Additional Problems for Self Practice (APSP)

✍ **Marked questions are recommended for Revision.**

This Section is not meant for classroom discussion. It is being given to promote self-study and self testing amongst the Resonance students.

PART - I : PRACTICE TEST-1 (IIT-JEE (MAIN Pattern))

Max. Marks: 100 **Max. Time : 1 Hour**

Important Instructions:

A. General :

1. The test paper is of **1** hour duration.
2. The Test Paper consists of **25** questions and each questions carries **4** Marks. Test Paper consists of **Two** Sections.

B. Test Paper Format and its Marking Scheme:

1. Section-1 contains **20** multiple choice questions. Each question has four choices (1), (2), (3) and (4) out of which **ONE** is correct. For each question in Section-1, you will be awarded 4 marks if you give the corresponding to the correct answer and zero mark if no given answers. In all other cases, minus one **(–1)** mark will be awarded.
2. Section-2 contains **5** questions. The answer to each of the question is a **Numerical Value**. For each question in Section-2, you will be awarded 4 marks if you give the corresponding to the correct answer and zero mark if no given answers. No negative marks will be answered for incorrect answer in this section. In this section answer to each question is **NUMERICAL VALUE** with two digit integer and decimal upto two digit. If the numerical value has more than two decimal places **truncate/round-off** the value to **TWO** decimal placed.

SECTION-1

This section contains **20** multiple choice questions. Each questions has four choices (1), (2), (3) and (4) out of which Only **ONE** option is correct.

1. In a lattice of X and Y atoms, if X atoms are present at corners and Y atoms at the body centre & one X atom is removed from a corner from each unit cell, then the formula of the compound will be :
(1) X_7Y (2) X_8Y_7 (3) X_7Y_8 (4) X_7Y_7

2. When NaCl crystal is heated in sodium vapors, then it attains yellow colour. It is due to :
(1) electrons trapped in cation vacancies.
(2) F-centres, which is electron trapped in anion vacancy created by Cl^-.
(3) F-centres, which is cation trapped in cation vacancy created by Na^+.
(4) interstitial defect caused by external impurity.

3. 1 g of X has atoms arranged in cubic packing so as to give best packing efficiency. The possible arrangement is :
(1) simple cubic (2) face centred cubic
(3) body certred cubic (4) hexagonal close packing

4. ✍ If x = radius of Na^+ & y = radius of Cl^- & a is the unit cell edge length for NaCl crystal, then which of the given relation is correct ?
(1) x + y = a (2) 2x + 2y = a (3) x + y = 2a (4) x + y = $\sqrt{2a}$

5. The lattice of CaF_2 is called fluorite structure. $SrCl_2$ has fluorite structure. Which of the following statements is true for $SrCl_2$?
(1) Sr^{2+} are at the corners and face centres of the cubic arrangment
(2) Sr^{2+} are arranged in bcc lattice
(3) a^- are arranged in fcc lattice
(4) Cl^- occupy octahedral holes in the lattice.

6. The most unsymmetrical system is :
(1) Cubic (2) Hexagonal (3) Triclinic (4) Orthorhombic

7. Schottky defect occurs mainly in electrovalent compounds where :
(1) positive ions and negative ions are of different size
(2) positive ions and negative ions are of same size
(3) positive ions are small and negative ions are big
(4) posiive ions are big and negative ions are small.

8. An ionic compound is expected to have tetrahedral structure if r_+/r_- lies in the range of :
(1) 0.155 to 0.225 (2) 0.732 to 0.414 (3) 0.414 to 0.732 (4) 0.225 to 0.414

9. Malleability and ductility of metals can be acounted due to :
(1) the capacity of layers of metal ions to slide over the other
(2) the interaction of electrons with metal ions in the other
(3) the presence of electrostatic forces
(4) the crystalline structure of metal

10. A solid compound contains X, Y and Z atoms in a cubic lattice with X atom occupying the corners, Y atoms in the body centred positions and Z atoms at the centres of faces of the unit cell. What is the empirical formula of the compound :
(1) XY_2Z_3 (2) XYZ_3 (3) $X_2Y_2Z_3$ (4) X_8YZ_6

11. In AgBr, there can occur
(1) only schottky defect (2) only Frenkel defect (3) both (1) and (2) (4) None of these

12. In face-centred cubic unit cell, edge length is :
(1) $\frac{4}{\sqrt{3}}r$ (2) $\frac{4}{\sqrt{2}}r$ (3) 2r (4) $\frac{\sqrt{3}}{2}r$

13. In an antifluorite structure, cations occupy :
(1) octahedral voids (2) centre of the cube (3) tetrahedral voids (4) corners of the cube

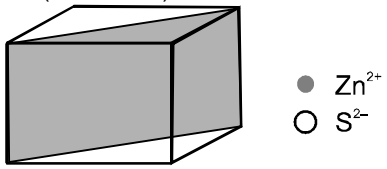
14. The interionic distance for cesium chloride crystal will be :
(1) a (2) a/2 (3) $\sqrt{3}$ a/2 (4) $2a/\sqrt{3}$

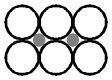
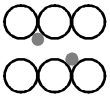
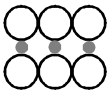
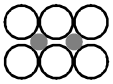
15. A substance A_xB_y crystallizes in a face centred cubic (FCC) lattice in which atoms 'A' occupy each corner of the cube and atoms 'B' occupy the centres of each face of the cube. Identify the correct composition of the substance A_xB_y.
(1) AB_3 (2) A_4B_3
(3) A_3B (4) Composition cannot be specified

16. The number of atoms in 100 g of a fcc crystal with density = 10.0 g/cm^3 and cell edge equal to 200 pm is equal to :
(1) 5×10^{24} (2) 5×10^{25} (3) 6×10^{23} (4) 2×10^{25}

17. In the sphalerite (ZnS) structure, S^{2-} ions form a face-centred cubic lattice. Then Zn^{2+} ions are present on the body diagonals at
(1) $\frac{1}{3}$rd of the distance (2) $\frac{1}{4}$th of the distance
(3) $\frac{1}{6}$th of the distance (4) $\frac{1}{8}$th of the distance

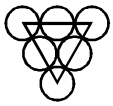
18. In a solid, S^{2-} ions are packed in fcc lattice. Zn^{2+} occupy half of the tetrahedral voids in an alternating arrangement. Now if a plane is cut (as shown) then the cross-section would be :



(1)  (2)  (3)  (4) 

19. **S_1 :** Cubic system have four possible type of unit cells.
S_2 : H_2O is diamagnetic substance and it is weakly attracted in magnetic field.
S_3 : Graphite is a covalent solid with vanderwaal's forces as well.
(1) F F T (2) F T F (3) T F F (4) F F F

20. **S_1 :** Distance between Na^+ & Cl^- in NaCl crystal is more than half of edge length.
S_2 : The no. of triagular viods in the given arrangement in the enclosed region is 3.



S_3 : In ZnS structure, $2Zn^{2+}$ & $2S^{2-}$ ions are present in each unit cell.
(1) F F T (2) F T F (3) T F F (4) F F F

SECTION-2
This section contains **5** questions. Each question, when worked out will result in **Numerical Value**.

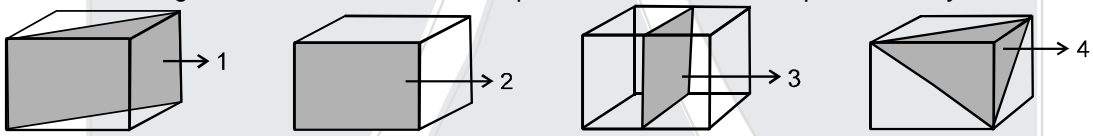
21. The vacant space in B.C.C. unit cell is :

22. In 3D close packed structures, for every 100 atoms, number of octahedral voids will be:

23. The co-ordination number of calcium fluoride (CaF_2) type structure is a : b. Find a + b

24. KCl crystallises in the same type of lattice as does NaCl. Given that $r_{Na^+}/r_{Cl^-} = 0.55$ and $r_{K^+}/r_{Cl^-} = 0.72$. Calculate the ratio of the side of the unit cell of KCl to that of NaCl :

25. In a bcc- arrangement which of the marked planes have maximum spatial density of atoms ?



Practice Test-1 (IIT-JEE (Main Pattern))

OBJECTIVE RESPONSE SHEET (ORS)

Que.	1	2	3	4	5	6	7	8	9	10
Ans.										
Que.	11	12	13	14	15	16	17	18	19	20
Ans.										
Que.	21	22	23	24	25					
Ans.										

PART - II : JEE (MAIN) OFFLINE PROBLEMS (PREVIOUS YEARS)

1. Na and Mg crystallize in BCC and FCC type crystals respectively, then the number of atoms of Na and Mg present in the unit cell of their respective crystal is **[AIEEE-2002, 3/225]**
(1) 4 and 2 (2) 9 and 14 (3) 14 and 9 (4) 2 and 4

2. How many unit cells are present in a cube-shaped ideal crystal of NaCl of mass 1.00g?
[Atomic masses : Na = 23, Cl = 35.5] **[AIEEE-2003, 3/225]**
(1) 2.57×10^{21} (2) 5.14×10^{21} (3) 1.28×10^{21} (4) 1.71×10^{21}.

3. What type of crystal defect is indicated in the diagram below? **[AIEEE-2004, 3/225]**

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

(1) Frenkel defect (2) Schottky defect
(3) interstitial defect (4) Frenkel and Schottky defects

4. An ionic compound has a unit cell consisting of A ions at the corners of a cube and B ions on the centers of the faces of the cube. The empirical formula for this compound would be **[AIEEE-2005, 1½/225]**

(1) AB (2) A_2B (3) AB_3 (4) A_3B

5. Total volume of atoms present in a face-center cubic unit cell of a metals (r is atomic radius). **[AIEEE-2006, 3/165]**

(1) $\frac{20}{3}\pi r^3$ (2) $\frac{24}{3}\pi r^3$ (3) $\frac{12}{3}\pi r^3$ (4) $\frac{16}{3}\pi r^3$

6. In a compound, atoms of element Y form ccp lattice and those of element X occupy 2/3rd of tetrahedral voids. The formula of the compound will be **[AIEEE-2008, 3/105]**

(1) X_2Y_3 (2) X_2Y (3) X_3Y_4 (4) X_4Y_3

7. Copper crystallises in fcc with a unit cell length of 361 pm. What is the radius of copper atom ? **[AIEEE-2009, 8/144]**

(1) 127 pm (2) 157 pm (3) 181 pm (4) 108 pm

8. The edge length of a face centred cubic cell of an ionic substance is 508 pm. If the radius of the cation is 110 pm, the radius of the anion is **[AIEEE-2010, 4/144]**

(1) 288 pm (2) 398 pm (3) 618 pm (4) 144 pm

9. Percentages of free space in cubic close packed structure and in body centered packed structure are respectively. **[AIEEE-2010, 4/144]**

(1) 30% and 26% (2) 26% and 32% (3) 32% and 48% (4) 48% and 26%

10. In a face centred cubic lattice, atom A occupies the corner positions and atom B occupies the face centre positions. If one atom of B is missing from one of the face centred points, the formula of the compound is: **[AIEEE-2011, 4/120]**

(1) A_2B (2) AB_2 (3) A_2B_3 (4) A_2B_5

11. Copper crystallises in fcc lattice with a unit cell edge of 361 pm. The radius of copper atom is: **[AIEEE-2011, 4/120]**

(1) 108 pm (2) 128 pm (3) 157 pm (4) 181 pm

12. Lithium forms body centred cubic structure. The length of the side of its unit cell is 351 pm. Atomic radius of the lithium will be : **[AIEEE-2012, 4/120]**

(1) 75 pm (2) 300 pm (3) 240 pm (4) 152 pm

13. Experimentally it was found that a metal oxide has formula $M_{0.98}O$. Metal M, present as M^{2+} and M^{3+} in its oxide. Fraction of the metal which exists as M^{3+} would be : **[JEE(Main) 2013, 3/120]**

(1) 7.01% (2) 4.08% (3) 6.05% (4) 5.08%

14. CsCl crystallises in body centred cubic lattice. If 'a' its edge length then which of the following expressions is correct ? **[JEE(Main)-2014, 4/120]**

(1) $r_{Cs^+} + r_{Cl^-} = 3a$ (2) $r_{Cs^+} + r_{Cl^-} = \frac{3a}{2}$ (3) $r_{Cs^+} + r_{Cl^-} = \frac{\sqrt{3}}{2}a$ (4) $r_{Cs^+} + r_{Cl^-} = \sqrt{3}a$

15. Sodium metal crystallizes in a body centred cubic lattice with a unit cell edge of 4.29Å. The radius of sodium atom is approximately: **[JEE(Main)-2015, 4/120]**

(1) 1.86Å (2) 3.22Å (3) 5.72Å (4) 0.93Å

16. Which of the following compounds is metallic and ferromagnetic ? **[JEE(Main)-2016, 4/120]**

(1) CrO_2 (2) VO_2 (3) MnO_2 (4) TiO_2

17. A metal crystallises in a face centred cubic structure. If the edge length of its unit cell is 'a', the closest approach between two atoms in metallic crystal will be : **[JEE(Main)-2017, 4/120]**

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

18. Which type of 'defect' has the presence of cations in the interstitial sites ? **[JEE(Main)-2018, 4/120]**

(1) Frenkel defect (2) Metal deficiency defect
(3) Schottky defect (4) Vacancy defect

PART - III : NATIONAL STANDARD EXAMINATION IN CHEMISTRY (NSEC) STAGE-I

1. Number of atoms per unit cell for Body Centered Cubic system is : **[NSEC-2001]**
(A) six (B) four (C) two (D) one

2. Co-ordination number for sodium metal is : **[NSEC-2001]**
(A) 11 (B) 12 (C) 8 (D) 10

3. Sodium chloride crystallises in a face centred cubic lattice in which each **[NSEC-2003]**
(A) sodium ion is tetrahedrally surrounded by 4 chloride ions and each chloride ion is tetrahedrally surrounded by 4 sodium ions
(B) sodium ion is tetrahedrally by 4 chloride ions and each chloride ion is octahedrally surrounded by 6 sodium ions
(C) sodium ion is octahedrally surrounded by 6 chloride ions and each chloride ion is surrounded by 4 sodium ions
(D) sodium ion is octahedrally surrounded by 6 chloride ions and each chloride ion is octahedrally surrounded by 6 sodium ions.

4. An element crystallises in a face centered cubic lattice. Hence, its unit cell contains **[NSEC-2004]**
(A) 14 atoms of the element and 8 of them belong to the unit cell
(B) 14 atoms of the element and 4 of them belong to the unit cell
(C) 8 atoms of the unit cell and only 1 of them belongs to the cell
(D) 8 atoms of the unit cell and only 2 of them belong to the cell

5. Arsenic is used to dope germanium to obtain **[NSEC-2005]**
(A) intrinsic semiconductors (B) p-type semiconductors
(C) n-type semiconductors (D) non-conducting germanium.

6. Carborundum is a **[NSEC-2005]**
(A) molecular solid (B) covalent solid (C) ionic solid (D) amorphous solid.

7. If $a \neq b \neq c$ and $\alpha = \beta = 90^o$, $\gamma \neq 90^o$, the crystal system is called **[NSEC-2005]**
(A) monoclinic (B) triclinic (C) hexagonal (D) orthorhombic.

8. The number of units cells in 117.0 grams of NaCl is approximately **[NSEC-2006]**
(A) 12×10^{20} (B) 3×10^{23} (C) 6×10^{23} (D) 1×10^{24}

9. In the unit cell of the crystal formed by the ionic compound of X and Y, the corners are occupied by X and the centers of the faces by Y. The empirical formula of the compound is : **[NSEC-2007]**
(A) XY (B) X_2Y (C) XY_3 (D) X_8Y_6

10. How many nearest neighbours surround each ion in a face-centered cubic lattice of an ionic crystal ? **[NSEC-2008]**
(A) 4 (B) 6 (C) 8 (D) 12

11. A match box exhibits **[NSEC-2008]**
(A) Cubic geometry (B) Monoclinic geometry
(C) Tetragonal geometry (D) Orthorhombic geometry

12. For a face centered cubic lattice, the unit cell content is – **[NSEC-2009]**
(A) 1 (B) 2 (C) 3 (D) 4

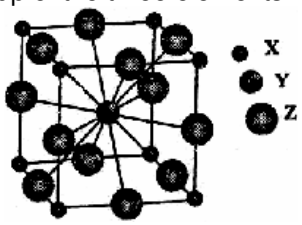
13. Body-centred cubic lattice has a coordination number of : **[NSEC-2010]**
(A) 8 (B) 10 (C) 6 (D) 4

14. If $a \neq b \neq c$ and $\alpha = \beta = \gamma = 90^o$, the crystal system is **[NSEC-2011]**
(A) monoclinic (B) triclinic (C) hexagonal (D) orthorhombic

15. The number of atoms per unit cell and number of the nearest neighbour in a body centred cubic structure are : **[NSEC-2011]**
(A) 4, 12 (B) 2, 6 (C) 9, 6 (D) 2, 8

16. Ionic salt AX grows in face centered cubic lattice with cell length 'a'. The ratio r_{A^+}/r_{X^-} for this salt will be **[NSEC-2014]**
(A) 0.155 (B) 0.225 (C) 0.414 (D) 0.732

17. The unit cell of a compound made up of the three elements X, Y and Z is given below.



The formula of this compound is : **[NSEC-2014]**

(A) X_2YZ_3 (B) XY_3Z (C) XYZ_3 (D) X_3YZ_2

18. The metal M crystallizes in a body centered lattice with cell edge 400 pm. The atomic radius of M is. **[NSEC-2015]**

(A) 200pm (B) 100pm (C) 173pm (D) 141pm

19. Ice crystallizes in a hexagonal lattice. At ascertain low temperature, the lattice constants are a = 4.53 Å and c = 7.41 Å. The number of H_2O molecules contained in a unit cell (d ≈ 0.92 g cm^{-3} at the given temperature) is **[NSEC-2015]**

(A) 4 (B) 8 (C) 12 (D) 24

20. One mole crystal of a metal halide of the type MX with molecular weight 119 g having face centered cubic structure with unit cell length 6.58 Å was recrystallized. The density of the recrystallized crystal was found to be 2.44 g cm^{-3}. The type of defect introduced during the recrystalization is **[NSEC-2015]**

(A) a ditional M^+ and X^- ions at interstitial sites (B) Schottky defect
(C) F-centre (D) Frenkel defect

21. An ionic solid LaI_2 shows electrical conduction due to presence of : **[NSEC-2016]**

(A) La^{2+} and $2I^-$ (B) La^{3+}, $2I^-$ and e^- (C) La^{2+}, I_2 and $2e^-$ (D) La^{3+}, I_2 and $3e^-$

22. In a cubic crystal structure, divalent metal-ion is located at the body-centered position, the smaller tetravalent metal ions are located at each corner and the O^{2-} ions are located half way along each of the edges of the cube. The number of nearest neighbour for oxygen is : **[NSEC-2016]**

(A) 4 (B) 6 (C) 2 (D) 8

23. HgO is prepared by two different methods: one shows yellow colour while the other shows red colour. The difference in colour is due to difference in **[NSEC-2016]**

(A) electronic d-d transitions (B) particle size
(C) Frenkel defect (D) Schottkey defect

24. When NiO is doped with a small quantity of Li_2O **[NSEC-2017]**

(A) both cation and anion vacancies are generated
(B) Shottky defects are generated
(C) NiO becomes an n-type semiconductor
(D) NiO becomes a p-type semiconductor

25. A crystal of KCl containing a small amount of $CaCl_2$ will have **[NSEC-2018]**

(A) vacant Cl^- sites
(B) vacant K^+ sites and a higher density as compared to pure KCl
(C) vacant K^+ sites and a lower density as compared to pure KCl
(D) K^+ ions in the interstitial sites

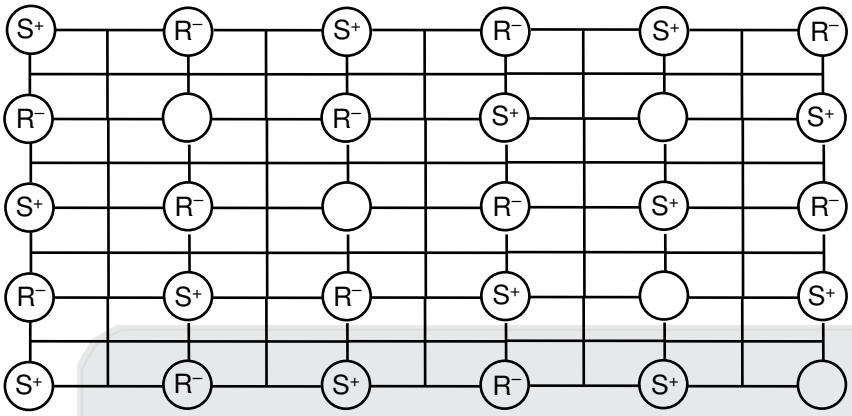
26. A scientist attempts to replace a few carbon atoms in 1.0 g of diamond with boron atoms or nitrogen atoms in separate experiments. Which of the following is correct ? **[NSEC-2018]**

(A) The resulting material with B doping will be an n-type semiconductor
(B) The resulting material with B doping will be an p-type semiconductor
(C) B doping is NOT possible as B cannot from multiple bonds
(D) The resulting material with N doping will be a p-type semiconductor

27. A solid comprises of three types of elements, 'P', 'Q' and 'R'. 'P' forms an FCC lattice in which 'Q' and 'R' occupy all the tetrahedral voids and half the octahedral voids respectively. The molecular formula of the solid is **[NSEC-2019]**

(A) P_2Q_2R (B) PQ_2R_4 (C) P_4Q_2R (D) P_4QR

28. The crystal defect indicated in the diagram below is **[NSEC-2019]**



(A) Frenkel defect
(B) Schottky defect
(C) Frenkel and Schottky defects
(D) Interstitial defect

PART - IV : HIGH LEVEL PROBLEMS (HLP)

ONLY ONE OPTION CORRECT TYPE

1. Consider a cube 1 of Body Centered Cubic unit cell of edge length a now atom at the body center can be viewed to be lying on the corner of another cube 2.Find the volume common to cube 1 and cube 2.

(A) $\frac{a^3}{27}$ (B) $\frac{a^3}{64}$ (C) $\frac{a^3}{2\sqrt{2}}$ (D) $\frac{a^3}{8}$

2. In an arrangement of type ABABA... (HCP), identical atoms of I layer A and III layer A are joined by a line passing through their centers. Suggest the correct statement.
(A) No void is found on the line
(B) Only Tetrahedral voids are found on the line
(C) Only octahedral voids are found on the line
(D) Equal number of tetrahedral and octahedral voids are found on the line

3. Square packed sheets are arranged on the top of other such that a sphere in the next layer rests on the center of a square in the previous layer. Identify the type of arrangement and find the the coordination number.
(A) Simple Cubic, 6
(B) Face Centered Cubic, 8
(C) Face Centered Cubic, 12
(D) Body Centered Cubic, 8

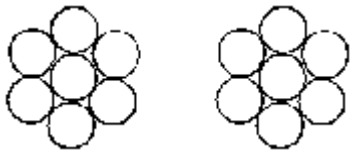
4. Given an alloy of Cu, Ag and Au in which Cu atoms constitute the CCP arrangement.If the hypothetical formula of the alloy is Cu_4Ag_3Au. What are the probable locations of Ag and Au atoms.
(A) Ag - All tetrahedral voids; Au - all octahedral voids
(B) Ag - $3/8^{th}$ tetrahedral voids; Au - $1/4^{th}$ octahedral voids
(C) Ag - 1/2 octahedral voids; Au - 1/2 tetrahedral voids
(D) Ag - all octahedral voids; Au - all tetrahedral voids

5. The distance between adjacent, oppositely charged ions in rubidium chloride is 3.285 Å; in potassium chloride is 3.139Å; in sodium bromide is 2.981 Å and in potassium bromide is 3.293 Å. The distance between adjacent oppositely charged ions in rubidium bromide is :
(A) 3.147 Å (B) 3.385 Å (C) 3.393 Å (D) 3.439 Å

6. Zinc sulphide exists in two different forms-zinc blende and wurtzite. Both occur as 4:4 co-ordination compounds. Choose the correct option from among the following :
(A) zinc blende has a bcc structure and wurtzite an fcc structure
(B) zinc blende has an fcc structure and wurtzite an hcp structure
(C) zinc blende as well as wurtzite have a hcp structure
(D) zinc blende as well as wurtzite have a cpp structure

SINGLE AND DOUBLE VALUE INTEGER TYPE

7. The 2 D unit cell of an element is shown. The two layers are placed one over the other and touching each other. Find the effective number of atoms in the unit cell :



8. The density of solid argon is 1.65 g/mL at – 233ºC. If the argon atom is assumed to be sphere of radius 1.54×10^{-8} cm, what percentage of solid argon is apparently empty space ? (At. wt. of Ar = 40)

9. How many number of tetrahedral voids are completely inside the HCP unit cell.

10. How many number of atoms present in half of HCP unit cell.

11. Let $MgTiO_3$ exists in pervoskite structure. In this lattice, all the atoms of one of the face diagonals are removed. Calculate the density of unit cell if the radius of Mg^{2+} is 0.7 Å and the corner ions are touching each other. [Given atomic mass of Mg = 24, Ti = 48]

12. A mineral having the formula AB_2, crystallises in the cubic close - packed lattice, with the A atoms occupying the lattice points. The co-ordination number of the A atoms is x, that of B atoms is y. Report your answer (x – y).

ONE OR MORE THAN ONE OPTIONS CORRECT TYPE

13. Which of the following is not true about the voids formed in 3 dimensional hexagonal close packed structure?
(A) A tetrahedral void is formed when a sphere of the second layer is present above triangular void in the first layer.
(B) All the triangular voids are not covered by the spheres of the second layer.
(C) Tetrahedral voids are formed when the triangular voids in the second layer lie above the triangular voids in the first layer and the triangular shapes of these voids do not overlap.
(D) Octahedral voids are formed when the triangular voids in the second layer exactly overlap with similar voids in the first layer.

14. The co-ordination number of FCC structure for metals is 12, since
(A) each atom touches 4 others in same layer, 3 in layer above and 3 in layer below.
(B) each atom touches 4 others in same layer, 4 in layer above and 4 in layer below.
(C) each atom touches 6 others in same layer, 3 in layer above and 3 in layer below.
(D) each atom touches 3 others in same layer, 6 in layer above and 6 in layer below.

15. Three lines are drawn from a single corner of an FCC unit cell to meet the other corner such that they are found to pass through exactly only 1 octahedral void, no voids of any type and exactly 2 tetrahedral voids with 1 octahedral void. Identify the line?
(A) Edge length (B) Body diagonal (C) Face diagonal
(D) A line which passes through only two face centres of opposite faces

PART - V : PRACTICE TEST-2 (IIT-JEE (ADVANCED Pattern))

Max. Time : 1 Hr. **Max. Marks : 66**

Important Instructions

A. General :
1. The test is of 1 hour duration.
2. The Test Booklet consists of 22 questions. The maximum marks are 66.

B. Question Paper Format :
3. Each part consists of five sections.
4. Section-1 contains 7 multiple choice questions. Each question has four choices (A), (B), (C) and (D) out of which ONE is correct.

5. Section-2 contains 5 multiple choice questions. Each question has four choices (A), (B), (C) and (D) out of which ONE OR MORE THAN ONE are correct.
6. Section-3 contains 6 questions. The answer to each of the questions is a single-digit integer, ranging from 0 to 9 (both inclusive).
7. Section-4 contains 1 paragraphs each describing theory, experiment and data etc. 3 questions relate to paragraph. Each question pertaining to a partcular passage should have only one correct answer among the four given choices (A), (B), (C) and (D).
8. Section-5 contains 1 multiple choice questions. Question has two lists (list-1 : P, Q, R and S; List-2 : 1, 2, 3 and 4). The options for the correct match are provided as (A), (B), (C) and (D) out of which ONLY ONE is correct.

C. Marking Scheme :

9. For each question in Section 1, 4 and 5 you will be awarded 3 marks if you darken the bubble corresponding to the correct answer and zero mark if no bubble is darkened. In all other cases, minus one (–1) mark will be awarded.
10. For each question in Section 2, you will be awarded 3 marks. If you darken all the bubble(s) corresponding to the correct answer(s) and zero mark. If no bubbles are darkened. No negative marks will be answered for incorrect answer in this section.
11. For each question in Section 3, you will be awarded 3 marks if you darken only the bubble corresponding to the correct answer and zero mark if no bubble is darkened. No negative marks will be awarded for incorrect answer in this section.

SECTION-1 : (Only One option correct Type)

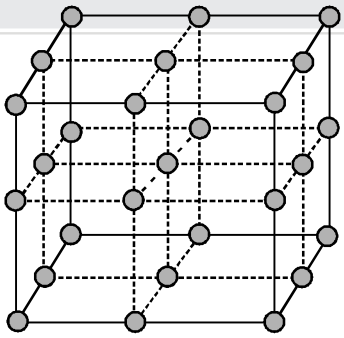
This section contains 7 multiple choice questions. Each questions has four choices (A), (B), (C) and (D) out of which Only ONE option is correct.

1. In a square close packing pattern, one atom is in contact with how many atoms in the 2-D plane base?
(A) 2 (B) 4 (C) 6 (D) 8

2. In a face centerd lattice of X and Y, X atoms are present at the corners while Y atoms are at face centers. Then the formula of the compound would be if one of the X atoms is missing from a corner in each unit cell
(A) X_7Y_{24} (B) $X_{24}Y_7$ (C) XY_{24} (D) $X_{24}Y$

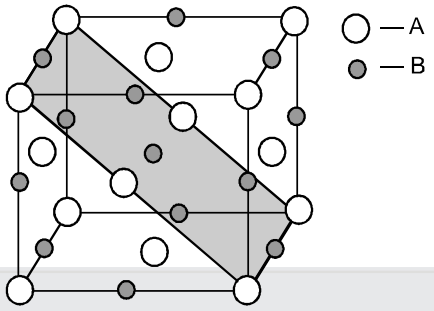
3. In a ccp structure of X atoms, Y atoms occupy all the octahedral holes. If 2X atom are removed from corners and replaced by Z, then the formula of the compound will be :
(A) $X_{15}Y_{16}Z$ (B) X_7Y_8Z (C) $X_{7.5}\ Y_8Z$ (D) $X_8Y_8Z_3$

4. The following diagram shows arrangement of lattice point with a = b = c and $\alpha = \beta = \gamma = 90^\circ$.
Choose the correct options.



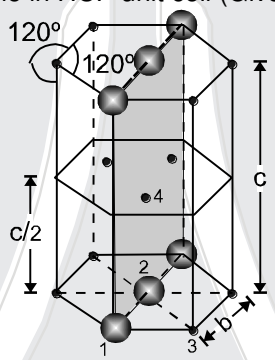
(A) The arrangement is SC with each lattice point surrounded by 6 nearest neighbours.
(B) The arrangement is SC with each lattice point surrounded by 8 nearest neighbours.
(C) The arrangement is FCC with each lattice point surrounded by 12 nearest neighbours.
(D) The arrangement in BCC with each lattice point surrounded by 8 nearest neighbours

5. A crystal is made of particles A and B. A forms FCC packing and B occupies all the octahedral voids. If all the particles along the plane as shown in figure are removed, then, the formula of the crystal would be :



(A) AB (B) A_5B_7 (C) A_7B_5 (D) None of these.

6. Calculate the perimeter of given plane in HCP unit cell (Given that radius of atoms = R Å).



(A) 6.437 R (B) 15.32 R (C) 16 R (D) None of these

7. $MgAl_2O_4$, is found in the Spinal structure in which O^{2-} ions constitute CCP lattice, Mg^{2+} ions occupy 1/8th of the Tetrahedral voids and Al^{3+} ions occupy 1/2 of the Octahedral voids.
Find the total +ve charge contained in one unit cell.
(A) +7/4 electronic charge (B) +6 electronic charge
(C) +2 electronic charge (D) +8 electronic charge

Section-2 : (One or More than one options correct Type)

This section contains 6 multipole choice questions. Each questions has four choices (A), (B), (C) and (D) out of which ONE or MORE THAN ONE are correct.

8. Lead metal has a density of 11.34 g/cm^3 and crystallizes in a face–centered lattice. Choose the correct alternatives
(A) the volume of one unit cell is 1.214×10^{-22} cm^3
(B) the volume of one unit cell is 1.214×10^{-19} cm^3
(C) the atomic radius of lead is 175 pm
(D) the atomic radius of lead is 155.1 pm

9. Given that interionic distance in Na^+, F^- crystal is 2.31Å and r_{F^-} = 1.36Å, which of the following predictions will be right
(A) $r_{Na^+}/r_{F^-} \approx 0.7$
(B) coordination number of Na^+ = coordination nunber of F^- = 6
(C) Na^+, F^- will have rock salt type crystal structure
(D) effective nuclear charge for Na^+ and F^- are equal

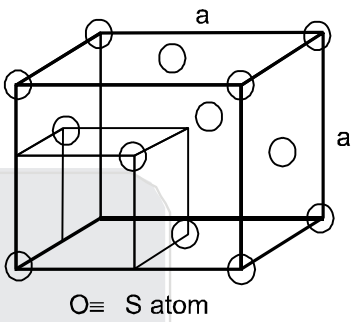
10. Which of the following statement(s) for crystal having schottky defect is/are correct.
(A) Schottky defect arises due to absence of cations & anion from positions which they are expected to occupy.
(B) The density of crystal having shottky defect is smaller than that of perfect crystal.
(C) Schottky defect are more common in co-valent compound with higher co-ordination number.
(D) The crystal having shottky defect is electrically neutral as a whole.

11. For each of the following substances, identify the intermolecular force or forces that predominate. Using your knowledge of the relative strengths of the various forces, rank the substances in order of their normal boiling points. Al_2O_3, F_2, H_2O, Br_2, ICl, NaCl

(A) $F_2 < Br_2 <$ ICl (B) $H_2O <$ NaCl $< Al_2O_3$

(C) ICl $< H_2O$ (D) $H_2O <$ ICl

12. The ZnS zinc blende structure is cubic. The unit cell may be described as a face-centered sulfide ion sublattice with zinc ions in the centers of alternating minicubes made by partitioning the main cube into 8 equal parts (as shown in fig.)



(a) How many nearest neighbors does each Zn^{2+} have?

(b) How many nearest neighbors does each S^{2-} have?

(c) What angle is made by the lines connecting any Zn^{2+} to any two of its nearest neighbors?

(d) What minimum r_+/r_- ratio is needed to avoid anion-anion contact, if closest cation-anion pairs are assumed to touch ?

(A) C.N. of Zn^{2+} & S^{2-} = 4 & 4 (B) C.N. of Zn^{2+} & S^{2-} = 6 & 6

(C) 109°28' (D) $\frac{r_{Zn^{2+}}}{r_{S^{2-}}} = 0.225$

13. A metal (M), shows ABAB arrangement of atoms in solid state, then what is the relation between radius of atom (r) and edge length (a) and height (c) of HCP unit cell.

(A) $a = 2R$ (B) $c = \left(\sqrt{\frac{2}{3}}\right) 4r$ (C) $c = \left(\sqrt{\frac{3}{2}}\right) 4r$ (D) $a = \left(2\sqrt{2}\right) r$

Section-3 : (One Integer Value Correct Type.)

This section contains 5 questions. Each question, when worked out will result in one integer from 0 to 9 (both inclusive)

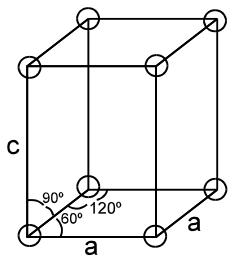
14. A mineral of iron contains an oxide containing 72.36% iron by mass and has a density of 5.2 g/cc. Its unit cell is cubic with edge length of 839 pm. What is the total number of atoms (ions) present in each unit cell ? (Fe - 56, O-16)

15. Percentage of void space in AB solid having rock salt structure if $\frac{r_+}{r_-} = \frac{1}{2}$ having cation anion contact.

Given $\pi = 3.15$.

16. In an ionic solid $r_{(+)} = 1.6$ Å and $r_{(-)} = 1.864$ Å. Use the radius ratio rule to determine the edge length of the cubic unit cell in Å.

17. 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 c = 7.41 Å (as shown in fig.). How many H_2O molecules are contained in a unit cell? (Density of ice = 0.92 gm/cc)



18. A spinal is an important class of oxides consisting of two types of metal ions with the oxides ions arranged in CCP layers. The normal spinal has one-eighth of the tetrahedral holes occupied by one type of metal ion and one-half of the octahedral holes occupied by another type of metal ion. Such a spinal is formed by Zn^{2+}, Al^{3+} and O^{2-} with Zn^{2+} in the tetrahedral holes. If formula of the compound is $Zn_xAl_yO_z$, then find the value of (x + y + z) ?

SECTION-4 : Comprehension Type (Only One options correct)

This section contains 1 paragraphs, each describing theory, experiments, data etc. 3 questions relate to the paragraph. Each question has only one correct answer among the four given options (A), (B), (C) and (D).

Paragraph for Questions 19 to 21

Two dimensional close packed structure can be generated by stacking the rows of close packed spheres. This can be done in two different ways.

(I) The second row may be placed in contact with the first one, such that the spheres of the second row are exactly above those of first row. The spheres of the two rows are aligned vertically as well as horizontally.

If we call the first row as 'A' type of row, the second row being exactly same as the first one is also of 'A' type. Similarly, we may place more rows to obtain AAAA.... type arrangement.

(II) In this type, the second row may be placed above the first one in a staggered manner such that its spheres. fit in depressions of first row. If the arrangement of spheres in the first row is called 'A' type, the one in the second row is different and may be called 'B' type. When the third row is placed adjacent to the second in staggered manner, its spheres are aligned with those of first layer. Hence this layer is also 'A' type. The spheres of similarly placed fourth row will be aligned with those of the second row ('B' type). Hence this arrangement is of ABAB.....type.

19. The type of packing generated by type (I) is :
(A) hexagonal close packing (B) square close packing
(C) cubic close packing (D) body centered packing

20. Of type (I) & type (II), the packing efficiency :
(A) is better in type I (B) is better in type II (C) is same in both (D) can't be compared

21. The types of voids generated in type (I) & (II) respectively are
(A) tetrahedral, octahedral (B) octahedral, tetrahedral
(C) triangular, square (D) square, triangular

SECTION-5 : Matching List Type (Only One options correct)

This section contains 1 questions, each having two matching lists. Choices for the correct combination of elements from List-I and List-II are given as options (A), (B), (C) and (D) out of which one is correct

22. Match list-I with list-II and select the correct answer by using the codes given below:

	List I		**List II**
	(Shapes)		**(Radius ratio)**
P.	Planar triangle	1.	0.732
Q.	Square planar	2.	0.225
R.	Body centered cubic	3.	0.155
S.	Tetrahedral	4.	0.414

Code :

	P	Q	R	S		P	Q	R	S
(A)	3	4	1	2	(B)	3	2	1	4
(C)	2	1	4	3	(D)	1	3	4	2

Practice Test-2 (IIT-JEE (ADVANCED Pattern))

OBJECTIVE RESPONSE SHEET (ORS)

Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Ans.										
Que.	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Ans.										
Que.	**21**	**22**								
Ans.										

APSP Answers

PART – I

1.	(3)	**2.**	(2)	**3.**	(2)	**4.**	(2)	**5.**	(1)
6.	(3)	**7.**	(2)	**8.**	(4)	**9.**	(1)	**10.**	(2)
11.	(3)	**12.**	(2)	**13.**	(3)	**14.**	(3)	**15.**	(1)
16.	(1)	**17.**	(2)	**18.**	(2)	**19.**	(1)	**20.**	(4)
21.	32	**22.**	100	**23.**	12	**24.**	1.123	**25.**	1

PART – II

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

PART – III

1.	(C)	**2.**	(C)	**3.**	(D)	**4.**	(B)	**5.**	(C)
6.	(B)	**7.**	(A)	**8.**	(B)	**9.**	(C)	**10.**	(D)
11.	(D)	**12.**	(D)	**13.**	(A)	**14.**	(D)	**15.**	(D)
16.	(B)	**17.**	(C)	**18.**	(C)	**19.**	(C)	**20.**	(B)
21.	(B)	**22.**	(C)	**23.**	(B)	**24.**	(D)	**25.**	(C)
26.	(B)	**27.**	(A)	**28.**	(B)				

PART – IV

1.	(D)	**2.**	(B)	**3.**	(C)	**4.**	(B)	**5.**	(D)
6.	(B)	**7.**	3	**8.**	62	**9.**	8	**10.**	3
11.	≈ 65 g/cm^3	**12.**	4 (8 – 4)	**13.**	(CD)	**14.**	(BC)	**15.**	(ABC)

PART – V

1.	(B)	**2.**	(A)	**3.**	(A)	**4.**	(A)	**5.**	(A)
6.	(D)	**7.**	(D)	**8.**	(AC)	**9.**	(ABC)	**10.**	(ABD)
11.	(ABC)	**12.**	(ACD)	**13.**	(AB)	**14.**	56	**15.**	30
16.	4	**17.**	4 water molecules			**18.**	7 = (1 + 2 + 4)	**19.**	(B)
20.	(B)	**21.**	(D)	**22.**	(A)				

APSP Solutions

PART – I

1. At corner $= \frac{1}{8}$ (for per atom)

$\Rightarrow X_{1-\frac{1}{8}} Y$ (one X atom removed)

$\Rightarrow X_{7/8}\, y$

$\Rightarrow x_7y_8$

2. When NaCl crystal is heated in sodium vapors, then it attains yellow colour. It is due to F-centres, which is electron trapped in anion vacancy created by Cl^-.

3. Packing efficiency of ccp is 74% so it best packing is cubic packing.

4. $2(r^+ + r^-) = a$ or $r^+ = x$ = radius of Na^+

$2(x + y) = a$ $r^- = y$ = radius of Cl^-

5. Sr^{2+} are at the corners and face centre of the cubic arrangement.

6. Triclinic $a \neq b \neq c$

$\alpha \neq \beta \neq \gamma$

7. Schottky defect ocure in electrovalent compound which has same bond size positive and negative ion.

8. For tetrahedral void r_+/r- range will be $0.225 \leq \frac{r^+}{r^-}$ 0.414.

9. Malleability and ductility is tendency of metal ion layer Slide over the other layer.

10. At corner $= \frac{1}{8}$ × (for per atom) $= \frac{X}{8} \times 8$

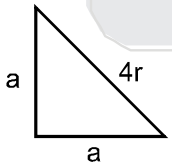
At body center = 1 × (for per atom) = Y

At face center $= \frac{1}{2}$ × (for per atom) $= \frac{Z}{2} \times 6$

Simple ration of all there XYZ_3

11. AgBr show schottky and frenkel defect.

12.



$(4r)^2 = a^2 + a^2$

$a = \frac{4}{\sqrt{2}} r$

13. In antifluorite structure anion form F.C.C. structure and cation occupy all tetrahedral void.

14. CsCl have simple cubic structure. In this structure body idagenal of simple cube $\sqrt{3}\, a = 2 \times (r_{Cs^+} + r_{Cl^-})$

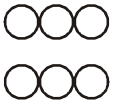
So interionic distance = $2 \times (r_{Cs^+} + r_{Cl^-})$

15. A at corner $= \frac{1}{8} \times 8 \times A = A$

B at face center $= \frac{1}{2}$ × 6 × B = 3B = AB_3

16. $d = \frac{Z \times M}{N_A a^3} \quad \Rightarrow \quad N_A = \frac{4 \times 100}{10 \times (2 \times 10^{-8})^3} = 5 \times 10^{24}$ (here : 200 Pm = 2×10^{-8} cm.)

18. S^{2-} ion form fcc lattice

$\longrightarrow$ Zn^{+2} ion ocupy alternate four tetrahedral void i.e. 

19. Cubic system have three unit cell
(1) Simple cubic (2) F.C.C. (3) B.C.C
H_2O is a paramagnetic substance.
Graphit is a covalent soid in layer form. In these layer vanderwaal's forces present.

20. S_1 : edge length = $2(r_{Na^+} + r_{Cl^-})$
distance b/w Na^+ and Cl^- is less than edge length
S_2 : 4 triangular void.
S_3 : In Zns structure $4Zn^{+2}$ and $4s^{-2}$ present in each unit cell.

21. Packing efficiency = $\frac{2 \times \frac{4}{3}\pi R^3}{\left(\frac{4R}{\sqrt{3}}\right)^3} = \frac{\sqrt{3}\pi}{8} = 68\%$

vacent space = 100 – 68 = 32 %

22. In 3D close packed structure for every 100 atoms it contain 100 octahedral voids.

23. C.N. of Cu^{2+} ion = 8
C.N. of F^- ion = 4
$\therefore$ C.N. of CaF_2 type structure is = 8 : 4

24. NaCl and KCl has octahedral structure

$\frac{r_{Na^+}}{r_{Cl^-}} = 0.55$ and $\frac{r_{K^+}}{r_{Cl^-}} = 0.74$

In octahedral edge length = $r_{cation} + r_{anion}$

$\frac{r_{Na^+} + r_{Cl^-}}{r_{Cl^-}} = 1.55$ .....(1)

$\frac{r_{K^+} + r_{Cl^-}}{r_{Cl^-}} = 1.74$ .....(2)

a = edge length of KCl octahedral.
$a = r_{K^+} + r_{Cl^-}$
b = edge length of NaCl octahedral
$b = r_{Na^+} + r_{Cl^-}$

$\frac{a}{b} = \frac{r_{K^+} + r_{Cl^-}}{r_{Na^+} + r_{Cl^-}} = \frac{1.74}{1.55} = 1.123$

PART – II

1. BCC - points are at corners and one in the center of the unit cell.

Number of atoms per unit cell = $8 \times \frac{1}{8} + 1 = 2$

FCC - Points are at the corners and also center of the six faces of each cell.

Number of atoms per unit cell = $8 \times \frac{1}{8} + 6 \times \frac{1}{2} = 4$.

2. mass (m) = density × volume = 1.00 g
Mol. wt. (M) of NaCl = 23 + 15.5 = 58.5
Number of unit cells present in a cube shaped crystal of NaCl of

mass 1.00 g = $\frac{\rho \times a^3 \times N_A}{M \times Z} = \frac{m \times N_A}{M \times Z} = \frac{1 \times 6.023 \times 10^{23}}{58.5 \times 4}$

(In NaCl each unit cells has 4 NaCl units. Hence Z = 4)

$\therefore$ Number of unit cells = $0.02573 \times 10^{23} = 2.57 \times 10^{21}$ unit cells.

3. When an atom or ion is missing from its normal lattice site, a lattice vacancy is created. This defect is known as Schottky defect. Here equal number of Na^+ and Cl^- ions are missing from their regular lattice position in the crystal. So it is Schottky defect.

4. Number of A ions per unit cell = $\frac{1}{8} \times 8 = 1$

Number of B ions per unit cell = $\frac{1}{2} \times 6 = 3$ Empirical formula = AB_3.

5. In case of a face-centerd cubic structure, since four atoms are present in a unit cell, hence volume.

$V = 4\left(\frac{4}{3}\pi r^3\right) = \frac{16}{3}\pi r^3$

6. According to question : Number of Y atom in ccp unit cell = 4

Number of X atom in ccp unit cell = $8 \times \frac{2}{3} = \frac{16}{13}$

Formula of compound = $X_{16/3}Y_4 = X_{16}Y_{12} = X_4Y_3$

7. In fcc unit cell $4r = \sqrt{2}a$ [r = radius of Cu atom, a = edge length]

So, $r = \frac{\sqrt{2}a}{4}$

$r = \frac{\sqrt{2} \times 361}{4} = 127$ pm.

8.  $2 \times 110 + 2 \times r_- = 508$

$2r_- = 288$
$r_- = 144$ pm

9. Packing fraction of CCP = $\frac{\pi}{3\sqrt{2}} = 0.74 \Rightarrow 74\%$

$\therefore$ Percentage of free space in CCP = 100 – 74 = 26%

Packing fraction of BCC = $\frac{\pi\sqrt{3}}{8} = 0.68 \Rightarrow 68\%$

$\therefore$ Percentage of free space in BCC = 100 – 68 = 32%

10. $A_{8\times\frac{1}{8}}$ $B_{5\times\frac{1}{2}}$

Formula of compound A_2B_5.

11. FCC lattice
a = 361 pm
$a\sqrt{2} = 4r$

$r = \frac{361 \times \sqrt{2}}{4} = 127.6 \approx 128$ pm.

12. For BCC structure $\sqrt{3}\ a = 4r$ $r = \frac{\sqrt{3}}{4}a = \frac{\sqrt{3}}{4} \times 351 = 152$ pm.

13. $M_{0.98}O$

Consider one mole of the oxide.

Moles of M = 0.98, Moles of O^{2-} = 1

Let moles of M^{3+} = x

$\Rightarrow$ Moles of M^{2+} = 0.98 – x

$\Rightarrow$ Doing charge balance

(0.98 – x) × 2 + 3x – 2 = 0

$\Rightarrow$ 1.96 – 2x + 3x – 2 = 0

$\Rightarrow$ x = 0.04

$\Rightarrow$ % of $M^{3+} = \frac{0.04}{0.98} \times 100 = 4.08\%$

14. In CsCl, Cl^- lie at corners of simple cube and Cs^+ at the body centre.

Hence, along the body diagonal, Cs^+ & Cl^- touch each other so $\frac{\sqrt{3}a}{2} = r_{Cs^+} + r_{Cl^-}$

15. $R = \frac{\sqrt{3}}{4} a = 1.86$ Å

16. NCERT based (Solid state).

17. For FCC, $\sqrt{2}a = 4R$

So, $2R = \frac{a}{\sqrt{2}}$

18. Frenkel Defect.

PART – IV

1. Common Volume = $\left(\frac{a}{2}\right)^3 = \frac{a^3}{8}$ [$\therefore$ Common vol is a cube of edge length $\frac{a}{2}$]

2. Only tetrahedral, since there is one tetrahedral voids just above the atom & one just below the atom.

3. Unit cell is face centered cubic so coordination number is 12.

4. Cu_4 Ag_3 Au

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Froms c.c.p., $\frac{3}{8}^{th}$ of tetrahedral voids, $\frac{1}{4}$ of octahedral voids [$\therefore$ No. of O- voids = 4]

z = 4 , [$\therefore$ No. of T- voids = 8].

5. $\left(r_{Rb^+} + r_{Cl^-}\right) + \left(r_{K^+} + r_{Br^-}\right) - \left(r_{K^+} + r_{Cl^-}\right) = \left(r_{Rb^+} + r_{Br^-}\right)$

3.285 + 3.293 – 3.139 = 3.439.

6. These are isomorphous.

7. Number of atoms in 2D unit cells = $\frac{1}{3}$ × 6 + 1 × 1 = 3.

8. Volume of one atom of Ar = $\frac{4}{3}\pi r^3$

Also, number of atoms in 1.65 g or one mL = $\frac{1.65}{40} \times 6.023 \times 10^{23}$

$\therefore$ Total volume of all atoms of Ar in solid state

$= \frac{4}{3} \pi r^3 \times \frac{1.65}{40} \times 6.023 \times 10^{23} = \frac{4}{3} \times \frac{22}{7} \times (1.54 \times 10^{-8})^3 \times \frac{1.65}{40} \times 6.023 \times 10^{23} = 0.380 \text{ cm}^3$

Volume of solid argon = 1 cm^3

$\therefore$ % empty space = $\frac{[1-0.380]}{1} \times 100 = 62\%$

10. $3 \times \frac{1}{2} + \frac{1}{6} \times 6 + \frac{1}{2} \times 1 = 3$

11. No. of Mg^{2+} per unit cell = 8 [At corners] $\times \frac{1}{8} = 1$

No. of Ti per unit cell = 1 [body center] $\times \frac{1}{1} = 1$

No of O per unit cell = 6 [Face center] $\times \frac{1}{2} = 3$

So formula = $MgTiO_3$

Atom are removed along face diagonal

No. of Mg^{2+} = 6[At corner] $\times \frac{1}{8} = \frac{6}{8} = \frac{3}{4}$

No. of Ti per unit cell = 1 [Body center] $\times \frac{1}{1} = 1$

No. of O per unit cell = 5 [Face center] $\times \frac{1}{2} = \frac{5}{2}$

So formula of compound = $Mg_{\frac{3}{4}}TiO_{\frac{5}{2}}$

Formula mass = $24 \times \frac{3}{4} + 48 + 16 \times \frac{5}{2} = 18 + 48 + 40 = 106$ amu

As corner ion are touching so = $a = 2\ r_{Mg^{2+}} = 2 \times 0.7 = 1.4$ Å

$d = \frac{\text{mass}}{\text{Volume}} = \frac{106 \times 1.67 \times 10^{-24}}{(1.4)^3 \times 10^{-24}}$ g/cm^3 = 64.5 g/cm^3 $\approx$ 65 g/cm^3

12. It is fluorite (CaF_2) structure. Since formula is AB_2

$\Rightarrow$ No. of B atoms is twice the no. of A atoms. Hence B occupies all the tetrahedral voids (100%).

AB_2 is (8 : 4) compound (Fluorite Structure Compound)

↓ ↓

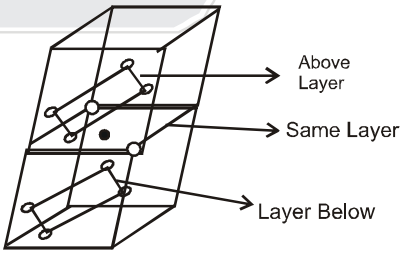
C.N. of A C.N. of B.

14. FCC can be viewed in two following ways -

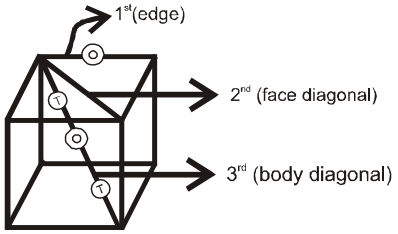
(i) Planes along the faces (and parallel to it) of the unit cell.

$\Rightarrow$ Each atom touches 4 in same layer, 4 in layer above and 4 in layer bellow it.

(ii) Planes along closest packed spheres $\rightarrow$ each atom touches 6 atom in same layer, 3 in layer above and 3 in layer below it.



15.



PART – V

1. Coordination number of square packing pattern is 4.

2. No. of X atom per unit cell = $7 \times \frac{1}{8} = \frac{7}{8}$

No. of Y atom per unit cell = $6 \times \frac{1}{2} = 3$

$\therefore$ Formula = $X_{7/8}\ Y_3$ or $X_7\ Y_{24}$.

4. According to figure, it shows a simple cubic lattice. Now observe the center atom, its has 6 nearest neighbours

5. In new arrangement, A particles = $\left(\frac{1}{8}\times 8+\frac{1}{2}\times 6\right) - \left(\frac{1}{8}\times 4+\frac{1}{2}\times 2\right) = \frac{5}{2}$

& B particles = $\left(\frac{1}{4}\times 12+1\right) - \left(1+\frac{1}{4}\times 2\right) = \frac{5}{2}$

So, formula is AB

6. Perimeter of plane is = 2C + 8R = $\frac{2\times 4\sqrt{2}R}{3} + 8R = 11.77\ R$

7. Total positive charge = Charge on Mg^{2+} + Charge on Al^{3+} = $\frac{1}{8} \times 8 \times 2 + \frac{1}{2} \times 4 \times 3 = 8$ electronic charge.

8. $\text{Density} = \frac{Z \times M}{N_A \times \text{volume}}$

so, $\text{Volume} = \frac{4 \times 207}{6.02 \times 10^{23} \times 11.34} = 1.213 \times 10^{-22}\ cm^3; 4r = a\sqrt{2}$

$r = \frac{4.95 \times 10^{-8} \times \sqrt{2}}{4} = 175\ pm$

$\text{Volume} = a^3 = 1.213 \times 10^{-22}$

so, $a = (1.213 \times 10^{-24})^{1/3}$

$a = 4.95 \times 10^{-8}$ cm.

9. Na^+ & F^- are isoelectronic hence they will have same screening const (s) but not the effective nuclear charge.

$\therefore$ $r_{Na^+}/r_{F^-} \approx 0.7$ (coordination = 6, rock salt structure)

10. Schottky defect is only observed in ionic compound.

11. $A\ell_2O_3$ – ionic Br_2 – vanderwaal F_2 – vanderwaal

ICl – dipole dipole H_2O – dipole - dipole (H–bonding) NaCl – ionic,

$F_2 < Br_2 < ICl < H_2O < NaCl < Al_2O_3$

12. (a) As each Zn^{2+} ion is present in tetrahedral void. So it is coordination number is = 4.
(b) Similarly S^{2-} ion have coordination number = 4.
(c) As Zn^{2+} ion is present in tetrahedral void that's why line's connecting any two nearest neighbour and Zn^{2+} have angle = 109º28'.

(d) For tetrahedral voids radius ratio is $\frac{r_{Zn^{2+}}}{r_{S^{2-}}} = 0.225$.

13. $a = 2R,\ c = \sqrt{\frac{2}{3}}\ 2a = \sqrt{\frac{2}{3}}\ 4r$

14. $\frac{72.36}{56}$ 'Fe', $\frac{27.64}{16}$ 'O' $\Rightarrow$ 1.292 'Fe', 1.7275 'O'

Hence proportion is 1 : 1.33; So Empirical formula is Fe_3O_4 , Empirical formula mass = 232 amu
Now if there are x formula units in the unit cell

$$5.2 = \frac{\frac{x(232)}{6.02 \times 10^{23}}}{(8.39 \times 10^{-8})^3} \quad \Rightarrow \quad x = 7.9688$$

Hence number of ions in the unit cell = 56

15. $r_+ + r_- = \frac{a}{2} \quad \Rightarrow \quad \frac{3r_-}{2} = \frac{a}{2}$; $r_- = \frac{a}{3}$ and $r_+ = \frac{a}{6}$

$$\text{Packing fraction} = \frac{4 \times \frac{4}{3}\pi(r_+^3 + r_-^3)}{a^3} = \frac{4 \times \frac{4}{3}\pi\left[\left(\frac{a}{6}\right)^3 + \left(\frac{a}{3}\right)^3\right]}{a^3} = 0.7.$$

Percentage void = 30%.

16. $\frac{r_+}{r_-} = \frac{1.6}{1.864} = 0.858$

So, it is CsCl type unit cell

So $\sqrt{3}\, a = 2(r_+ + r_-)$

So $a = \frac{2(1.864 + 1.6)}{\sqrt{3}}$ Å = 2 x 2Å = 4Å

17. $d = \frac{Z \times M}{N_0 \times \text{Volume}}$ $\Rightarrow 0.92 = \frac{Z \times 18}{6.02 \times 10^{23}\left[\frac{6\sqrt{3}a^2}{4} \times c\right]}$

$$\Rightarrow \quad 0.92 = \frac{Z \times 18}{6.02 \times 10^{23}\left[\frac{6\sqrt{3}}{4} \times (4.53)^2 \times 7.41 \times 10^{-24}\right]} \quad \Rightarrow Z = 4.$$

18. $O_4\, Zn_{\frac{1}{8}\times 8}\, Al_{\frac{1}{2}\times 4}$

So, formula is $ZnAl_2O_4$.

22.

Radius ratio	Types of structure	Coordination No.
$r_+/r_- < 0.155$	linear void	2
$0.155 \le r_+/r_- < 0.225$	triangular void	3
$0.225 \le r_+/r_- < 0.414$	tetrahedral void	4
$0.414 \le r_+/r_- < 0.732$	octahedral void	6
$0.732 \le r_+/r_- < 1$	cubical void	8