorphous solid when slowly cooled becomes crystalline
   c) Glass melts over a range of temperatures d) Quartz has irregular chains of SiO_4 units.

7.

Column-A	Column-B
A) Glass	1) Framework silicate
B) Quartz	2) Malleable & ductile
C) Metallic crystal	3) Pseudo solid

The correct match is

	A	B	C		A	B	C		A	B	C		A	B	C
a)	1	3	2	b)	3	1	2	c)	2	1	3	d)	1	2	3

8. Which is not correct about valence bond theory of metals
   a) It is also called resonance theory
   b) It was proposed by Linus Pauling
   c) The metallic bond is essentially a polar (or) non polar covalent bond
   d) It explains metallic lusture

9. In a crystal lattice a specific fundamental structure appears again and again which is a
   a) triangle b) rectangle c) tetrahedron d) parallelogram

10. The angle corresponding to maximum diffraction of x-rays on solid crystal is determined by electrometre reading in
   a) Bragg's experiment b) Powder method
   c) Debye-Hull method d) Max Von Laue experiment

More than One correct answer Type Questions

11. Which type of crystals contain only one Bravais lattice?
   a) Hexagonal b) Triclinic c) Rhombohedral d) Monoclinic

12. Crystalline solids have
   a) Sharp melting point b) Anisotropic character
   c) The character of super cooled liquid d) Smooth cooling curve

13. Which are amorphous solids?
   a) NaCl b) CaF_2 c) Glass d) Plastics

Matrix Matching Type Questions

14.

Column-I (Crystal system)	Column-II (Edge length and angle)
A) Monoclinic	p) $a \neq b \neq c$
B) Hexagonal	q) $a = b \neq c$
C) Rhombohedral	r) $a = b = c$
D) Triclinic	s) $\alpha \neq \beta \neq \gamma \neq 90^0$

15.

Column-I	Column-II
A) $C_{(solid)}$	p) Covalent solid
B) CH_3OH	q) Molecular solid
C) $Water_{(solid)}$	r) Hydrogen bonding
D) HNO_3	s) Dipole-dipole interactions

EXERCISE-II

(Close Packed Structures and Voids)

LEVEL-I (MAIN)

Straight Objective Type Questions

1. Which of the following packing is more efficient:
   1) square close - packing 2) hexagonal close - packing
   3) tetrahedral arrangement 4) none of the above

2. The packing fraction for a body centred cube is
1) 0.74 2) 0.76 3) 0.68 4) 0.86

3. The packing efficiency in a face - centred cubic cell system of crystals is :
1) 52% 2) 68% 3) 74% 4) 92%

4. Na and Mg crystallize in BCC and FCC type of crystals respectively, then the number of atoms of Na and Mg present in the unit cell of their respective crystals is
1) 4, 2 2) 9, 14 3) 14, 9 4) 2, 4

5. Among the following which has a different structure from others ?
1) Ba 2) Cr 3) Mo 4) Tl

6. A metal 'M' is crystallised in F.C.C lattice. The number of unit cells in it having 2.4×10^{24} atoms
1) N 2) N/2 3) 2N 4) 4N

7. In which of the following crystal the void efficiency is 32%?
1) Zn 2) Po 3) Cu 4) Rb

8.

Column-A (Metal)	Column-B (Co-ordination number)
A) Po	1) 6
B) K	2) 8
C) Co	3) 12
D) Pb	4) 4

The correct match is :

	A	B	C	D		A	B	C	D		A	B	C	D		A	B	C	D
1)	1	2	3	3	2)	1	2	3	4	3)	2	1	3	4	4)	2	1	4	3

9. In a close packed lattice containing 'n' particles, the number of tetrahedral voids
1) n 2) n/2 3) 2n 4) cannot say

10. AB is an ionic solid. If the ratio of ionic radii of A^+ and B^- is 0.52. What is the co-ordination number of B^-?
1) 2 2) 3 3) 6 4) 8

11. In a compound atoms of element 'Y' form C.C.P. lattice and those of element 'X' occupy 2/3rd of tetrahedral voids. The formula of the compound will be
1) X_2Y_3 2) X_2Y 3) X_3Y_4 4) X_4Y_3

12. Gold crystallizes with a
1) fcc 2) bcc 3) simple cubic 4) orthorhombic

13. A metallic element crystallises into a lattice containing a sequence of layers of ABABAB... Any packing of spheres leaves out voids in the lattice. Volume percentage of empty space is
1) 52% 2) 26% 3) 50% 4) 74%

14. A compound alloy of gold and copper crystallises in a cubic lattice in which the gold atoms occupy the lattice points at the corners of a cube and the copper attoms occupy the centres of each of the cube faces. Hence, compound alloy has formula
1) AuCu 2) Au_3Cu 3) Au_2Cu 4) $AuCu_3$

15. Zinc blende structure is obtained by when Zn^{2+} occupies.
1) All tetrahedral sites 2) half tetrahedral sites
3) All octahedral sites 4) half octahedral sites

16. In b.c.c structure of lattice constant 'a' the minimum distance between atoms is
1) $\frac{a\sqrt{3}}{2}$ 2) $a\sqrt{2}$ 3) $\frac{a}{\sqrt{2}}$ 4) $\frac{a}{2}$

17. In a cubic cell, seven of the eight corners are occupied by atoms A and centres of faces are occupied by atoms B. The general formula of the compound is:
1) A_7B_6 2) A_7B_{12} 3) A_7B_{24} 4) $A_{24}B_7$

18. A TV in FCC is formed by atoms at
1) 3 corners + 1 facecenter 2) 2 facecenters + 2 corners
3) 3 facecenters + 1 corner 4) 2 facecenters + 2 corners + one bodycenter

19. If R is the radius of the octahedral void and r is the radius of the atom in close packing, then r/R is equal to
1) 4.76 2) 3.22 3) 2.41 4) 9.1

Numerical Value Type Questions

20. Potassium crystallises in a body centred cubic unit cell. The mass of one unit cell is $x \times 10^{-23}$gm. $x =$

21. Copper crystallises in a f.c.c. lattice, the length of the unit cell is 3.63 A°. The radius of Cu-atom is ____ (A°)

22. The radius of an atom of an element is 80 pm. If it crystallises as a body centred cubic lattice, what is the edge of its unit cell?

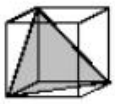
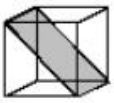
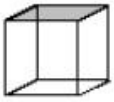
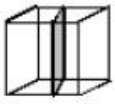
23. In an atomic bcc, what percent of edge is not covered by atoms?

24. The packing efficiency of a simple cubic crystal with an interstitial atom exactly fitting at the body centre is :

LEVEL-II (ADVANCED)

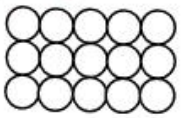
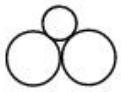
Straight Objective Type Questions

1. In FCC crystal, which of the following shaded planes contains the following type of arrangement of atoms

a)  b)  c)  d) 

2. Hexagonal closest packed structure and cubic closest packed structure for a given element would be expected to have the same density because of
a) same molar mass b) same coordination number and packing fraction
c) both (a) and (b) d) none of the above

3. Which of the following figure represent the cross section of an octahedral site?

a)  b)  c)  d) 

4. Distance between tetrahedral void and octahedral void in the lattice will be (a = edge length of unit cell)

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

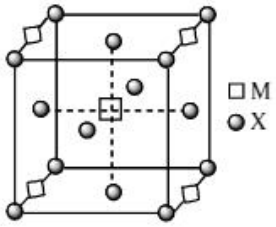
5. If the radius of K^+ and F^- are 133 pm and 136 pm respectively, the distance between K^+ and F^- in KF is

a) 269 pm b) 134.5 pm c) 136 pm d) 3 pm

6. A compound is formed by elements A and B. This crystallizes in the cubic structure where the A atoms are at the corners of the cube and B atoms are at the body centres. The simplest formula of the compound is

a) AB b) A_2B c) AB_2 d) AB_6

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



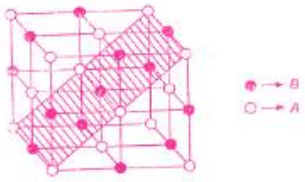
a) MX

b) MX_2

c) M_2X

d) M_5X_{14}

8. If all the atoms, on the shaded plane are removed then the molecular formula of the solid will be



a) A_5B_7 b) A_7B_5 c) AB d) A_3B_4

9. How many unit cell are present in 4.0 gm of crystal AB (formula mass of AB = 40) having rock salt type structure? (N_A = Avogadro's no.)

a) N_A b) $\frac{N_A}{10}$ c) $40N_A$ d) None of these

10. Which of the follwing expression is correct for packing fraction of NaCl if the ions along the face are diagonally removed

a) $\frac{\frac{13}{3}\pi r_-^3 + \frac{16}{3}\pi r_+^3}{8(r_+ + r_-)^3}$ b) $\frac{\frac{13}{3}\pi r_-^3 + \frac{4}{3}\pi r_+^3}{8(r_+ + r_-)^3}$ c) $\frac{\frac{16}{3}\pi r_-^3 + \frac{13}{3}\pi r_+^3}{8(r_+ + r_-)^3}$ d) $\frac{\frac{4}{3}\pi r_-^3 + \frac{13}{3}\pi r_+^3}{8(r_+ + r_-)^3}$

11. Ferrous oxide has a cubic structure and eged length of the unit cell is 5.0 Å. Assuming the density of ferrous oxide to be 3.84g/ cm^3 the no. of Fe^{2+} and O^{-2} ions present in each unit cell are (use $N_A = 6 \times 10^{23}$)

a) $4Fe^{2+}$ and $4O^{2-}$ b) $2Fe^{2+}$ and $2O^{2-}$ c) $1Fe^{2+}$ and $1O^{2-}$ d) $3Fe^{2+}$ and $4O^{2-}$

12. CdO has NaCl structure with density 8.27 g/cc. If the ionic radius of O^{2-} is 1.24 Å, determine ionic radius of Cd^{2+}
a) 1.5 Å b) 1.1 Å c) 1.9 Å d) 1.5 Å

13. When over a two-dimensional square packing same layers are kept in the way so that the centers are aligned in all three dimensions, coordination number of each sphere is
a) 8 b) 6 c) 12 d) 10

14. Li forms a body-centered cubic lattice. If the edge of the cube is 3.5×10^{-10} m and the density is 5.3×10^{2} kgm^{-3}, calculate the percentage occupancy of Li metal.
a) 48% b) 74% c) 26% d) 98%

15. A certain oxide of metal M crystallises in such a way that O^{2-} ions occupy hcp arrangement following AB AB....pattern. The metal ions, however, occupy 2/3rd of the octahedral voids. The formula of the compound is
a) M_2O_3 b) M_3O c) $M_{8/3}O_3$ d) MO_2

16. Each rubidium halide crystallising in the RbCl type lattice has a unit cell length 0.30A° greater than that for corresponding potassium salt ($r_{(K^+)} = 1.33$ Å) of the same halogen. Hence, ionic radius of Rb^+ is
a) $1.18A^0$ b) $1.48A^0$ c) $1.63A^0$ d) $1.03A^0$

More than One correct answer Type Questions

17. Edge length of NaCl unit cell is 552 pm. Then which are correct statements
a) distance between Na^+ and Cl^- ions is 276 pm
b) radii of Na^+ and Cl^- ion will be 95 pm and 181 pm
c) nearest distance between two Na^+ ions is $276\sqrt{2}$ pm
d) nearest distance between Cl^- ions is $95\sqrt{2}$ pm

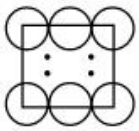
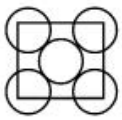
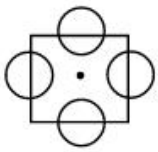
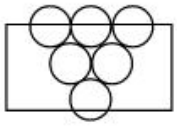
18. In the unit cell of NaCl, which of the following statements are correct?
a) Na^+ ions have six Cl^- ions in its nearest neighbourhood
b) Cl^- ions have six Na^+ ions in its nearest neighbourhood
c) Second nearest neighour of Na^+ ion are twelve Na^+ ions
d) NaCl has 68% of occupied space

19. Which of the following statement(s) is (are) correct for CaF_2?
a) Ca^{2+} ions are present only at the corners of a cube
b) c.c.p. type structure
c) F^- ions are present in all the octahedral voids
d) The structrue has 8 : 4 co-ordination number

20. Which of the following crystals have 8 : 8 coordination?
a) NH_4Cl b) AlFe c) MnO d) NH_4Br

21. Radius ratio (r_c/r_a) calculations
a) assume 100% ionic nature of crystal
b) indicate the coordination number 8, 6 etc
c) are only approximate since many factors such as polarizabilities of ions are ignored
d) can decide the crystal structure of ionic solids

22. Which planes are present in Na_2O structure (unit cell)

a)  b)  c)  d) 

23. Which statements are correct ?

a) The size of octahedral void is larger than that of tetrahedral void.

b) BCC arrangement does not provide tetrahedral voids.

c) In an FCC arrangement each octahedral void has '12' more octahedral voids in equal distance.

d) In FCC octahedral voids amount 26% of space.

Linked Comprehension Type Questions

Passage-I :

Density of a unit cell is represented as

$$\rho = \frac{Effective\ no.of\ atom(s) \times Mass\ of\ a\ unit\ cell}{Volume\ of\ a\ unit\ cell} = \frac{Z.M.}{N_A.a^3}$$

Where, mass of unit cell = mass of effective no. of atom(s) or ion(s).

M = At. wt./formula wt. ; N_A = Avogadro's no. $\Rightarrow$ 6.023×10^{23}

a = edge length of unit cell

24. Silver crystallizes in a fcc lattice and has a density of $10.6 g/cm^3$. What is the length of an edge of the unit cell?

a) 0.407 nm b) 0.2035 nm c) 0.101 nm d) 4.07 nm

25. An element crystallizes in a structure having fcc unit cell of an edge 200 pm. Calculate the density, if 100g this element contains 12×10^{23} atoms :

a) $41.66\ g/cm^3$ b) $4.166\ g/cm^3$ c) $10.25\ g/cm^3$ d) $1.025\ g/cm^3$

Passage II:

KCl crystallizes in the same type of lattice as does NaCl (Rock salt). Given that $\frac{r_{Na^+}}{r_{Cl}} = 0.5$ and $\frac{r_{Na^+}}{r_{K^+}} = 0.7$

26. What is the ratio of the side of the cell for KCl to that for NaCl ?

a) 1.143 b) 2.57 c) 2.4 d) 1.2

27. What is the ratio of density of NaCl to that of KCl ?

a) 1.49 b) 1.17 c) 1.90 d) 1.143

Passage-III:

In ZnS structure S^{-2} ions make FCC lattice in which Zn^{+2} occupies alternate tetrahedral voids. In CaF_2 structure Ca^{+2} ions make FCC lattice and F^- ions occupy all the tetrahedral voids.

28. How many ZnS formula with are present per unit cell?

a) 1 b) 2 c) 3 d) 4

29. One mole each of ZnS and CaF_2 are taken. What is the ratio of number of unitcells in the sample?

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

30. In CaF_2 structure the nearest inter cationic distance in 'x' what is the nearest inter anionic distance?

a) $\left(\sqrt{\frac{3}{2}}\right)x$ b) $\left(\frac{1}{\sqrt{2}}\right)x$ c) $\sqrt{2}\,x$ d) $\left(\sqrt{\frac{3}{2}}\right)x$

Matrix Matching Type Questions

31. Match the solid in Column-I with its characteristic in Column-II.

Column-I (Solid)	Column-II (Characteristic)
A) NaCl	p) Body centred cubic
B) CsCl	q) Packing fraction = 0.68
C) Na	r) Packing fraction $= \frac{2\pi}{3}\frac{(r_+^3 + r_-^3)}{(r_+ + r_-)^3}$
D) TiCl	s) Packing fraction $\frac{\sqrt{3}}{2}\pi\frac{(r_+^3 + r_-^3)}{(r_+ + r_-)^3}$

32.

Column-I	Column-II (A-cation, B-anion)
A) Rock salt structure	p) general formula is AB
B) Zinc blende structure	q) general formula is AB_3
C) Fluorite structure	r) general formula is A_2B
D) Anti fluorite structure	s) general formula is AB_2

Integer Type Questions

33. The edge length of unit cell of metal having molecular weight 75g/mol is $5A^0$ which crystallises in simple cubic lattice. If the density is 2g/cc then the radius of metal atom in pm is $x \times 10^2$ then 'x' is $[N_A = 6 \times 10^{23}]$

34. The number of atoms in HCP unit cell is _____.

35. How many effective Na^+ ions are present in the rock salt NaCl if ions along one axis joining opposite faces are removed?

36. A metal exists in 'hcp' and 'ccp' allotropic forms. The density of 'hcp' form in 9gm/cc, what is the density of its 'ccp' form in 'gm/cc'units ?

37. Potassium crystallizes in a body centered cubic lattice. The approximate number of unit cells in 4.0g of potassium is $X \times 10^{22}$, then the value of X is (Atomic mass of potassium = 39)

EXERCISE-III

(Defects and Properties of Solids)

LEVEL-I (MAIN)

Straight Objective Type Questions

1. Schottky defect in crystals is observed when

1) Unequal number of cations and anions are missing from the lattice
2) Equal number of cations and anions are missing from the lattice
3) An ion leaves its normal site and occupies an interstitial cells
4) Density of the crystal is increased

2. **Column - I** **Column - II**

A) Crystal defect 1) Amorphous
B) Carborundum 2) Frenkel
C) Pitch 3) Covalent crystal

The correct match is

	A	B	C		A	B	C		A	B	C		A	B	C
1)	3	1	2	2)	2	1	3	3)	2	3	1	4)	1	2	3

3. Which of the following is a 'Berthollide Compound'?

1) MgO 2) Al_2O_3 3) Na_2O 4) ZrH

4. Frenkel defect is the

1) Schottky defect 2) interstitial defect
3) combination of (1) and (2) 4) none of the above

5. **(A) :** With increase in temperature the condicutivity of metals decreases.
(R) : With increase in temperature lattice vibrations increase in metals.

1) Both (A) and (R) are true and (R) is the correct explanation of (A)
2) Both (A) and (R) are true and (R) is not the correct explanation of (A)
3) (A) is true but (R) is false 4) (A) is false but (R) is true

6. Ferromagnetic substances have

1) Zero magnetic moment 2) Small magnetic moment
3) Large magnetic moment 4) Any value of magnetic moment

7. Ferromagnetism is maximum in

1) Fe 2) Ni^{2+} 3) Co^{3+} 4) Cu^{2+}

8. The magnetic behavior is different from others in

1) O_2 2) VO_2 3) ZrO_2 4) Ti_2O_3

9. The general formula of ferrites is MFe_2O_4. Where 'M' would not be

1) Mg 2) Cu 3) Al 4) Zn

10. Which substance shows anti ferro magnetism?

1) ZrO_2 2) CdO 3) CrO_2 4) V_2O_3

11. The allignment of magnetic dipoles shown below ↑ ↓ ↓ ↑ ↓ ↓ represents which of the following?

1) Diamagnetism 2) Ferri magnetism 3) Ferro magnetism 4) Anti-ferromagnetism

12. **Column-I** **Column-II**

A) Antiferromagnetic 1) $ZnFe_2O_4$
B) Covalent crystal 2) NiO
C) Ferrimagnetic 3) Diamond

The correct match is

	A	B	C		A	B	C		A	B	C		A	B	C
1)	2	3	1	2)	3	2	1	3)	1	2	3	4)	1	3	2

13. The allignment of magnetic dipoles in Co is

1) ↑↑↑↑↑ 2) ↑↓↑↓ 3) ↑↑↑↓↓ 4) none of these

14. Which is true
1) Rochelle's salt is ferroelectric while lead zirconate is antiferro electric
2) Rochelle's salt is antiferroelectric and lead zirconate is ferro electric
3) Both are ferro electric
4) Both are antiferro electric

Numerical Value Type Questions

15. If NaCl is dopes with 10^{-4} mol% $SrCl_2$, the concentration of cation vacancies will be 6×10^x, x is

LEVEL-II (ADVANCED)

Straight Objective Type Questions

1. The presence of excess sodium chloride makes the crystal appearance yellow. This is due to presence of
a) Schottky defect b) Frenkel defect c) F-centres d) Interstitial defect

2. When AgCl crystal is doped with $CdCl_2$, then it produces a
a) Schottky defect b) Frenkel defect
c) p-type semiconductor d) Interstitial defect

3. An ion that leaves its regular site and occupies position in the space between the lattice sites called
a) Frenkel defect b) Schottky defect c) Impurity defect d) Vacancy defect

4. In case of an ionic crystal, the experimental density is found to be higher that the theoretical density. Hence the defect could be
a) Frenkel b) Interstitial c) Schottky d) both (a) and (b)

5. Superconductors are substances which
a) Conducts electricity at low temperatures
b) Conduct electricity at high temperature
c) Offers very high resistance to the flow of current
d) Offers no resistance to the flow of current

6. Which of the following acts as a superconductor at 2.2 K?
a) He b) Cu c) K d) Mg

7. Addition of arsenic in small amount to pure germanium will result in the formation of
a) n-type semiconductor b) Germanium arsenide
c) p-type semiconductor d) A super conducting alloy

8. Solids in which the dipoles may align themselves in an ordered manner so that there is no net dipole moment, exhibit
a) Pyro-electricity b) Piezo-electricity c) Ferro-electricity d) Anti ferro-electricity

9. Which of the following is a ferromagnetic substance?
a) Fe_2O_3 b) Cr_2O_3 c) Fe_3O_4 d) CrO_2

More than One correct answer Type Questions

10. Which of the following is/are ferromagnetic substance?
a) CrO_2 b) Fe c) Co d) Ni

11. The yellow colour of ZnO and conducting nature produced on heating is due to
    a) Metal excess defects due to interstitial cation
    b) Extra positive ions present in interstitial site
    c) Trapped electrons
    d) None of these

12. Which of the following statement(s) is/are true?
    a) Conductivity of semiconductors increases with increase in temperature
    b) Pure ionic solids are insulators
    c) NaCl is a diamagnetic substance
    d) TiO_2 is a paramagnetic substance

13. Which of the following is/are correct?
    a) In Schottky defect density of crystal decreases
    b) In Frenkel defect density remains the same
    c) Pyroelectricity is produced when some polar crystals are heated
    d) In Frenkel defect density of crystal decreses.

14. Schottky defect does not causes
    a) Increase in the density of solid
    b) Decrease in the density of solid
    c) No change in the density of solid
    d) Decrease in the conductivity of solid

15. Schottkey defects ____
    a) Are common is alkalimetal halides
    b) Are stoichiometric defects
    c) Are thermodynamic defects
    d) Cause drop in density

16. Frenkel defects are ____
    a) Caused by doping process
    b) Interstitial as well as point defects
    c) Most common in salts with high limiting radius ratio
    d) Stoichiometric defects

Linked Comprehension Type Questions

Passage :

Crystal defects give some important properties to solids. The defects are due to either metal excess of metal defficiency of doping

17. ZnO an strong heating becomes yellow due to ___
    a) Oxidation of metal ions
    b) Oxidation of oxide
    c) Reduction of metal ions
    d) dislocation of metal ion

18. Colour Causing F–Center is created when ____
    a) Insufficient iron is oxidised with excess oxygen
    b) Potasium vapour is blown into KCl crystals
    c) Strong heating of MgO
    d) Doping of $SrCl_2$ into NaCl

19. When 'Na' vapour is blown over NaCl solid. The crystals attain yellow colour. This is due to ____
    a) Formation of F–Centres in cationic sites
    b) Formation of F–Centres in anionic sites
    c) Escape of Na^+ ions
    d) Escape of Cl^- ions

Matrix Matching Type Questions

20.

Column-I	Column-II
A) F-centers	p) Extra cations present in interstitial sites
B) Metal excess defect	q) Some cations are replaced with one of higher valence
C) Metal deficiency defect	r) Both cations and anions are missing from lattices
D) Schottky defects	s) Electrons trapped in anionic vacancies

KEY SHEET (PRACTICE SHEET)

EXERCISE-I

LEVEL-I

1) **1** 2) **4** 3) **1** 4) **1** 5) **2** 6) **2** 7) **2** 8) **2**
9) **4** 10) **3** 11) **4** 12) **230** 13) **0.11**

LEVEL-II

1) **d** 2) **b** 3) **c** 4) **c** 5) **b** 6) **d** 7) **b** 8) **d**
9) **d** 10) **a** 11) **abc** 12) **ab** 13) **cd**
14) **A-p; B-q; C-r; D-ps** 15) **A-p; B-rs; C-qr; D-rs**

EXERCISE-II

LEVEL-I

1) **2** 2) **3** 3) **3** 4) **4** 5) **4** 6) **1** 7) **4** 8) **1**
9) **3** 10) **3** 11) **4** 12) **1** 13) **2** 14) **4** 15) **2** 16) **1**
17) **3** 18) **3** 19) **3** 20) **12.95** 21) **1.28** 22) **184.7**
23) **13.40** 24) **0.73**

LEVEL-II

1) **a** 2) **b** 3) **d** 4) **a** 5) **a** 6) **a** 7) **b** 8) **c**
9) **d** 10) **a** 11) **a** 12) **b** 13) **b** 14) **d** 15) **a** 16) **b**
17) **abc** 18) **abc** 19) **bd** 20) **abd** 21) **abcd** 22) **abd** 23) **abc** 24) **a**
25) **a** 26) **a** 27) **b** 28) **d** 29) **a** 30) **a**
31) **A-r; B-ps; C-pq; D-ps** 32) **A-p; B-p; C-s; D-r**
33) **2** 34) **6** 35) **3** 36) **9** 37) **3**

EXERCISE-III

LEVEL-I

1) **2** 2) **3** 3) **4** 4) **2** 5) **1** 6) **3** 7) **1** 8) **3**
9) **3** 10) **4** 11) **2** 12) **1** 13) **1** 14) **1** 15) **17**

LEVEL-II

1) **c** 2) **d** 3) **a** 4) **b** 5) **d** 6) **a** 7) **a** 8) **d**
9) **d** 10) **abcd** 11) **abc** 12) **abc** 13) **abc** 14) **acd** 15) **abcd** 16) **bd**
17) **b** 18) **b** 19) **b** 20) **A-s; B-p; C-q; D-r**

ADDITIONAL PRACTICE EXERCISE

LEVEL-I (MAIN)

Straight Objective Type Questions

1. Which one is called pseudo solid?
   1) CaF_2 2) Glass 3) NaCl 4) All
2. Solids which do not show the same physical properties in different directions are called:
   1) Pseudo solids 2) Isotropic solids 3) Polymorphic solids 4) Anisotropic solids
3. Which of the crystal systems contains the maximum number of Bravais lattices?
   1) Cubic 2) Hexagonal 3) Triclinic 4) Orthorhombic
4. In the primitive cubic unit cell, the atoms are present at the:
   1) corners of the unit cell 2) centre of the unit cell
   3) centre of each face of the unit cell 4) one set of faces of the unit cell
5. The effective number of atoms per unit cell in a simple cube, face centred cube and body centred cube are respectively:
   1) 1, 4, 2 2) 1, 2, 4 3) 8, 14, 9 4) 8, 4, 2
6. Which of the following crystal lattice has the minimum empty space?
   1) Simple cubic 2) Body centred cubic 3) Face centred cubic 4) Simple tetragonal
7. Polonium crystallizes in a simple cubic structure. The edge of the unit cell is 0.236 nm. What is the radius of the polonium atom:
   1) 0.144 nm 2) 0.156 nm 3) 0.118 nm 4) 0.102 nm
8. What are the number of atoms per unit cell and the number of nearest neighbours in a face centered cubic structure?
   1) 4, 8 2) 2, 8 3) 2, 6 4) 4, 12
9. The face centered cubic cell of platinum has a length of 0.392 nm. Calculate the density of platinum (g/cm^3) : (Atomic weight : Pt = 195)
   1) 20.9 2) 20.4 3) 19.6 4) 21.5
10. Which of the following layering pattern will have a void fraction of 0.260 ?
    1) ABCCBAABC 2) ABBAABBA 3) ABCABCABC 4) ABCAABCA

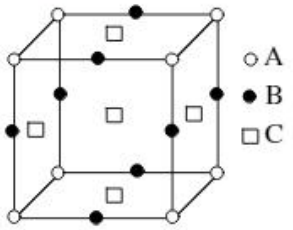
LEVEL-II

LECTURE SHEET (ADVANCED)

Straight Objective Type Questions

1. When heated above 916^0C, iron changes its bcc crystalline form to fcc without the change in the radius of atom. The ratio of density of the crystal before heating and after heating is :
   a) 1.069 b) 0.918 c) 0.725 d) 1.231
2. In an atomic bcc, what fraction of edge is not covered by atoms ?
   a) 0.32 b) 0.16 c) 0.134 d) 0.268

3. Given : The unit cell structure of compound is shown below:



The formula of compound is

a) $A_8B_{12}C_5$ b) AB_2C_3 c) $A_2B_2C_5$ d) ABC_5

4. How many unit cells are present in 4.0 gm of crystal AB (formula mass of AB = 40) having rock salt type structure ? (N_A = Avogadro's no.)

a) N_A b) $\frac{N_A}{10}$ c) $4N_A$ d) none of these

5. The density of CaF_2 (fluorite structure) is 3.18 g/cm^3. The length of the side of the unit cell is

a) 253 pm b) 344 pm c) 546 pm d) 273 pm

More than One correct answer Type Questions

6. Select the correct statement(s)

a) Co-ordination no. of an atom at a lattice point in simple cubic arrangement is 6

b) Co-ordination no. of an atom at octahedral site is 8

c) Co-ordination no. of an atom at a lattice point in hcp arrangement is 6

d) Co-ordination no. of an atom at octahedral site is 6

7. Packing fraction of an identical solid sphere is 74% in:

a) simple cubic structure b) fcc structure c) hcp structure d) bcc structure

8. In fcc structure octahedral sites are present at:

a) edge centers b) face centers c) body centers d) corners

Linked Comprehension Type Questions

Passage-I :

Packing fraction of a unit cell is defined as the fraction of the total volume of the unit cell ooccupied by the atom(s)

$$P.F. = \frac{\text{Volume of the atom(s) present in a unit cell}}{\text{Volume of unit cell}} = \frac{Z \times \frac{4}{3}\pi r^3}{a^3}$$

and % of empty space = 100 – P.F. × 100

where Z = effective number of atoms in a cube;

r = radius of an atom; a = edge length of the cube.

9. % of empty space in body centered cubic unit cell is nearly:

a) 52.36 b) 68 c) 32 d) 26

10. Packing fraction in face centered cubic unit cell is:

a) 0.7406 b) 0.6802 c) 0.5236 d) none of these

Matrix Matching Type Questions

11.

Column-I	Column-II
A) For spinel structure $(TV/OV)_{occupied}$	p) 2 : 1
B) For spinel structure $(TV/OV)_{unoccupied}$	q) 1 : 2
C) For inverse spinel structure $(TV/OV)_{occupied}$	r) 7 : 2
D) For inverse spinel structure $(TV/OV)_{unoccupied}$	s) 2 : 7

12.

Column-I	Column-II
A) Tetragonal and Hexagonal	p) are two crystal systems
B) Cubic and Rhombohedral	q) $\alpha = \beta = \gamma$
C) Monoclinic and Triclinic	r) $a \neq b \neq c$
D) Cubic and Orthorhombic	s) $a = b = c$

PRACTICE SHEET (ADVANCED)

Straight Objective Type Questions

1. An ionic compound is expected to have octahedral structure if r_c/r_a ($r_c < r_a$) lies in the range of
a) 0.414 to 0.732 b) 0.732 to 0.82 c) 0.225 to 0.414 d) 0.15 to 0.225

2. If the anions (A) from hexagonal closest packing and cations (C) occupy only 2/3 octahedral voids in it, then the general formula of the compound is:
a) CA b) CA_2 c) C_2A_3 d) C_3A_2

3. Which of the following statements is correct in the rock-salt structure of an ionic compound?
a) Co-ordination number of cation is four and anion is six
b) Co-ordination number of cation is six and anion is four
c) Co-ordination number of each cation and anion is four
d) Co-ordination number of each cation and anion is six

4. The co-oridnation number of cation and anion in fluorite CaF_2 and anti-fluorite Na_2O are respectively:
a) 8 : 4 and 6 : 3 b) 6 : 3 and 4 : 4 c) 8 : 4 and 4 : 8 d) 4 : 8 and 8 : 4

5. When anion leaves the normal lattice site and electron occupies interstitial sites in its crystal lattice, it is called :
a) Schottky defect b) Frenkel defect c) Metal excess defect d) Stoichiometric defect

6. Ferrous oxide has a cubic structure and edge length of the unit cell is 5.0 $\overset{o}{A}$. Assuming the density of ferrous oxide to be 3.84 g/cm^3, the no. of Fe^{2+} and O^{2-} ions present in each unit cell be : (use $N_A = 6 \times 10^{23}$)
a) $4Fe^{2+}$ and $4O^{2-}$ b) $2Fe^{2+}$ and $2O^{2-}$ c) $1Fe^{2+}$ and $1O^{2-}$ d) $3Fe^{2+}$ and $4O^{2-}$

7. The distance between an octahedral and tetrahedral void in fcc lattice would be:
a) $\sqrt{3}a$ b) $\frac{\sqrt{3}a}{2}$ c) $\frac{\sqrt{3}a}{3}$ d) $\frac{\sqrt{3}a}{4}$

8. How many effective Na^+ and Cl^- ions are present respectively in a unit cell of NaCl solid (Rock salt structure) if all ions along line connecting opposite face centres are absent?
a) 3,3 b) $\frac{7}{2}$, 4 c) $\frac{7}{2}, \frac{7}{2}$ d) 4, $\frac{7}{2}$

9. A crystal is made of particles X and Y, X forms fcc packing and Y occupies all the octahedral voids. If all the particles along one body diagonal are removed then the formula of the crystal would be
a) X_4Y_3 b) X_5Y_4 c) X_4Y_5 d) none of these

10. An element X (atomic weight = 24 gm/mol) forms a face centered cubic lattice. If the edge length of the lattice is 4×10^{-8} cm and the observed density is 2.40×10^3 kg/m^3, then the percentage occupancy of lattice points by element X is: (Use $N_A = 6 \times 10^{23}$):
a) 96 b) 98 c) 99.9 d) none of these

More than One correct answer Type Questions

11. Select the correct statement(s):
a) The ionic crystal of AgBr may have Schottky defect
b) The unit cell having crystal parameters, $a = b \neq c$, $\alpha = \beta = 90^0$, $\gamma = 120^0$ is hexagonal
c) In ionic compounds having Frenkel defect the ratio r^+/r^- is high
d) The co-ordination number of Na^+ ion in NaCl is 6

12. Select the correct statement(s)
a) Co-ordination no. of Cs^+ and Cl^- are 8, 8 in CsCl crytal
b) If radius ratio $(r_c/r_a) < 0.225$ then shape of compound must be linear
c) If radius ratio (r_c/r_a) lies between 0.414 to 0.732 then shape of ionic compound may be square planer (Ex. $PtCl_4^{2-}$)
d) If radius ratio is less than 0.155 then shape of compound is linear

Linked Comprehension Type Questions

Passage :

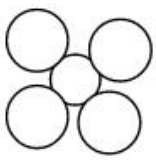
AX, AY, BX and BY have rock salt type structure with following internuclear distances

Salt	*Anion-anion distance in A°*	*Cation-anion distance in A°*
AX	*2.40*	*1.70*
AY	*1.63*	*1.15*
BX	*2.66*	*1.88*
BY	*2.09*	*1.48*

13. Ionic radii of A^+ and B^+, respectively, are
a) 0.68 and 0.35A° b) 0.35 and 0.68A° c) 1.20 and 0.80A° d) 0.80 and 1.20A°

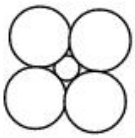
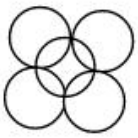
14. Ionic radii and X^- and Y^- respectively, are
a) 0.35 and 0.68A° b) 1.20 and 0.80A° c) 0.68 and 0.35A° d) 0.80 and 1.20A°

15. The structure given below is of



a) AY, BX BY and KCl b) AY, BX c) AY, BX, BY d) AX

16. Which of the following structure is, respectively by AX ?

a)  b)  c)  d) 

Integer Type Questions

17. In seven possible crystal system how many crystal system have more than one Bravais lattice?

18. Calculate the value of $\frac{Z}{10}$. Where Z = Co-ordination number of 2D- Square close packing + Coordination number of 2D-hcp + Co-ordination number of 3D-square close packing + Coordination number of 3D, ABCABC .... packing + Co-ordination number of 3D, ABAB .... Packing

KEY SHEET (ADDITIONAL PRACTICE EXERCISE)

LEVEL-I (MAIN)

1) **2**	2) **4**	3) **4**	4) **1**	5) **1**	6) **3**	7) **3**	8) **4**	9) **4**	10) **3**

LEVEL-II

LECTURE SHEET (ADVANCED)

1) **b**	2) **c**	3) **b**	4) **d**	5) **c**	6) **ad**	7) **bc**	8) **ac**	9) **c**	10) **a**

11) **A-q; B-r; C-p; D-p** 12) **A-p; B-ps; C-pr; D-pq**

PRACTICE SHEET (ADVANCED)

1) **a**	2) **c**	3) **d**	4) **c**	5) **c**	6) **a**	7) **d**	8) **a**	9) **b**	10) **a**
11) **abd**	12) **acd**	13) **b**	14) **b**	15) **a**	16) **a**	17) **4**	18) **4**		