O-I

SINGLE CORRECT :

1. Which of the following are the correct axial distances and axial angles for rhombohedral system ?

(A) $a = b = c, \alpha = \beta = \gamma \neq 90^0$ (B) $a = b \neq c, \alpha = \beta = \gamma = 90^0$

(C) $a \neq b = c, \alpha = \beta = \gamma = 90^0$ (D) $a \neq b \neq c, \alpha \neq \beta \neq \gamma \neq 90^0$

Cubic	$a=b=c$	$\alpha=\beta=\gamma=90^\circ$	S, BC, FC
Tetragonal	$a=b\neq c$	$\alpha=\beta=\gamma=90^\circ$	S, BC
Orthorhombic	$a\neq b\neq c$	$\alpha=\beta=\gamma=90^\circ$	S, BC, FC, EC
Monoclinic	$a\neq b\neq c$	$\alpha=\gamma=90^\circ,\ \beta\neq 90^\circ$	S, EC
Hexagonal	$a=b\neq c$	$\alpha=\beta=90^\circ,\ \gamma=120^\circ$	S
Rhombohedral	$a=b=c$	$\alpha=\beta=\gamma\neq 90^\circ$	S
Triclinic	$a\neq b\neq c$	$\alpha\neq\beta\neq\gamma\neq 90^\circ$	S

Total = 14.

2. $a \neq b \neq c, \alpha \neq \beta \neq \gamma \neq 90^0$ represents

(A) tetragonal system (B) orthorhombic system

(C) monoclinic system (D) triclinic system

from above table.

3. Diamond belongs to the crystal system :

(A) Cubic ✓ (B) triclinic (C) tetragonal (D) hexagonal

Diamond = FCC, two atoms at 1 lattice point

⇒ Cubic

4. A match box exhibits -

(A) Cubic geometry (B) Monoclinic geometry

(C) Tetragonal geometry (D) Orthorhombic geometry ✓

for match box, $a \neq b \neq c$ and $\alpha = \beta = \gamma = 90°$

⇒ orthorhombic

5. Which of the following solids substances will have same refractive index when measured in different directions?

⇒ Amorphous.

(A) NaCl → Crystalline (B) Monoclinic sulphur

(C) Rubber → Amorphous ✓ (D) Graphite

Only Rubber is amorphous.

6. An ionic compound has a unit cell consisting of A ions at the corners of a cube and B ions on the centres of the faces of the cube. The empirical formula of this compound would be-**[AIEEE-05]**

(A) A_2B (B) AB (C) A_3B (D) AB_3 ✓

A → At cornor ⇒ $8 \times \frac{1}{8} = 1$

B → At face centre ⇒ $6 \times \frac{1}{2} = 3$

} ⇒ Compound is AB_3.

7. In the body-centred cubic unit cell & face centred cubic unit cell, the radius of atom in terms of edge lengh(a) of the unit cell is respectively:

(A) $\frac{a}{2}, \frac{a}{2\sqrt{2}}$ (B) $\frac{a}{2\sqrt{2}}, \frac{\sqrt{3}a}{4}$ (C) $\frac{\sqrt{3}a}{4}, \frac{a}{2\sqrt{2}}$ (D) $\frac{\sqrt{3}a}{2}, \frac{a}{2\sqrt{2}}$

In bcc, $\sqrt{3}a = 4R \Rightarrow R = \frac{\sqrt{3}}{4}a$.

In fcc, $\sqrt{2}a = 4R = R = \frac{a}{2\sqrt{2}}$.

8. Crystal system in which maximum number of Bravais lattices are possible is

(A) Cubic (B) Triclinic (C) Orthorhombic (D) Rhombohedral

In orthorhombic all the four types simple, body centred, face centred and end centred unit cells are present.

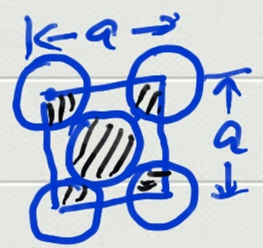
9. Number of atoms at second nearest position from a given atom in a BCC structure is

(A) 8 (B) 6 (C) 12 (D) 4

In BCC	distance	no. of atoms
Nearest	$\sqrt{3}a/2$	8
Next nearest	a	6

10. Percentage area of each face covered by atoms in a FCC unit cell is -

(A) 60.4% (B) 68% (C) 74% (D) 78.5%



Face of FCC.

$Z = 4 \times \frac{1}{4} + 1 = 2$

$\eta = \frac{Z \times \pi R^2}{a^2} = \frac{2 \times \pi R^2}{(2\sqrt{2}R)^2} = \frac{\pi}{4} = 78.5\%$.

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

$\Rightarrow a = 2\sqrt{2}R$.

11. Correct sequence of the coordination number in SC, FCC & BCC is-

(A) 6, 8, 12 (B) 6, 12, 8 (C) 8, 12, 6 (D) 8, 6, 12

[AIEEE-02]

Lattice	C.N	distance
SC	6	
FCC	12	
BCC	8	

12. The no. of atoms per unit cell in B.C.C. & F.C.C. is respectively : **[AIEEE-02]**

(A) 8, 10 (B) 2, 4 (C) 1, 2 (D) 1, 3

In BCC, $Z = 8\times\frac{1}{8} + 1 = 2 \Rightarrow \boxed{Z=2}$

In FCC, $Z = 8\times\frac{1}{8} + 6\times\frac{1}{2} = 4 \Rightarrow \boxed{Z=4}$

13. Total volume of atoms present in a face-centred cubic unit cell of a metal is (r is atomic radius) :

[AIEEE-06]

(A) $\frac{24}{3}\pi r^3$ (B) $\frac{12}{3}\pi r^3$ (C) $\frac{16}{3}\pi r^3$ (D) $\frac{20}{3}\pi r^3$

In FCC, $Z=4$ $\therefore$ Vol of 4 atoms $= 4\times\frac{4}{3}\pi r^3 = \frac{16}{3}\pi r^3$.

14. Percentages of free space in cubic close packed structure and in body centred packed structure are respectively :- **[AIEEE-10]**

(A) 48% and 26% (B) 30% and 26% (C) 26% and 32% (D) 32% and 48%

In CCP, $\eta = 74\% \Rightarrow$ void $= 26\%$.

In bcc, $\eta = 68\% \Rightarrow$ void $= 32\%$.

15. If 'Z' is the number of atoms in the unit cell that represents the closest packing sequence ---A B C A B C ---, the number of tetrahedral voids in the unit cell is equal to

(A) Z (B) 2Z (C) Z/2 (D) Z/4

no. of T.V./unit cell $= 2Z$.

16. The interstitial hole is called tetrahedral because

(A) It is formed by four spheres.

(B) Partly same and partly different.

(C) It is formed by four spheres the centres of which form a regular tetrahedron. → correct.

(D) None of the above three.

17. The size of an octahedral void formed in a closest packed lattice as compared to tetrahedral void is

(A) Equal (B) Smaller (C) Larger (D) Not definite

18. If the anions (A) form 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

Size: T.V. < O.V. < Cubic void.

$A \rightarrow$ CCP $\Rightarrow 6$

$C \rightarrow \frac{2}{3} \times O.V. = \frac{2}{3} \times 6 = 4$

$\Rightarrow$ formula is A_6C_4

$\Rightarrow A_3C_2 \Rightarrow C_2A_3$.

19. 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-08]**

(A) X_4Y_3 (B) X_2Y_3 (C) X_2Y (D) X_3Y_4

$Y \rightarrow$ CCP $\Rightarrow 4$

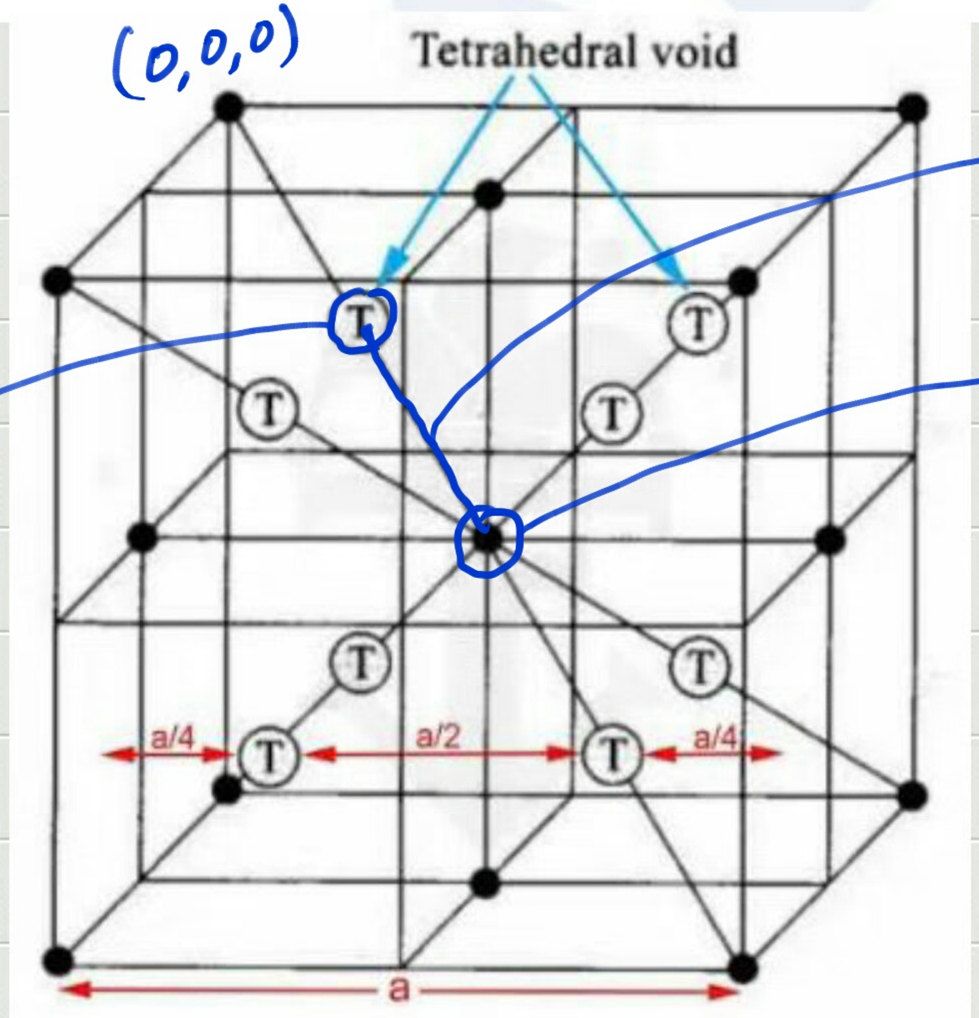
$X \rightarrow \frac{2}{3} \times T.V. = \frac{2}{3} \times 8 = \frac{16}{3}$

$\Rightarrow X_{\frac{16}{3}}Y_4 \Rightarrow X_{16}Y_{12}$

$\Rightarrow X_4Y_3$.

20. In fcc unit cell smallest distance between octahedral void & tetrahedral void is -
(a = edge length of unit cell)

(A) $\frac{a}{\sqrt{2}}$ (B) $\frac{\sqrt{3}a}{2}$ (C) a (D) $\frac{\sqrt{3}a}{4}$



(0,0,0)

T.V. $(\frac{a}{4},\frac{a}{4},\frac{a}{4})$

O.V. $(\frac{a}{2},\frac{a}{2},\frac{a}{2})$

Distance = $\frac{\sqrt{3}a}{4}$

$$\text{Distance} = \sqrt{\left(\frac{a}{2}-\frac{a}{4}\right)^2+\left(\frac{a}{2}-\frac{a}{4}\right)^2+\left(\frac{a}{2}-\frac{a}{4}\right)^2}$$

$$= \sqrt{\left(\frac{a}{4}\right)^2+\left(\frac{a}{4}\right)^2+\left(\frac{a}{4}\right)^2}$$

$$= \frac{\sqrt{3}a}{4}$$

21. What is not true regarding hexagonal close packing (hcp)

(A) packing fraction is 0.74

(B) coordination number is 12

(C) ABC ABC.....type packing

(D) Containing both tetrahedral and octahedral voids

In HCP, Pattern = ABABABAB ---- , $\eta = 0.74$, C.N. = 12,

Z = 6, O.V. = 6, T.V. = 12.

22. In which of the following arrangement distance between two nearest neighbours is maximum, considering identical sized atoms in all arrangements ?

(A) Simple cubic (B) bcc (C) fcc (D) equal in all

= R = same.

Distance between two nearest neighbours is always equal to 2R. ⇒ same.

23. How many unit cell are there in 1 gram cubic crystal of NaCl ?

(A) $\frac{4\times N_A}{58.5}$ (B) $\frac{N_A}{58.5}$ (C) $\frac{N_A}{58.5\times 4}$ (D) $\frac{N_A}{58.5\times 8}$

no. of unit cell = $\frac{\text{no. of molecules}}{4} = \frac{1\times N_A}{58.5\times 4}$.

24. How many unit cells are present in a cube-shaped ideal crystal of NaCl of mass 1.00g ?

(A) 1.28×10^{21} unit cells (B) 1.71×10^{21} unit cells **[AIEEE-03]**

(C) 2.57×10^{21} unit cells (D) 5.14×10^{21} unit cells

$$\text{no. of unit cells} = \frac{\text{no. of molecules}}{4} = \frac{1 \times 6 \times 10^{23}}{58.5 \times 4} = 2.57 \times 10^{21}$$

25. 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-10]**

(A) 144 pm (B) 288 pm (C) 398 pm (D) 618 pm

$a = 508\,pm$, $r^+ = 110\,pm$, $r^- = ?$

Assume NaCl type lattice $\Rightarrow \frac{a}{2} = r^+ + r^- \Rightarrow \frac{508}{2} = 110 + r^-$

or $r^- = 254 - 110 = 144\,pm.$

26. The coordination number of cation and anion in Fluorite CaF_2 and CsCl are respectively

(A) 8:4 and 6:3 (B) 6:3 and 4:4 (C) 8:4 and 8:8 (D) 4:2 and 2:4

CaF_2 = 8:4 co-ordination and CsCl = 8:8 co-ordination.

27. A compound XY crystallizes in 8 : 8 lattice with unit cell edge lenght of 480 pm. If the radius of Y^- is 225 pm, then the radius of X^+ is

(A) 127.5 pm (B) 190.68 pm (C) 225 pm

(D) 255 pm

8:8 ⇒ CsCl type, $a = 480$ Pm. $Y^- = 225$ Pm.

for CsCl type $\frac{\sqrt{3}a}{2} = r_{X^+} + r_{Y^-}$

or, $\frac{\sqrt{3} \times 480}{2} = r_{X^+} + 225$

or, $r_{X^+} = 190.68$ Pm.

28. The mass of a unit cell of CsCl corresponds to

(A) 1 Cs^+ and 1 Cl^- (B) 1 Cs^+ and 6 Cl^- (C) 4 Cs^+ and 4 Cl^- (D) 8 Cs^+ and 1 Cl^-

for CsCl, $Z = 1$ ⇒ (A) is correct.

29. An ionic compound AB has ZnS type structure. If the radius A^+ is 22.5 pm, then the ideal radius of B^- would be

(A) 54.35 pm ✓(B) 100 pm (C) 145.16 pm (D) none of these

for ideal radius in ZnS type:

$$\frac{r_{A^+}}{r_{B^-}} = 0.225 \Rightarrow r_{B^-} = \frac{22.5}{0.225} = 100\,pm.$$

30. Edge length of M^+X^- (NaCl structure) is 7.2 Å. Assuming $M^+ - X^-$ contact along the cell edge, radius of X^- ion is ($r_{M^+} = 1.6Å$) :

✓(A) 2.0 Å (B) 5.6 Å (C) 2.8 Å (D) 38 Å

$a = 7.2A^\circ$, $r_{M^+} = 1.6A^\circ$

$$\frac{a}{2} = r_{M^+} + r_{X^-} \Rightarrow \frac{7.2}{2} = 1.6 + r_{X^-} \Rightarrow r_{X^-} = 2.0\,A^\circ.$$

31. NH_4Cl crystallizes in CsCl type lattice with a unit cell edge length of 387 pm. The distance between the oppositively charged ions in the lattice is

✓(A) 335.1 pm (B) 83.77 pm (C) 274.46 pm (D) 137.23 pm

$a = 387\,pm$, $r_{NH_4^+} + r_{Cl^-} = \frac{\sqrt{3}a}{2} = \frac{\sqrt{3}\times 387}{2} = 335.1\,pm.$

32. $r_{Na^+} = 95$ pm and $r_{Cl^-} = 181$ pm in NaCl (rock salt) structure. What is the shortest distance between Na^+ ions?

(A) 778.3 pm (B) 276 pm (C) 195.7 pm (D) 390.3 pm ✓

For NaCl, $\frac{a}{2} = r_{Na^+} + r_{Cl^-} \Rightarrow a = 2(95+181) = 552$ pm.

Shortest distance bet^n two Na^+ ions $= \frac{a}{\sqrt{2}} = \frac{552}{\sqrt{2}} = 390.3$ pm.

33. AB crystallises itself as NaCl crystal. If $r_+ = \frac{2}{\sqrt{6}}$ and $r_- = \sqrt{6}$, the edge length of cube is

(A) $2\sqrt{3}$ (B) $\frac{4}{\sqrt{3}}$ (C) $\frac{8}{\sqrt{6}}$ (D) $\frac{16}{\sqrt{6}}$ ✓

$\frac{a}{2} = r_+ + r_- \Rightarrow a = 2\left(\frac{2}{\sqrt{6}} + \sqrt{6}\right) = 2\left(\frac{2+6}{\sqrt{6}}\right) = \frac{16}{\sqrt{6}}$

34. Which of the following is the most likely to show schottky defect ?

(A) CaF_2 (B) ZnS (C) AgCl (D) CsCl ✓

Schottky defect is common in alkali metal halides.

35. In the Schottky defect, in AB type ionic solids

(A) cations are missing from the lattice sites and occupy the interstitial sites

(B) equal number of cations and anions are missing

(C) anions are missing and electrons are present in their place

(D) equal number of extra cations and electrons are present in the interstitial sites

Schottky defect is a stoichiometric defect, so equal no. of cations and anions are missing.

36. Choose the correct option.

(A) Two adjacent face centre atom doesn't touch each other in fcc unit cell because they are not nearest atom of face each other in fcc lattice

(B) Number of nearest Na^+ ions of another Na^+ in Na_2O crystal will be 24.

(C) Minimum distance between two cubical voids in simple cube unit cell lattice will be 'a' where 'a' is length of edge of unit cell

(D) By defects in solids, density of solids either remains constant or decreases but it can never increase.

A) wrong, Distance bet^n two adjacent face centred atom

$= \sqrt{2} \times \frac{a}{2} = \frac{a}{\sqrt{2}} = 2R \Rightarrow$ touching. ($\because$ for FCC, $a = 2\sqrt{2}R$)

B) no. of nearest Na^+ ions of another Na^+ is 6 at a distance of $\frac{a}{2}$.

D) density can decrease / increase or remains const.

37. The measured density of AgI is 6.94 g/cm^{-3} and the theoretical density is 5.67 g/cm^{-3}. These data indicate that solid AgI has -

(A) Schottky defect

(B) Frenkel defect

(C) Interstitial impurities defect

(D) Both (A) and (B)

$d_{expt} > d_{Theo} \Rightarrow$ Interstitial defect.

38. Which of the following statement is **CORRECT** ?

(A) A metal can show only non- stoichiometric defects

(B) Schottky defect reduces the density of a solid due to significant increase in volume.

(C) Impurity defect always change the density.

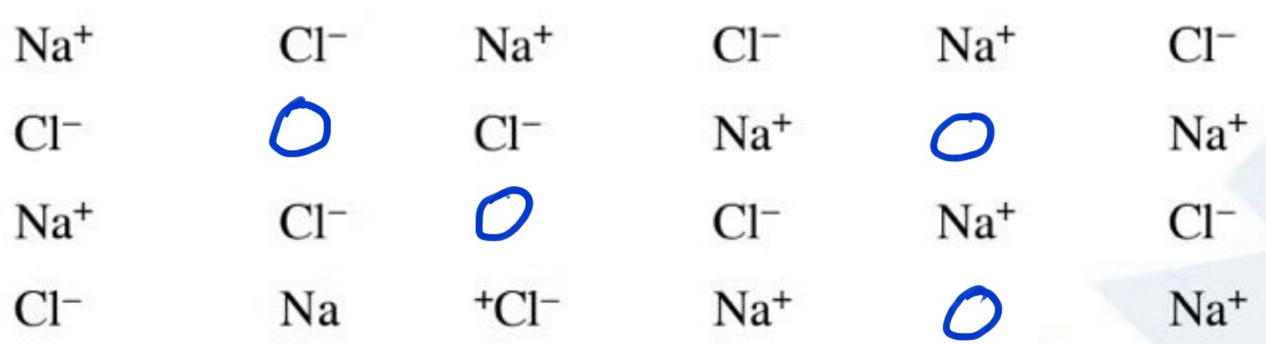
(D) Solids having F-centres may have metal excess defect due to missing anions.

A → Non-stoichiometric defects in metal has no meaning.

B) Schottky defect reduces density because of absence of cations and anions in stoichiometric ratio.

C) Impurity defect may or maynot change the density.

39. What type of crystal defect is indicated in the diagram below ? **[AIEEE-04]**



(A) Frenkel defect

(B) Schottky defect ✓

(C) Interstitial defect

(D) Frenkel and Schottky defects

Two Na^+ and two Cl^- are found missing from the lattice ⇒ Schottky defect.

40. Lattice energy of an ionic compound depends upon - **[AIEEE-05]**

(A) Size of the ion only

(B) Charge on the ion only

(C) Charge on the ion and size of the ion

(D) Packing of ions only

Lattice energy $\propto z^+ z^-$ $\quad z^+$ = charge on cation

z^- = " " anion

Lattice energy $\propto \frac{1}{(r^+ + r^-)}$ $\quad r^+$ = radius of cation

r^- = radius of anion