CHEMISTRY

BOOKS - CENGAGE CHEMISTRY (ENGLISH)

SOLID STATE

Illustration

1. A sample of a crystalline solid scatters a beam of X-rays of wavelength 70.93 pm at an angle 2θ of 14.66°. If this is a second-order reflection $(n = 2)$, calculate the distance between the parallel planers of atoms from which the scattered beam appears to have been reflected.

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2. Calculate λ of X-rays which give a diffraction angle $2\theta = 16.8^\circ$ for crystal, if the interplanar distance in the crystal is $0.2 nm$ and that only for the first-order diffraction is observed. Given $\sin 8.40^\circ = 0.146$.

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3. A compound formed by elements X and Y has a cubic structure in which X atoms are at the corner of the cube and Y atoms are at the face centres. One atoms X is misssing from the corner.

a. Calculate (i). Z_{eff}, (ii). total number of the atoms in the cube, and (iii). formula of the compound.

b. If alll the atoms are removed from one of the faces of the cube containing atoms at corners, as in (a) above, calculate (i) Z_{eff}, (ii) total number of atoms in a cube, and (iii) formula of the compound.

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4. A compound formed by elements X and Y has a cubic structure in which X atoms are at the corners of the cube of and two atoms (Y) are at each body diagonal of the cube.

a. Calculate: (i) Z_{eff}, (ii) total number of atoms in a cube, and (iii) formula of the compound.

b. If all atoms form one body diagonal of the cube except corners are removed, calculate: (i) Z_{eff}, (ii) total number of atoms in the cube, and (iii) formula of the compound.

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5. A compound formed by elements X and Y has a cubic structure in which X atoms are at the corner of the cube and Y atoms are at the face centres. One atoms X is misssing from the corner.

a. Calculate (i). Z_{eff}, (ii). total number of the atoms in the cube, and (iii). formula of the compound.

b. If alll the atoms are removed from one of the faces of the cube containing atoms at corners, as in (a) above, calculate (i) Z_{eff}, (ii) total number of atoms in a cube, and (iii) formula of the compound.

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6. A compound formed by elements X and Y has a cubic structure in which X atoms are at the corner of the cube and also at the face centers. Y atoms are present at the body centre and at the edge centre of the cube.

a. Celculate (i) Z_{eff}, (ii) total number of atoms in the cube, and (iii) formula of the compound.

b. If all the atoms are removed from one of the body diagonals of the cube, calculate (i) Z_{eff}, (ii) total number of atoms in the cube, and (iii) formula of the compound.

c. If all the atoms from the diagonals of the one of the face of the cube are removed, calculate (i) Z_{eff},

(ii) total number of atoms in the cube, and (iii) formula of the compound.

d. If all the atoms are removed from one of the plane passing through the middle of t he cube, calculate (i) Z_{eff}, (ii) total number of atoms in the cube, and (iii) formula of the compound.

e. If all the atoms are removed from one of the axes passing through one of the face centres of the cube, calculate (i) Z_{eff}, (ii) total number of atoms in the cube, and (iii) formula of the compound.

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7. A compound formed by elements X and Y has a cubic structure in which X atoms are at the corner of the cube and also at alternate face entres. Y atoms are present at the body centre and also at the alternate edge centre of the cube.

a. Calculate (i) Z_{eff}, (ii) total number of atoms in the cube, and (iii) formula of the compound.

b. If all the atoms are removed from one of the plane passing through the middle of the cube of the cube which contains atoms both on the edge entre as well as on the face centre, calculate (i) Z_{eff}, (ii) total number of atoms in the cube, (iii) formula of the compound.

c. If all the atoms are removed from the plane passing through the middle of the cube which contains atoms only on the edge centre but not on face centre, calculate (i) Z_{eff}, (ii) total number of atoms in t he cube, and (iii) fomula of the compound.

d. If all the atoms are removed from one of the plane passing through the middle of the cube which neither contains atoms on the edge centre nor on the face centre, calculate (i) Z_{eff}, (ii) total number of atoms in the cube, and (iii) formula of the compound.

e. If all the atoms are removed from on e of the axes passing through the middle of the cube containing face centre atoms, calculate (i) Z_{eff}, (ii) total number of atoms in a cube, and (iii) formula of the compound.

f. If all the atoms are remove from one of the axes passing through the middle of the cube nor containing face centre atoms, calculate (i) Z_{eff}, (ii) total number of atoms in a cube, and (iii) formula of the compound.

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8. Draw a two-dimesnsional haxagonal lattice. Try to visualize the possibility of pentagonal two-dimensional lattice.

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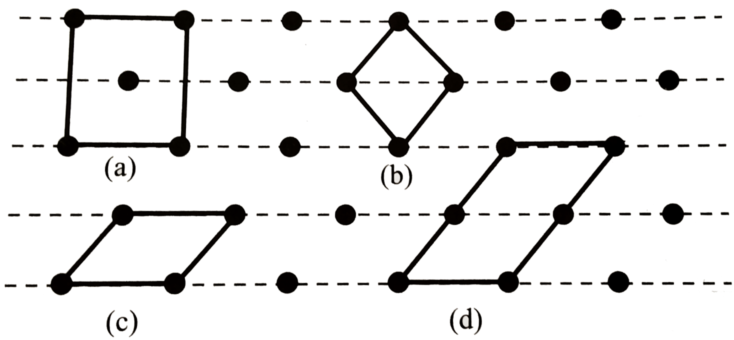
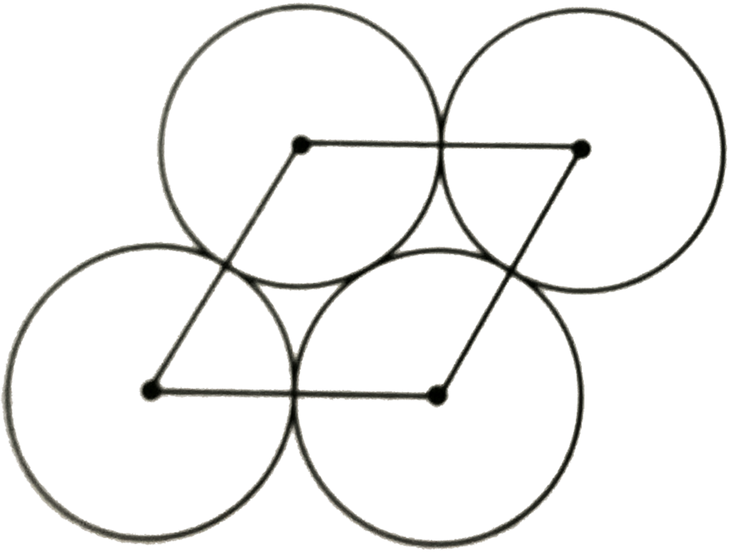
9. Consider the parallelotrams shown in the figure below representing two-dimensional cells.



a. Which of these are primitive and which are multiple unit cells? Are any of these orthogonal?

c. What is the relation between the radius of circle and the length of parallelogram for the unit cell shown in the figure below (space filling diagram)?



d. How many nearest neighbour circles does a given circle have in the second figure abov?

e. What is the radius of the triangular hole shown in the second figure above?

f. What is the packing fraction of the unit cell in the second figure above?

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

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11. Why an end-centred unit cell cannot he cubic? What is the highest possible symmetry for this type of unit cell?

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

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13. Select the close-packing arrangements in the following:

a. ... $ABABABA$ ..., b. ... $ABCABCABCA$ ...

c. ... $ABABCBCABC$ ... , d. ... $ACCBCABCABC$ ...

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14. A compound is formed by two elements X and Y. Atoms of the element Y (as anion) make ccp and those of element X (as cation) occupy all the octahedral voids. What is the formula of the compound?

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15. Atoms of elements B from hep lattice and those of element A occupy two-thirds of tetrahedral voids. What is the formula of the compound formed by elements A and B?

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16. An element has a bcc structure with a cell edge of 288 pm. The density of the element is $7.2 gcm^{-3}$. How many atoms are present in $208g$ of the element?

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

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

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19. Metallic gold crystallizes in the fcc lattice.

The length of the cubic unit cell is $a = 4.242A$.

a. What is the closest distance between gold atoms?

b. How many "nearest neighbours" does each gold atom have at the distance calculated in (a)?

(c) What is the density of gold? (Aw of Au $= 197.0gmol^{-1}$)

d. Prove that the packing factor for gold is 0.74.

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20. If the radius of an atom of an elements is 75 pm and the lattice type is body-centred cubic, what is the edge length of the unit cell?

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21. The radius of an atom of an element is 500 pm. If it crystallizes as a face-centred cubic lattice, what is the length of the side of the unit cell?

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22. Sodium has a bcc structure with nearest neighbour distance of 365.9 pm. Calculate its density. (Atomic mass of sodium $= 23$)

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23. A face-centred cubic element (atomic mass 60) has a cell edge of 400 pm. What is its density?

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24. Xenon crystallizes in the face-centred cubic lattice and the edge of the unit cell is 620 pm. What is the nearest neighbour distance and what is the redius of xenon atom?

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25. In a compound, oxide ions are arranged in $\text{p}.$ One-sixth of the tetrahedral voids are occupied by cations. (A) and one-third of OV_s are occupieed by cations (B). (a) What is the formula of the compound of the compound? (b) What are the charges on A and B ?

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26. A compund is made of two elements P and Q are in p arrangement while atoms P occupy all the tetrahedral voids. What is the formula of the compound?

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27. Two ions $A^{\oplus}$ and B^{Θ} have radii 88 and 200 pm, respectively. In the close-packed crystal of compound AB, predict coodination number of $A^{\oplus}$.

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28. If the close-packed cations in an AB-type solid gave a radius of 75 pm. What would be the maximum and minimum sizes of the anions filling the voids?

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29. If the radii of Mg^{2+}, $Cs^{\oplus}$, O^{2-}, S^{2-}, and CI^{Θ} ions are $0.65, 1.69, 1.40, 1.84,$ and $1.81 Å$, respectively, calculate the coordination number of the cation in the crystals of MgS, MgO, and C_sCI.

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30. Whenever two-demiensional square packing same layers are kept in the way so that the centres are aligned in all three dimensation, coordination numberof each sphere is

A. 6

B. 8

C. 12

D. 10

Answer: A

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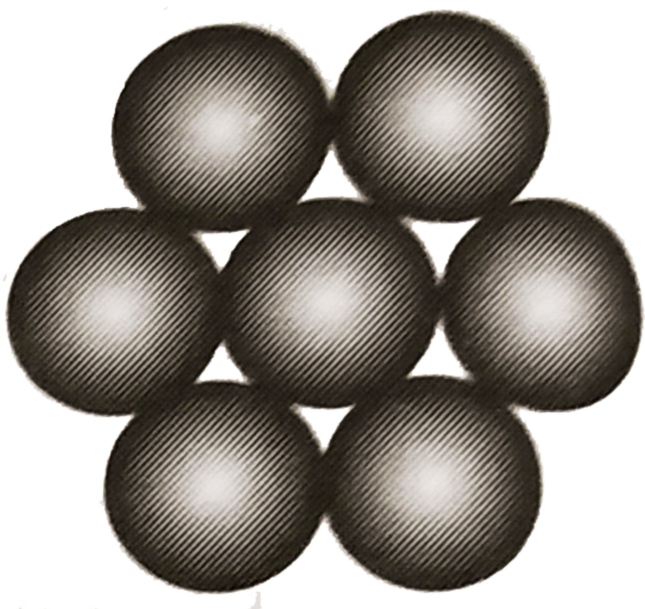
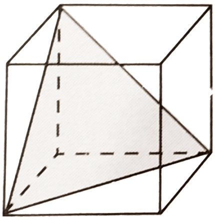
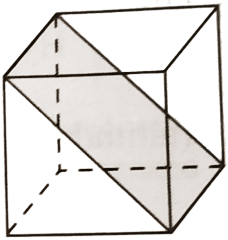
31. In an f crystal, which of the following shaded planes contain the given $(\rightarrow)$ type of type of arrangement of atoms?

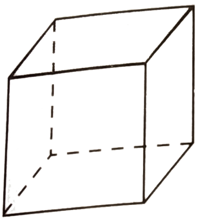


a.

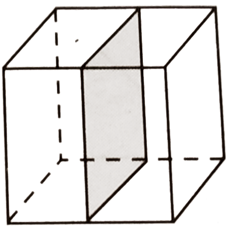


b.

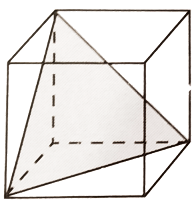




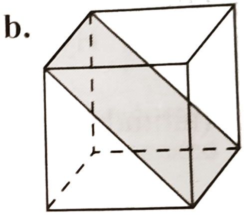
d.

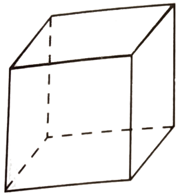


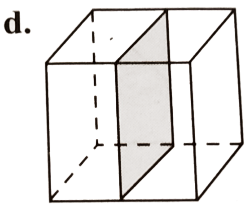
a.



A.

B. 

C. 

D. 

Answer: A

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32. In hexagonal close packing of spherer in three dimensions.

A. In one unit cell there are 12 octahedral voids and all are completely inside the unit cell.

B. In one unit cell there are six octahedral voids and all are competely inside the unit cell.

C. In one unit cell there are six octahedral voids and of which three are completely inside the unit cell and other three are from contributions of octahedral voids which are partially inside the unit cell

D. in one unit cell there are 12 tetrahedral voids, all are completely inside the unit cell.

Answer: B

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33. The coordination number of an f structure for a metal is 12, since

A. Each atom toucher four others in same layer, two in layer above and six in layer below

B. Each atom touches four others in same layer, four in layer above and four in layer below.

C. Each atom touches six others in same layer, three in layer above and three in layer below

D. Each atom touches eight others in same layer, two in layer above and two in layer below.

Answer: A

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34. Which of the following statements is correct for a two-dimensional haxagonal close-packed layer?

A. Each sphere is surrounded by six spheres

B. Each sphere is surrounded by six voids

C. Each sphere has three voids

D. Each voids is surrounded by three spheres

Answer: A::B::D

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35. A compound made of particles A, B, and C forms p lattice. Ions A are at lattice points, B occupy $TV_s C$ occupy OV_s. If all the ions along one of the edge axis are removed, then formula of the compound is

A. $A_{3.75}B_8C_{3.75}$

B. $A_{3.75}B_4C_8$

C. $A_4B_8C_{3.75}$

D. $A_4B_{3.75}C_8$

Answer: A

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36. A compound made of particles A, B, and C forms p lattice. In the lattice, ions A occupy the lattice points and ions B and C occupy the alternate TV_s. If all the ions along one of the body diagonals are removed, then formula of the compound is

A. $A_{3.75}B_3C_3$

B. $A_{3.75}B_3C_4$

C. $A_3B_{3.75}C_3$

D. $A_3B_3C_{3.75}$

Answer: A

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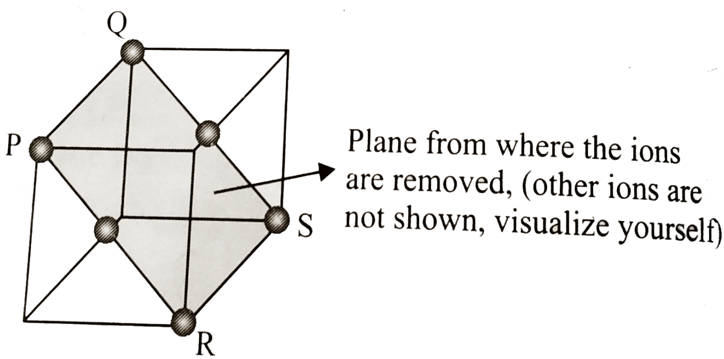
37. A compound made of particles A and B. A forms fcc packing and B occupies all the OV_s. If all the particles along the plane as shown in the figure below are removeed, then the simplest formula of the compound is



A. A_5B_7

B. A_7B_5

C. AB

D. $AB_{3.75}$

Answer: C

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38. In a solid having rock salt structure, if all tge atoms touching one body diagonal plane are removed (except at body centre), then the formula of the left unit cell is

A. $A_{3.5}B_{2.5}$

B. A_7B_3

C. A_5B_3

D. A_3B_5

Answer: A

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39. Calculate the value of Avogadro's number from the following data:

Density of $NaCl = 2.165 gcm^{-3}$

Distance between $Na^{\oplus}$ and Cl^{Θ} in $NaCl = 281$ pm

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40. $CsCl$ has bcc arrangement and its unit cell edge length is 400 pm. Calculate the interionic distance in $CsCl$.

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41. A solid AB has $CsCl$-type structure. The edge length of the unit cell is 404 pm. Calculate the distance of closest approach between $A^{\oplus}$ and B^{Θ} ions.

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42. $CsCl$ has cubic structure. Its density is $3.99gcm^{-3}$. What is the distance between $Cs^{\oplus}$ and Cl^{Θ} ions?

(Atomic mass of $Cs = 133$)

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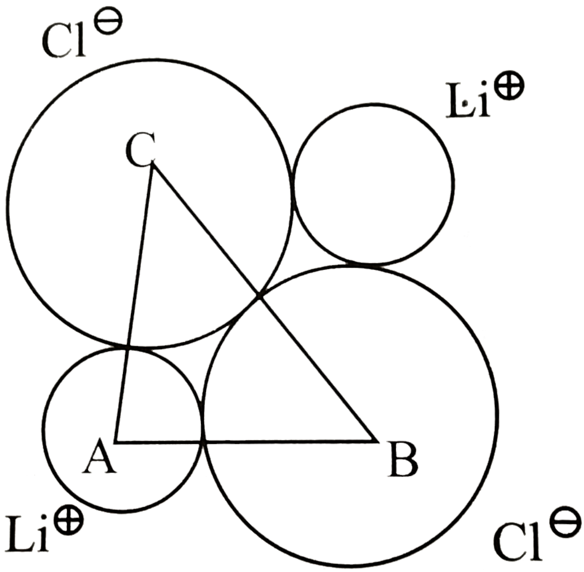
43. The unit cube length for $LiCl$ ($NaCl$ structure) is 5.14Å. Assuming anion-anion contact, calculate the ionic radius for chloride ion.



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44. Casium may be considered to form interpentrating simple primitice cubic crystal. The edge length of unit cell is 412 pm. Determine

a. The density of $CsCl$.

b. The inoic radius of $Cs^{\oplus}$ if the ionic radius of $Cl^{\ominus}$ is 181 pm. Given: $Aw(Cs) = 133 gmol^{-1}$

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45. KCI crystallizes in the same type of lacttice as does $NaCl$. Given that

$\frac{r_{Na^{\oplus}}}{r_{Cl^{\ominus}}} = 0.5$ and $\frac{r_{Na^{\oplus}}}{r_{K^{\oplus}}} = 0.7$

Calculate (a) the ratio of side of the unit cell for

KCl to that for $NaCl$, and (b) the ratio of density of $NaCl$ to that KCl.

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46. LiI occurs as cubical closed packing. If the edge lenth of unit cell is 624 pm, determine the ionic radii of $Li^{\oplus}$ and I^{Θ} inos.

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47. The composition of a sample of Wustite is $Fe_{0.93}O_{1.00}$. What percentage of the iron is present in the form of $Fe(III)$?

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48. $CsBr$ crystallizes in a body-centred cubic unit lattice with an edge length of 4.287Å. Calculate the angles at which the second-order reflection maxima may be expected for $(2, 0, 0)$, $(1, 1, 0)$, planes when X-rays of $\gamma = 0.50\text{Å}$ are used.

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49. Calculate the miller indices of crystal. Planes which cut through the crystal axes at

A. $(2a, 3b, c)$

B. (a, b, c)

C. $(6a, 3b, 3c)$

D. $(2a, -3b, -3c)$

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50. How do the spacings of the three planes 100, 110, and 111 of cube lattice vary?

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51. Potassium chloride crystallize with a body-centred cubic lattice. Calculate the distance between the 200, 110, and 222 Planes. The length of the side of the unit cell is 5.34Å.

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52. Diamond has face-centred cubic lattice. There are two atoms at $(0, 0, 0)$ and $\left(\frac{a}{4}, \frac{a}{4}, \frac{a}{4}\right)$ coordinates. The ratio of the carbon-carbon bond distance to the edge of the unit cell is

A. $\sqrt{\frac{3}{16}}$

B. $\sqrt{\frac{1}{4}}$

C. $\frac{1}{4}$

D. $\frac{1}{\sqrt{2}}$

Answer: A

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53. Which of the following statements is(are) correct for the diamond structure?

A. Each atom has 4 nearest neighbours and 12 next nearest neighbours.

B. It is relatively empty.

C. The maximum proportion of the available volume which may be filled by hard spheres is only 0.34.

D. The maximum proportion of the available volume which may be filled by hard sphere is only 0.46.

Answer: A::B::C

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54. Which of the following compounds are not isomorphous?

a. Copper sulphate and zine sulphate

b. Zinc sulphate and manganeous sulphate

c. Calcium carbonte and ferrous sulphate

d. Zine sulphate and ferrous sulphate

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55. Potassium selenate is isomorphous with potassium sulphate and contains 50.0% of Se. The atomic weight of Se is

a. 142, b. 71, c. 47.33, d. 284

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56. The Ew of an element is 13. It forms an acidic oxide which KOH forms a salt isomorphous with K_2SO_4. The Aw of element is

a. 13, b. 26, c. 52, d. 78

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

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58. If $NaCl$ is doped with $10^{-3} mol\,\%\; GaCl_3$, what is the concentration of the cation vacancies?

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59. If all the atoms touching one face plane are removed in solid $A^{\oplus}B^{\Theta}$ having rock salt type structure, then the formula of the compound left and the defect brought by this removal, respectively, is

a. AB, Frenkel defect

b. A_2B, Frenkel defect

c. AB, Schottky defect

d. A_2B, Schottky defect

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60. The addition of $CaCl_2$ crystal to KCl crystal

a. Lowers the density of the KCl crystal

b. Raises the density of the KCl crystal

c. Does not affect the density of the KCl crystal

d. Increases the Frenkel defects of the KCl crystal

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61. What fraction of the surface of a crystal of Cd at $T = 298K$ consists of vacancies? Assume that the energy needed to form a vacancy $= 0.5\Delta_{\text{sub}}H^{\Theta}$. For $Cd(s)$, $\Delta_{\text{sub}}H^{\Theta} = 112.0kJmol^{-1}$.

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62. Calcium crystallizesin f unit cell with $0.556nm$. Calculate the density if

a. It contains 0.2% Frenkel defects

b. It contains 0.1% Schottky defects

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Solved Examples

1. The pyknometric density of sodium chloride crystal is $2.165 \times 10^3 \text{ kg m}^{-3}$ while its X-ray density is $2.178 \times 10^3 \text{kg m}^{-3}$. The fraction of unoccupied sites in sodium chloride crystal is

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2. The molar volumes of KCl and $NaCl$ are $40mL$ and $30mL$, respectively. Find the ratio of the unit cube edges of the two crystals. Assume both have the same packing efficiency.

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3. Calculate the void space in closest packing of n spheres of radius 1 unit, n spheres of radiys 0.414 units, and $2n$ spheres of radius 0.225 units.

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4. Calculate the following:

a. Number of ZnS units in a unit cell of zinc blend.

b. Number of CaF_2 units in a unit cell of CaF_2.

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5. CsCl has bcc structure with Cs^{+} at the centre and Cl^{-} ion at each corner. If $r_{cs^{+}} is 1.69 Å$ and $r_{Cl^{-}} is 0.81 Å$, what is the edge length of the cube?

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6. For a cubiccrystal, the face diagonal is 3.5Å. Calculate the face length.

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7. Cesium chloride forms a body-centred cubic lattice. Cesiumm and chloride ions are in contact along the body diagoanl of a cell. The length of the side of the unit cell is $412 \pm$ and Cl^{Θ} ion has a radius of 181 pm. Calculate the radius of $Cs^{\oplus}$ ion.

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8. A unit of cell of sodium chloride has four formula units. The edge length of the unit cell is $0.564 nm$. What is the density of sodium chloride?

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9. In an LiI crystal, I^{-} ions from a cubical close-packed arrangement, and Li^{+} ion occupy octahedral holes. What is the relationship between the edge length of the unit cells and radii of the I^{-} ions if $a = 60$ pm.

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10. An element occurs in two crystalline form α and β. The α-form has an fcc with a = 3.68 Å and β-form has a bcc with a = 2.92 Å. Calculate the ratio of their densities.

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11. Find the simplest formula of a solid containing A and B atoms ia cubic arrangement In which A occuples corner and B the centre of the faces of unit cell. If the side length is 5Å, estimate the density of the solid assuming atomic weights of A and B as 60 and 90, respectively.

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12. In the cubic crystal of $CsCl(d = 3.97 g cm^{-3})$, the eight corners are occupied by Cl^{Θ} with a $Cs^{\oplus}$ at the centre and vice versa. Calculate the distance between the neighbouring $Cs^{\oplus}$ and Cl^{Θ} ions. What is the radius of the two ions? (Aw of $Cs = 132.91$ and $Cl = 35.45$)

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13. Li forms a body-centred cubic lattice. If the edge of the cube is $3.5 \times 10^{-10} m$ and the density is

$5.3 \times 10^2 kgm^{-3}$, calculate the percentage occupancy of Li metal.

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Exercises (Linked Comprehension)

1. If calcium crystallizes in bcc arrangement and the radius of Ca atom is $96 \pm$, then the volume of unit cell of Ca is

A. $10.9 \times 10^{-36} m^3$

B. $10.9 \times 10^{-30} m^3$

C. $21.8 \times 10^{-30} m^3$

D. $21.8 \times 10^{-36} m^3$

Answer: B

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2. The number of unit cells in the Ca atom lies on the surface of a cubic crystal that is $1.0 cm$ in length is

A. 9.17×10^{23}

B. 9.17×10^{22}

C. $2 \times 9.17 \times 10^{23}$

D. $2 \times 9.17 \times 10^{22}$

Answer: B

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3. The number of unit cells in the Ca atom lies on the surface of a cubic crystal that is $1.0cm$ in length is

A. 1.11×10^{-8}

B. 2.22×10^{-8}

C. 1.11×10^{-7}

D. 2.22×10^{-7}

Answer: A

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4. The OLIVINE series of minerals consists of crystal in which Fe^{2+} and Mg^{2+} ions may substitute for each other causing susbstitutional impurity defects without changing the volume of unit cell. In OLIVINE series of minerals, O^{2-} ions exist as fcc with Si^{4+} occupying one-fourth of OVs

and divalent metal ions occupying one-fourth of OVs and divalent metal ions occupying one-fourth of TVs. The density of "forsterite" (magnesium silicate) is $3.21 gcm^{-3}$ land that of "fayalite" (ferrous silicate) is $4.34 gcm^{-3}$.

The formula of "fayalite mineral" is

A. Fe_2SiO_4

B. $FeSiO_4$

C. Fe_2SiO_6

D. Fe_SiO_3

Answer: A

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5. The OLIVINE series of minerals consists of crystal in which Fe^{2+} and Mg^{2+} ions may substitute for each other causing susbstitutional impurity defects without changing the volume of unit cell. In OLIVINE series of minerals, O^{2-} ions exist as fcc with Si^{4+} occupying one-fourth of OVs and divalent metal ions occupying one-fourth of OVs and divalent metal ions occupying one-fourth of TVs. The density of "forsterite" (magnesium silicate) is $3.21 gcm^{-3}$ land that of "fayalite" (ferrous silicate) is $4.34 gcm^{-3}$.

If in "forsterite mineral" bivalent Mg^{2+} ions are to be replaced by unipositive $Na^{\oplus}$ ions, and if $Na^{\oplus}$ ions are occupying half of TV_s in$f$ lattice, the arrangement of rest of the constituents is kept same, then the formula of the new solid is:

A. Na_2SiO_4

B. Na_2SiO_3

C. Na_4SiO_4

D. $Na_2Si_2O_6$

Answer: C

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6. $AX, AY, BX,$ and BY have rock salt type structure with following internuclear distances:

Salt	Anion-anion distance in Å	Cation-anion distance in Å
AX	2.40	1.70
AY	1.63	1.15
BX	2.66	1.88
By	2.09	1.48

Ionic radii of $A^{\oplus}$ and $B^{\oplus}$, respectively, are

a. 0.35 and 0.68Å

b. 0.68 and 0.35Å

c. 1.20 and 0.80Å

d. 0.80 and 1.20Å

A. 0.35 and 0.68Å

B. 0.68 and 0.35Å

C. 1.20 and 0.80Å

D. 0.80 and 1.20Å

Answer: A

Watch Video Solution

7. $AX, AY, BX,$ and BY have rock salt type structure with following internuclear distances:

Salt	Anion-anion distance in Å	Cation-anion distance in Å
AX	2.40	1.70
AY	1.63	1.15
BX	2.66	1.88
By	2.09	1.48

Ionic radii of $X^{\oplus}$ and $Y^{\ominus}$, respectively, are

A. 0.35 and 0.68Å

B. 0.68 and 0.35Å

C. 1.20 and 0.80Å

D. 0.80 and 1.20Å

Answer: C

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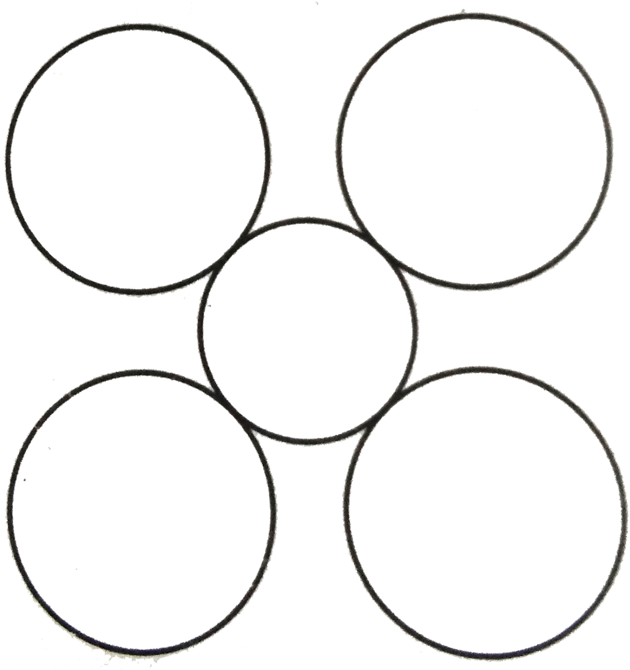
8. AX, AY, BX, and BY have rock salt type structure with following internuclear distances:

Salt	Anion-anion distance in Å	Cation-anion distance in Å
AX	2.40	1.70
AY	1.63	1.15
BX	2.66	1.88
By	2.09	1.48

The structure given below is of



(a) AX

(b) AY, BX

(c)AY, BX, BY

(d)AY, BX, BY and KCI

A. AX

B. AY, BX

C. AY, BX, BY

D. AY, BX, BY and KCI

Answer: D

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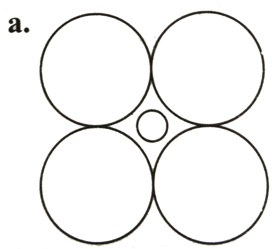
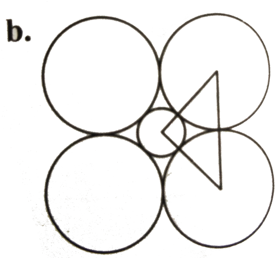
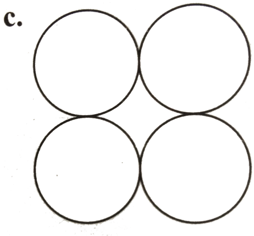
9. $AX, AY, BX,$ and BY have rock salt type structure with following internuclear distances:

Salt	Anion-anion distance inÅ	Cation-anion distance inÅ
AX	2.40	1.70
AY	1.63	1.15
BX	2.66	1.88
By	2.09	1.48

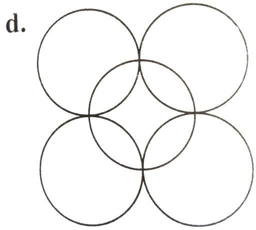
Which of the following structure is, respectively, by Ax?

(a) 

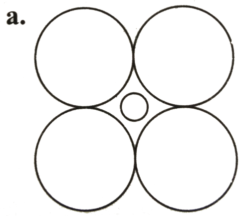
(b) 



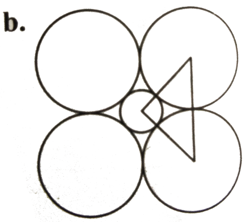
(c)



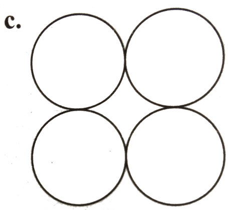
(d)



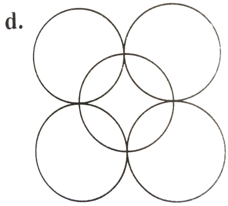
A.



B.



C.

D. 

Answer: A

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

Salt	Anion-anion distance in Å	Cation-anion distance in Å
AX	2.40	1.70
AY	1.63	1.15
BX	2.66	1.88
By	2.09	1.48

A salt MY crystallizes in the $CsCl$ structure. The anions at the corners touch each other and cation is in the centre. The radius ratio $(r_{\oplus} / r_{\ominus})$ for this structure is

A. 0.225

B. 0.414

C. 0.732

D. 1.0

Answer: C

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11. In a unit cell, atoms (A) are present at all corner lattices, (B) are present at alternate faces and all edge centres. Atoms (C) are present at face centres left from (B) and one at each body diagonal at disntance of $1/4th$ of body diagonal from corner. Formula of given solid is

A. $A_3B_8C_7$

B. AB_4C_6

C. $A_6B_4C_8$

D. $A_2B_9C_{11}$

Answer: B

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12. In a unit cell, atoms (A) are present at all corner lattices, (B) are present at alternate faces and all edge centres. Atoms (C) are present at face centres left from (B) and one at each body diagonal at disntance of $1/4th$ of body diagonal from corner.

A tetrad axis is passed from the given unit cell and all the atoms touching the axis are removed. The possible formula of the compound left is

A. AB_3C_6 and AB_4C_5

B. $A_3B_6C_7$ and $A_3B_6C_5$

C. $A_4B_5C_8$ and $A_4B_5C_7$

D. AB_2C and ABC_2

Answer: A

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13. In a unit cell, atoms (A) are present at all corner lattices, (B) are present at alternate faces and all edge centres. Atoms (C) are present at face centres left from (B) and one at each body diagonal at disntance of $1/4th$ of body diagonal from corner.

Total fraction of voids occupied are

A. 0.58

B. 0.25

C. 0.48

D. 0.86

Answer: A

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Exercises (Multiple Correct)

1. In fcc structure octahedral voids are present at :

A. Corners of unit cell

B. Edge centre of unit cell

C. Body centre of unit cell

D. Face centre of unit cell

Answer: B::C

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2. An hcp and a ccp structure for a given element would be expected to have

(a)The same co-ordinational number

(b)the same density

(c)the same packing fraction

(d)all of the above

A. The same coordination number

B. The same density

C. The same packing fraction

D. All of these

Answer: A::C

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3. Ions of $NaCl$ which are touched by 1 body diagonal are

A. $Cl^{\ominus}$ ions present at the corner of cube

B. $Cl^{\ominus}$ ions present at the face centre of cube

C. $Na^{\oplus}$ ions present at the edge centre of cube

D. $Na^{\oplus}$ ions present at body centre of cube

Answer: A::D

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4. Which of the follwing statements is/are correct for both fluorite and antifluorite structures?

A. Cation is present in alternate TV_s

B. Anion constitutes lattice.

C. Number of formula unit in one unit cell is 4.

D. 100% tetrahedral voids are occupied

Answer: C::D

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5. Identical spheres are undergoing two-dimensinal packing in squre close packing and hexagonal close packing. Which is correct regarding the spheres?

A. The ratio of coordination number for a sphere in first case to that in second case is $2:3$.

B. Packing in second case is more effective.

C. Packing in first case is more effective.

D. The stacking of layer on first type packing produces simple cubic structure.

Answer: A::B::D

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6. For which of the following cases, answer is 4

A. Coordination number of Zn^{2+} in Z inc blende

B. Number of body diagonal planes in a cube

C. Formula units in rock salt structure

D. Formula units in $CsCl$ structure

Answer: A::C

7. An octahedron has

A. 8 corners

B. 8 faces

C. 8 edges

D. 12 edges

Answer: B::D

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8. Aluminium metal has a density of $2.72 gcm^{-3}$ and crystallizes in a cubic lattice with an edge of 404 pm.

Which is//are correct?

A. It forms an fcc unit cell.

B. It forms a bcc unit cell.

C. Its coordination number is 8.

D. Its coordination number is 12.

Answer: A::D

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9. For the spinel structure $(MgAl_2O_4)$, the correct statement is//are

A. 1.50 $\% OV_s$ are occupied by ions.

B. 2.Al^{3+} is equally distributed in TVs and OVs.

C. 3.Oxide ions occupy ccp lattice.

D. 4.$12.5 \% TVs$ are occupied by ions.

Answer: A::C::D

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10. If the radius of anion is $0.20nm$, the maximum radius of cation which can be filleed in respective voids is correctly matched in

A. $r_{\oplus} = 0.0828nm$ for tetrahedral void

B. $r_{\oplus} = 0.045nm$ for triangular void

C. $r_{\oplus} = 0.1464nm$ for tetrahedral void

D. None of the above.

Answer: A::B::C

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11. Which of the following statements is/are correct?

A. Dislocation of ion from lattice site to interstitial site is called Frenkel defect.

B. Missing of $+ve$ and $-ve$ ions from their respective position producing a pair of holes is called Schottky defect.

C. The presence of ions in the vacent interstital sites along with lattice point is called interrstital defect.

D. Non-stoichiometric $NaCl$ is yellow solid.

Answer: A::B::C::D

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12. Select the correct statement(s).

A. The conductance through electron is called p-type conducation.

B. The conductance through positive holes is called p-type conduction.

C. The conductance through electrons is called n-type conduction.

D. The band gap in germanimum is small.

Answer: B::C::D

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13. Select the correct statement(s).

A. Solids with F-centres are paramagnetic.

B. Ferrimagnetic character of Fe_3O_4 at room temperature changes to paramagnetic character at $850K$.

C. Anti-ferrimagetic V_2O_3 changes to paramagnetic at $150K$.

D. Non-stoichiometric Cu_2O is a p-type semiconductor.

Answer: A::B::C::D

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14. Select the correct statement(s) about three-dimensional hcp system.

A. The number of atoms in hcp unit cell is six.

B. The volume of hcp unit cell is $24\sqrt{2}r^3$.

C. The empty space in hcp unit cell is 26%.

D. The base area of hcp unit is $6\sqrt{3}r^2$.

Answer: A::B::C::D

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15. In which of the following systeam primitives $a \neq b \neq c$?

A. Orthorhombic

B. Monoclinic

C. Triclinic

D. Hexagonal

Answer: A::B::C

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16. In which of the following systeams interfacial angles $\alpha = \gamma = 90^\circ$ but $\beta \neq 90^\circ$?

A. Monoclinic

B. Rhombohedral

C. Triclinic

D. Hexagonal

Answer: A::B

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17. The space in which atoms are not present in unit cell is

A. In sc 48%

B. In fcc 26%

C. In bcc 32%

D. In hexagonal 26%

Answer: A::B::C::D

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18. Which of the following having having their radius ratio between0.414 and 0.732, i.e., for $NaCl$ structure, have their radius ratio not in this range but posses $NaCl$-type structure?

A. LiBr

B. KCl

C. RbCl

D. BaO

Answer: A::B::C::D

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19. In the fluorite structure if the radius ratio is $\left(\sqrt{\frac{3}{2}}-1\right)$ how many ions does each cation touch?

A. 4 anions

B. 12 cations

C. 8 anions

D. No cations

Answer: B::C

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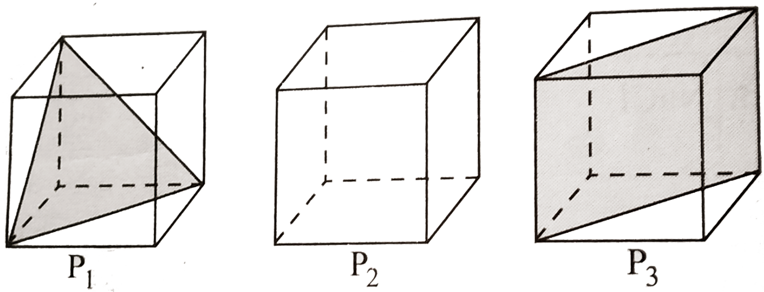
20. Following three planes (P_1, P_2, P_3) in an fcc unit cell are shown in the figure below. Consider the following statements and choose the correct option/options that follow:



(a) P_1 contains no three-dimensional voids.

(b) P_2 contains only octahedral voids.

(c) P_3 contains both octahedral and tetrahedral voids

(d) All of these

A. P_1 contains no three-dimensional voids.

B. P_2 contains only octahedral voids.

C. P_3 contains both octahedral and tetrahedral voids

D. All of these

Answer: A::B::C::D

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21. If the radious of $Cs^{\oplus} = 1.69 \text{Å}$ and $Br^{\Theta} = 1.95 \text{Å}$, then which of the following is//are correct statement?

A. The edge length of unit cell is 4.2Å.

B. The coordination number for $Cs^{\oplus}$ is 6.

C. $CsBr$ has bcc-type structure.

D. Br^{Θ} ions touch each other along the edge.

Answer: A::C

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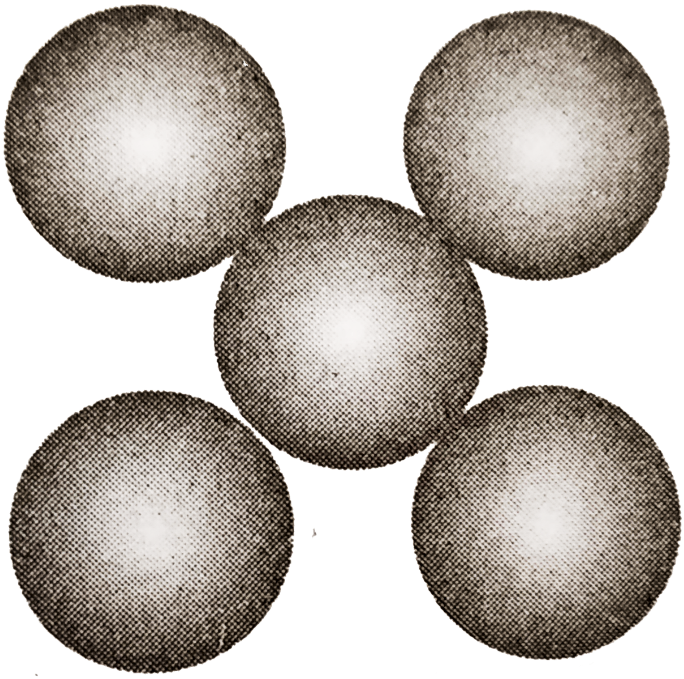
22. Given is the arrangement of atoms in a crystallographic plane.

Name one plane which correctly represent(s) the adjacent drawn structure?



A. Face plane in fcc

B. Body diagonal plane in fcc

C. Face plane in bcc

D. Body diagonal plane in bcc

Answer: A::D

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23. In fcc structure octahedral voids are present at :

A. Edge centre of unit cell

B. Body centre of unit cell

C. Corners of unit cell

D. Face centre of unit cell

Answer: A::B

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24. Position of TVs in closest packed structure is//are

A. Edge centre of unit cell

B. Two TVs on each body diagonal

C. Position of each TV from corner is $\sqrt{3}a/4$.

D. Face centre of unit cell

Answer: B::C

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25. Which of the following statements is/are correct about TVs in an fcc unit cell?

A. Number of TVs per atom in fcc unit cell is 2.

B. Number of TVs per unit cell is 8.

C. Number of TVs is twice the number of atoms in the fcc unit cell.

D. Number of TVs is equal to the number of atoms in the fcc unit cell?

Answer: A::B::C

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26. Which of the following statements is//are correct about TVs in an fcc unit cell?

Given: Edge length $= a$

Body diagonai $= b$

A. Each TV lies at a diastance b//4 from the nearest corner.

B. Each TV lies at a distance $3b/4$ from the farthest corner.

C. Each TV lies at a distance of $\sqrt{3}a/4$ from the nearest corner.

D. The distance between two TV_s is $b/2$.

Answer: A::B::C::D

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27. Graphite

A. A good conductor

B. sp^2 hybridized

C. An amorphous solid

D. A convalent crystal

Answer: A::B::D

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28. Diamond

A. A covalent solid

B. A non-conductor

C. A lubricant

D. sp^3 hybridized

Answer: A::B::D

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

A. The unit cell is fcc.

B. $Z = 4$.

C. There are four constituents/unit cells.

D. There are 8 ions at corners and 6 at the centres of the faces.

Answer: A::B::C::D

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30. What is true about a bcc unit cell?

A. The number of atoms in the unit cell is 2.

B. In addition to an atom at the centre of the body, in a unit cell there are 8 atoms at 8 different corners.

C. One-eighth of an atom at a corner of the unit cell.

D. None of the above.

Answer: A::B::C

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31. What is true about simple cubic type of unit cells?

A. Eight constituents are at different corners of the cube.

B. $Z_{eff} = 1$.

C. Contribution by one corner is $(1)/(8)th$ of an atom`.

D. None of the above.

Answer: A::B::C

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32. Which of the following is//are convalent solids?

A. Fe

B. Diamond

C. $NaCl$

D. Graphite

Answer: B::D

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33. Which is/are not amorphous solid(s)?

A. Rubber

B. Graphite

C. Glass

D. Plastics

Answer: B

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34. Non-stoichiometric compounds are

A. Cu_2O

B. Cu_2S

C. FeO

D. $Hg_2Ba_2YCaCu_2O_7$

Answer: A::B::C::D

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35. Recently discovered superconductivity materials are

A. M_3C_{60}

B. $YBa_2Cu_3O_7$

C. SiC

D. $Hg_2Ba_2YCaCu_2O_7$

Answer: A::B::D

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36. If a mixture of $LiCl$ and $NaCl$ is malted and then cooled,

A. A solid solution is formed.

B. Mixture formed is called eutectic mixture.

C. $TiO_{1.8}$ is non-stoichiometric solid solution of Ti_2O_3 and TiO_2.

D. Neither $LiCl$ nor $NaCl$ separates.

Answer: A::B::C::D

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37. Which of the following statements is/are correct?

A. If three Fe^{2+} ions are missing from their lattice inFeO, then there must be two Fe^{3+} ions somewhere in the lacttice.

B. Crystals with matal deficiency defects are called super conductors.

C. Crystals with metal deficiency are called semiconductors.

D. 1 Bohr Magneton $= 9.27 \times 10^{-24} Am^2$

Answer: A::C::D

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38. Select the correct statement(s).

A. The non-stoichiometric from of $NaCl$ is yellow and that of KCl is blue-lilac.

B. Solids containing F-centres (Farbe) are paramagentic.

C. Non-stoichiometric compounds are called Berthollide compounds.

D. Conduction by electrons is called n-type semiconductor.

Answer: A::B::C::D

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39. A mineral having the formula AB_2 crystallizes in the p lattice, with A atoms occupying the lattice points. Select the correct statement(s).

A. The coordination number (CN) for A atoms $= 8.$

B. The CN for B atom $= 4$

C. 100% of TV_s are occupied by B atoms

D. 50% of TV_s are occupied by B atoms.

Answer: A::B::C

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Exercises (Single Correct)

1. A crystal is made of particles X,Y and Z.X form fcc packing . Y occupies all the octahedral void of X and Z occupies all the tetrahedral voids of X . If all the particles along one body diagonal are removed then the formula of the crystal would be:

A. XYZ_2

B. X_2YZ_2

C. $X_8Y_4Z_5$

D. $X_5Y_4Z_8$

Answer: D

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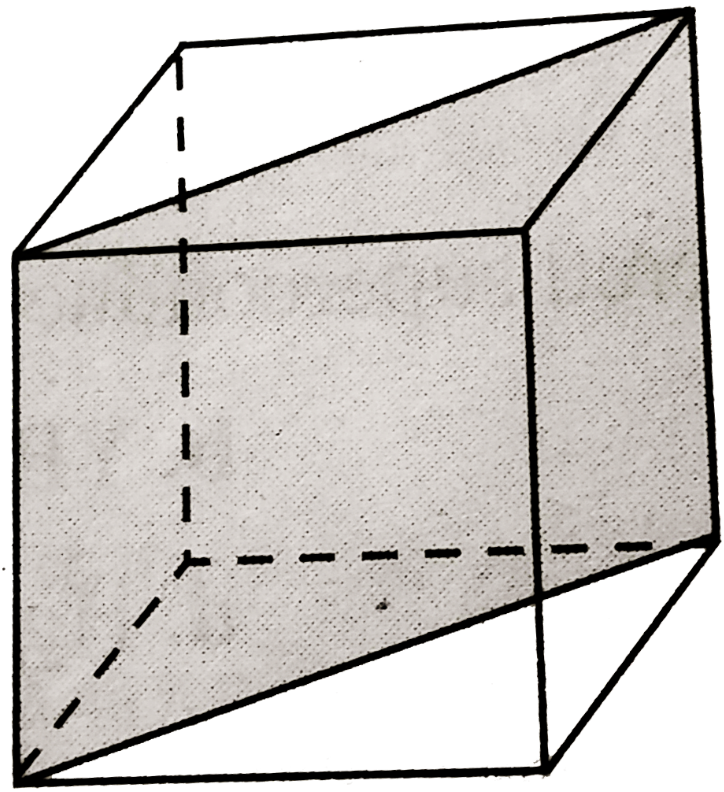
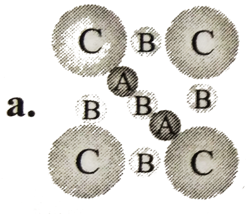
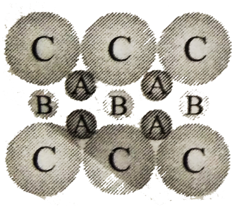
2. In a hypothetical solid, C atoms are found to form cubical close-packed lattice. A atoms occupy all tetrahedral voids and B atoms occupy all octahedrals voids.

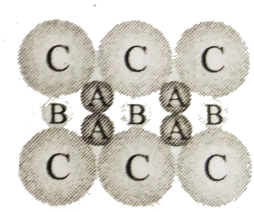


A and B atoms are of appropriate size, so that there is no distortion in the p lattice of C atoms. Now if a plane as shown in the following figure is cut, then the cross section of this plane will look like

A. 

B.

C. 

D. 

Answer: C

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3. What is the maximum number of layers of atom in close-packed planes that will lie within two imaginary parallel planes having a distance between them of $13\sqrt{\frac{2}{3}}r$ (where r is the radius of atom) in the copper crystal (fcc)?

(Consider the atoms to be within the parallel planes if their centres are on or within the two parallel planes).

A. 5

B. 6

C. 7

D. 8

Answer: C

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4. Analysis show that nickel oxide consists of nickel ion with 96% ions having d^8 configuration and 4% having d^7 configuration. Which amongst the following best represents the formula of the oxide?

A. $Ni_{1.02}O_{1.00}$

B. $Ni_{0.96}O_{1.00}$

C. $Ni_{0.98}O_{0.98}$

D. $Ni_{0.98}O_{1.00}$

Answer: D

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5. What is the density of Na_2O having antifluorite-type crystgal stryctutre, if the edge length of cube is $100gm$ and what is the effect on density by 0.05% Frenkel defect?

A. $823.5gcm^{-3}$, density decreases

B. $4.14.16gcm^{-3}$, density decreases

C. $823.5gcm^{-3}$, density remains same

D. $414.16gcm^{-3}$, density remains same

Answer: D

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6. In the CaF_2 structure, the C.N of cations and anions are respectively:

A. 6 and 6

B. 8 and 4

C. 4 and 4

D. 4 and 8

Answer: B

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7. A metallic crystal cystallizes into a lattice containing a sequence of layers $ABABAB....$ Any packing of spheres leaves out voids in the lattice. What percentage by volume of this lattice is empty spece?

A. 74%

B. 26%

C. 50%

D. None of these

Answer: B

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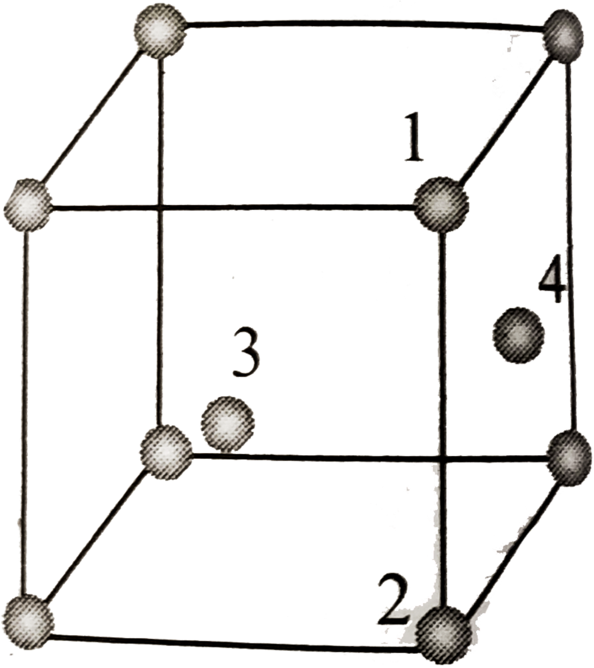
8. In fcc unit cell, atoms are numbered as shown below.

The atoms not touching each other are (Atom numbered 3 is face centre of front face)



A. 3 and 4

B. 1 and 3

C. 1 and 2

D. 2 and 4

Answer: C

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9. The number of nearest neighbours and next nearest neighbours of an $Na^{\oplus}$ ion in a crystal of $NaCl$ are, respectively,

A. $6Na^{\oplus}, 12Cl^{\ominus}$

B. $6Cl^{\ominus}$, and $12Na^{\oplus}$

C. $12Cl^{\ominus}, 12Na^{\oplus}$

D. $6Cl^{\ominus}, 6Na^{\oplus}$

Answer: B

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10. In the closet packing of atoms:

A. The size of TV is greater than that of OV.

B. The size of TV is smaller than that of OV.

C. The size of TV is equal to that of OV.

D. The size of TV may be greater or smaller or equal to that of OV depending upon the size of atoms.

Answer: B

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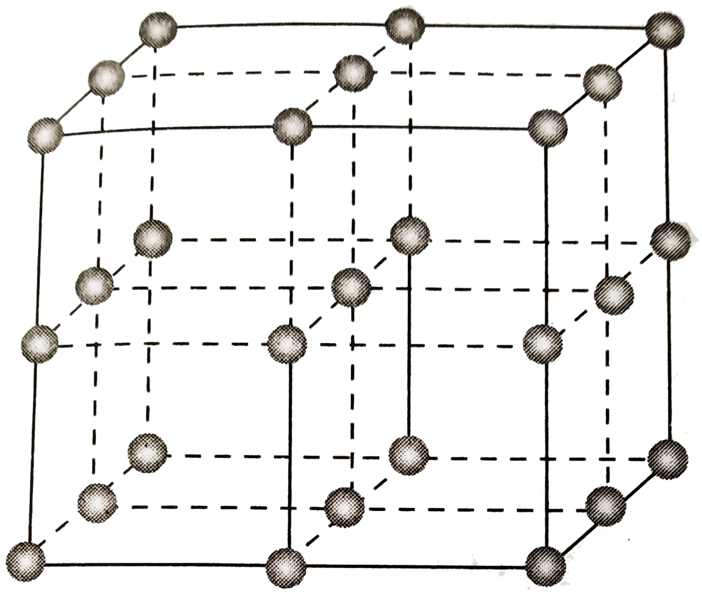
11. The following diagram shows the arrangement of lattice points with $a = b = c$ and $\alpha = \beta = \gamma = 90^{\circ}$. Choose the correct options.



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 is bcc with each lattice point surroundeed by 8 nearest neigbours

Answer: A

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12. The number of atoms in $100g$ of an fcc crystal with density $= 10.0 gcm^{-3}$ and cell edge equal to $200 \pm$ is equal to

A. 5×10^{24}

B. 5×10^{25}

C. 6×10^{23}

D. 2×10^{25}

Answer: A

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13. What is the effect of Frenkel defect on the density of ionic solids ?

A. Increases

B. Decreases

C. Does not change

D. Changes

Answer: C

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14. In a tetragonal crystal

A. $a = b = c, \alpha = \beta = 90^{\circ} \neq \gamma$

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

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

D. $\alpha = \beta = 90^{\circ}, \gamma = 120^{\circ}, a = b \neq c$

Answer: B

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15. Which of the following is not a ferroelectric compound?

A. Rochelle salt

B. $K_4[Fe(CN)_6]$

C. $BaTiO_3$

D. KH_2PO_4

Answer: B

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16. The material used in solar cells contains

A. Cs

B. Si

C. Sn

D. Ti

Answer: B

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17. If the lattice parameter of $Si = 5.43\text{Å}$ and the mass of Si atom is $28.08 \times 1.66 \times 10^{-27} kg$, the density of silicon in kgm^{-3} is (Given: Silicon has diamondcubic structure)

A. 2330

B. 1115

C. 3445

D. 1673

Answer: A

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18. The lacttice parameter of $GaAs$ (radius of $Ga = 1.22\text{Å}$, $As = 1.25\text{Å}$) is

A. 5.635Å

B. 2.852Å

C. 5.774Å

D. 4.94Å

Answer: B

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19. In cubic $ZnS(II - VI)$ compounds, if the radii of Zn and S atoms are 0.74Å and 1.70Å, the lattice parameter of cubic ZnS is

A. 11.87Å

B. 5.634Å

C. 5.14Å

D. 2.97Å

Answer: B

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20. Na and Mg crystallize in bcc- and fcc-type crystals, the ratio of number of atoms present in the unit cell of their respective crystal is

A. 1

B. 0.5

C. 3

D. 4

Answer: B

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21. In a close packed structure of mixed oxides , the lattice is composed of oxide ions, one-eighth of tetrahedral voids are occupied by divalent cations while one-half of octahedral voids are occupied by trivalent cations. The formula of the oxide is

A. A_2BO_3

B. AB_2O_3

C. A_2BO_4

D. AB_2O_4

Answer: D

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22. An ionic solid $A^{\oplus}B^{\Theta}$ crystallizes as an bcc structure. The distance between cation and anion in the lattice is $338 \pm$. The edge length of cell is

A. 338 pm

B. 390.3 pm

C. 292.7 pm

D. 507 pm

Answer: B

Watch Video Solution

23. An ionic solid $A^{\oplus}B^{\Theta}$ crystallizes as an fcc structure. If the edge length of cell is 508 pm and the radius of anion is $144 \pm$, the radius of cation is

A. 110 pm

B. 364 pm

C. 220 pm

D. 288 pm

Answer: A

Watch Video Solution

24. The γ-form of iron has f structure (edge length $386 \pm$) and β-form has b structure (edge length $290 \pm$). The ratio of density in γ-form and β-form is

A. 0.9788

B. 1.02

C. 1.57

D. 0.6344

Answer: A

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25. The density of an ionic compounds $(Mw = 58.5)$ is $2.165 kgm^{-3}$ and the edge length of unit cell is 562 pm, then the closest distance between $A^{\oplus}B^{\ominus}$ and Z_{eff} of unit cell is

A. 281 pm, 4

B. 562 pm, 2

C. 562 pm, 4

D. 281 pm, 2

Answer: A

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26. The edge length of unit cell of a metal $(Mw = 24)$ having cubic structure is 4.53Å. If the density of metal is $1.74 gcm^{-3}$, the radius of metal is $(N_A = 6 \times 10^{23})$

A. 180 pm

B. 160 pm

C. 140 pm

D. 190 pm

Answer: B

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27. The ratio of packing fraction in fcc, bcc, and cubic structure is, respectively,

A. $1 : 0.92 : 0.70$

B. $0.70 : 0.92 : 1$

C. $1 : 0.70 : 0.92$

D. $0.92 : 0.70 : 1$

Answer: A

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28. If R is the radius of the octahedral voids and r is the radius of the atom in close packing, then r / R is equal to

A. 2.41

B. 4.76

C. 3.22

D. 9.1

Answer: A

Watch Video Solution

29. How many unit cells are present in a cubic shaped ideal crystal of NaCl of mass 1.0 g ?

A. 1.28×10^{21}

B. 1.71×10^{21}

C. 2.57×10^{21}

D. 5.14×10^{21}

Answer: C

Watch Video Solution

30. What type of crystal defect is shown in the figure given below ?

$$\begin{array}{ccccc} Na^{+} & Cl^{-} & Na^{+} & Cl^{-} & Na^{+} \\ Cl^{-} & \square & Cl^{-} & Na^{+} & Cl^{-} \\ Na^{+} & Cl^{-} & Na^{+} & \square & Na^{+} \\ Cl^{-} & Na^{+} & \square & Na^{+} & Cl^{-} \\ Na^{+} & Cl^{-} & Na^{+} & Cl^{-} & \square \end{array}$$

A. Both Frenkel and Schottky defects

B. Schottky defect

C. Interstitial defect

D. Frenkel defect

Answer: B

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31. The volume of atom present in a face-centred cubic unit cell of a metal (r is atomic radius) is

A. $\frac{20}{3}\pi r^3$

B. $8\pi r^3$

C. $4\pi r^3$

D. $\frac{16}{3}\pi r^3$

Answer: D

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32. An elemental crystal has density of $8570 kgm^{-3}$. The packing efficiency is 0.68. If the closest distance between neighbouring atoms is 2.86Å. The mass of one atom is $\left(1a\mu = 1.66 \times 10^{-27}\right)kg)$

A. 186 amu

B. 93 amu

C. 46.5 amu

D. 43 amu

Answer: B

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33. The atomic fraction (d) of tin in bronze (fcc) with a density of $7717 kgm^{-3}$ and a lattice parameter of 3.903Å is $\left(AwCu = 63.54, Sn = 118.7, 1a\mu = 1.66 \times 10^{-27kg}\right)$

A. 0.01

B. 0.05

C. 0.10

D. 3.8

Answer: B

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34. Every atom or ion that forms an fcc unit cell is surrounded by

A. Six OVs and eight TVs.

B. Eight OVs and Six TVs.

C. Six OVs and six TVs.

D. Eight OVs and four TVs.

Answer: A

Watch Video Solution

35. Consider the structure of $CsCl$ $(8:8$ coordination). How many $Cs^{\oplus}$ ions occupy the second nearest neighbour locations of a $Cs^{\oplus}$ ion?

8

24

6

16

A. 8

B. 24

C. 6

D. 16

Answer: C

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36. A metal of density $7.5 \times 10^3 kgm^{-3}$ has an fcc crystal structure with lattice parameter $a = 400 \pm$. Calculater the number of unit cells present in $0.015kg$ of metal.

A. 6.250×10^{22}

B. 3.125×10^{23}

C. 3.125×10^{22}

D. 1.563×10^{22}

Answer: C

Watch Video Solution

37. The ratio of the volume of a tetragonal lattice unit cell to that of a hexagonal lattice unit cell is (both having same respective lengths)

a. $\frac{\sqrt{3}}{2}abc$

b. $\frac{2}{3\sqrt{3}}$

c. $\frac{2}{\sqrt{3}\frac{a^2c}{b}}$

d. 1

A. $\frac{\sqrt{3}}{2}abc$

B. $\frac{2}{3\sqrt{3}}$

C. $\frac{2}{\sqrt{3}\frac{a^2c}{b}}$

D. 1

Answer: B

Watch Video Solution

38. An fcc lattice has a lattice parameter $a = 400$ pm. Calculater the molar volume of the lattice including all the empty space.

A. $10.8mL$

B. $96mL$

C. $8.6mL$

D. $9.6mL$

Answer: D

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39. A TV in fcc is formed by atoms at

A. 3 corners $+1$ face centre

B. 3 face centres $+1$ corner

C. 2 face centres $+2$ corners

D. 2 face centres $+1$ corner $+1$ body centre

Answer: B

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40. A metal crystallizes in b lattice. The percent fraction of edge length not covered by atom is

A. 10.4%

B. 13.4%

C. 12.4%

D. 11.4%

Answer: B

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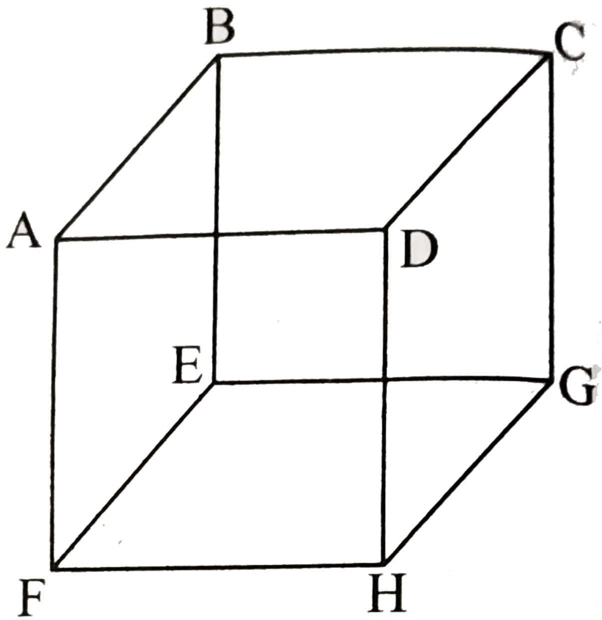
41. In the cubic lattice given below, the three distances between the atoms $A-B$, $A-C$, and $A-G$ are, respectively,



A. $a,\ \sqrt{2}a,\ \sqrt{3}a$

B. $a,\ \sqrt{3}a,\ \sqrt{2}a$

C. $\frac{a}{2}, \frac{a}{\sqrt{2}}, \frac{\sqrt{3}a}{2}$

D. $a, \frac{\sqrt{3}a}{2}, \sqrt{2}a$

Answer: A

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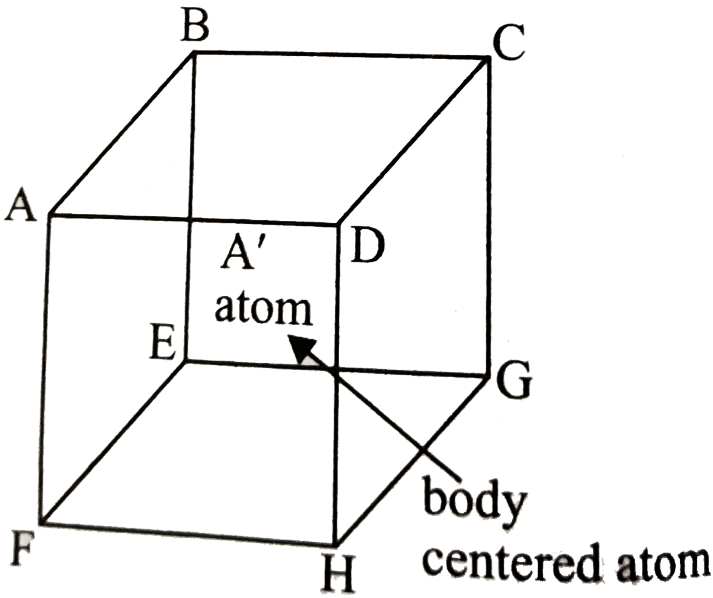
42. In body-centred cubic lattice given below, the three disntances AB, AC, and $\forall$ ' are



A. $a, \sqrt{2}a, \frac{\sqrt{3}a}{2}$

B. $a, \frac{\sqrt{3}a}{2}, \sqrt{2}a$

C. $\frac{\sqrt{3}a}{2}, \sqrt{2}a, a$

D. $a, \frac{a}{\sqrt{2}a}, \frac{\sqrt{3}a}{2}$

Answer: A

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43. Two ionic solids AB and CB crystallize in the same lattice. If $r_{A^{\oplus}} / r_{B^{\ominus}}$ and $r_{C^{\oplus}} / r_{B^{\ominus}}$ are 0.50 and 0.70, respectively, then the ratio of edge length of AB and CD is

A. 0.68

B. 0.78

C. 0.88

D. 0.98

Answer: C

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44. A molecule $A_2B(Mw = 166.4)$ occupies triclinic lattice with $a = 5\text{Å}$, $b = 8\text{Å}$, and $c = 4\text{Å}$,. If the density of A_2B is $5.2 gcm^{-3}$, the number of molecules present in one unit cell is

A. 2

B. 3

C. 4

D. 5

Answer: B

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45. Silicon dopped with group 13 and group 15 member element is, repectively, called ...... semiconductor

A. p-type, n-type

B. n-type, p-type

C. p-type

D. n-type

Answer: A

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46. 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

A. 4 and 2

B. 9 and 14

C. 14 and 9

D. 2 and 4

Answer: B

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47. The electrical conductivity of semiconductor is

A. $10^8 ohm^{-1} cm^1$

B. $10^{-22} ohm^{-1} cm^1$

C. In the range of 10^{-9} to $10^2 ohm^{-1} cm^{-1}$

D. None of the above

Answer: C

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48. Pure silicon and germanium behave as

A. Conductors

B. Insulators

C. Semiconductors

D. May be any one of the above

Answer: B

Watch Video Solution

49. A solid has a structure in which W atoms are located at the corners of a cubic lattice, O atom at the centre of edges, and Na atom at the centre of the cube. The formula for the compound is

A. $NaWO_2$

B. $NaWO_3$

C. Na_2WO_3

D. $NaWO_4$

Answer: B

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50. Which of the following is a ferroelectric compound?

A. $BaTiO_3$

B. $K_4[Fe(CN)_6]$

C. Pb_2O_3

D. None of these

Answer: A

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51. The intermetallic compound LiAg crystallizes in cubic lattice in which both lithium and silver have co-ordination number of eight. The crystal class is

A. Simple cubic

B. Body-centred cubic

C. Face-centred cubic

D. None of these

Answer: B

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52. The edge length of a face-centred cubic unit cell is $508 pm$. If the radius of the cation is $110 pm$ the radius of the anion is

A. 144pm

B. 288 pm

C. 618 pm

D. 398 pm

Answer: A

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53. In the crystals of which of the following ionic compounds would you expect maximum distance between the centres of the cations and anion?

A. LiF

B. CsF

C. Csl

D. LiI

Answer: C

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54. Schottky defect is observed in crystals when

A. Unequal number of cations and anions are missing from the lattice.

B. Equal number of cations and anions are missing from the lattice.

C. An ion leaves its normal site and occupies an interstitial site.

D. Density of the crystal is increased.

Answer: B

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55. How many kinds of space lattices are possible in a crystal?

A. 23

B. 7

C. 230

D. 14

Answer: D

Watch Video Solution

56. Potassium crystallizes with a

A. Face-centred cubic lattice

B. Body-centred cubic lattice

C. Simple cubic lattice

D. Orthorhombic lattice

Answer: B

Watch Video Solution

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

A. AB_3

B. AB

C. A_3B

D. A_2B_2

Answer: A

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58. The number of unit cells in 58.5 g of NaCl is nearly :

A. 6×10^{20}

B. 3×10^{22}

C. 1.5×10^{23}

D. 0.5×10^{24}

Answer: C

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59. The number of octahedral sites per sphere in fcc structure is

A. 8

B. 4

C. 2

D. 1

Answer: D

Watch Video Solution

60. The packing fraction for a body-centred cube is

A. 0.42

B. 0.53

C. 0.68

D. 0.82

Answer: C

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61. Which of the following has Frenkel defect?

A. Sodium chloride

B. Graphite

C. Silver bromide

D. Diamond

Answer: C

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62. In $NaCl$, the chloride ions occuphy the space in a fashion of

A. fcc

B. bcc

C. Both

D. None

Answer: A

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63. To get n-type of doped semi conductor, the impurity to be added to silicon should have the following number of valence electrons ?

A. 2

B. 5

C. 3

D. 1

Answer: B

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64. The range of radius ratio (cationic to anionic) for an octahedral arrangement of ions in an ionic solid is

A. $0.155 - 0.225$

B. $0.225 - 0.414$

C. $0.414 - 0.732$

D. $0.732 - 1.000$

Answer: C

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65. When molten zinc is cooled to solid state, it assumes hcp structure. Then the number of nearest neighbours of zinc atom will be

A. 4

B. 6

C. 8

D. 12

Answer: D

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66. Superconductors are derived from the compounds of

A. p-block elements

B. Lanthanides

C. Actinides

D. Transition elements

Answer: A

Watch Video Solution

67. A semiconductor of Ge can be made p-type by adding

A. Trivalent impurity

B. Tetravalent impurity

C. Pentavalent impurity

D. Divalent impurity

Answer: A

Watch Video Solution

68. The interionic distance for cesium chloride crystal will be

A. a

B. $a/2$

C. $\sqrt{3}a/2$

D. $2a/\sqrt{3}$

Answer: C

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69. Which of the following metal oxides is antiferromagnetic in nature ?

A. MnO_2

B. TiO_2

C. VO_2

D. CrO_2

Answer: A

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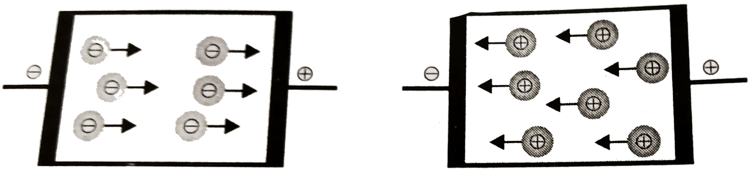
70. What are types of following semiconductors I and II.



(I) (II)

A. $I \Rightarrow p-type, II \Rightarrow n-type$

B. $I \Rightarrow n-type, II \Rightarrow p-type$

C. Both n-type

D. Both p-type

Answer: B

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71. In the structure of diamond, carbon atoms appear at

a. $0, 0, 0$, and $\frac{1}{2}, \frac{1}{2}, \frac{1}{2}$

b. $\frac{1}{4}, \frac{1}{4}, \frac{1}{4}$, and $\frac{1}{2}, \frac{1}{2}, \frac{1}{2}$

c. $0, 0, 0$, and $\frac{1}{4}, \frac{1}{4}, \frac{1}{4}$

d. $0, 0, 0$, and $\frac{3}{4}, \frac{3}{4}, \frac{3}{4}$

A. $0, 0, 0$, and $\frac{1}{2}, \frac{1}{2}, \frac{1}{2}$

B. $\frac{1}{4}, \frac{1}{4}, \frac{1}{4}$, and $\frac{1}{2}, \frac{1}{2}, \frac{1}{2}$

C. $0, 0, 0$, and $\frac{1}{4}, \frac{1}{4}, \frac{1}{4}$

D. $0, 0, 0$, and $\frac{3}{4}, \frac{3}{4}, \frac{3}{4}$

Answer: A

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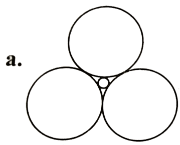
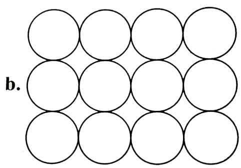
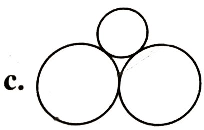
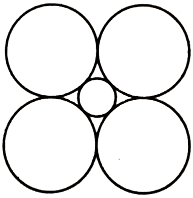
72. Which of the following figures represesets the cross-section of an octahedral site?

A. 

B. 

C. 

D. 

Answer: A

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Exercises (Assertion-Reasoning)

1. Assertion (A) : in $CsCl$ crystal, $Cs^{\oplus}$ ions asopt bcc arragement.

Reason (R) : For N atoms adopting bcc arragement, there are $2NOVs$.

a.If both (A) and (R) are correct, and (R) is the correct explanation of (A)

b.If both (A) and (R) are correct, but (R) is not the correct explanation of (A)

c.If (A) is correct, but (R) is incorrect.

d.If both (A) is incorrect, but (R) is correct.

A. If both (A) and (R) are correct, and (R) is the correct explanation of (A)

B. If both (A) and (R) are correct, but (R) is not the correct explanation of (A)

C. If (A) is correct, but (R) is incorrect.

D. If both (A) is incorrect, but (R) is correct.

Answer: C

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2. Assertion (A) : $CsCl$ crystal, the coordination number of $Cs^{\oplus}$ ion is 8.

Reason (R) : $Cl^{\ominus}$ ion in $CsCl$ adopt b type of packing,

a.If both (A) and (R) are correct, and (R) is the correct explanation of (A)

b.If both (A) and (R) are correct, but (R) is not the correct explanation of (A)

c.If (A) is correct, but (R) is incorrect.

d.If both (A) is incorrect, but (R) is correct.

A. If both (A) and (R) are correct, and (R) is the correct explanation of (A)

B. If both (A) and (R) are correct, but (R) is not the correct explanation of (A)

C. If (A) is correct, but (R) is incorrect.

D. If both (A) is incorrect, but (R) is correct.

Answer: A

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3. Assertion (A) : In sodium chloride crystal, the coordination number of $Na^{\oplus}$ IS 6.

Reason (R) : The sodium atom is smaller than chloring atom.

a.If both (A) and (R) are correct, and (R) is the correct explanation of (A)

b.If both (A) and (R) are correct, but (R) is not the correct explanation of (A)

c.If (A) is correct, but (R) is incorrect.

d.If both (A) is incorrect, but (R) is correct.

A. If both (A) and (R) are correct, and (R) is the correct explanation of (A)

B. If both (A) and (R) are correct, but (R) is not the correct explanation of (A)

C. If (A) is correct, but (R) is incorrect.

D. If both (A) is incorrect, but (R) is correct.

Answer: B

Watch Video Solution

4. Assertion (A) : The density of crystal having Schottky defect is lowered.

Reason (R) : The crystals suffering from Schottky defect have same number of cation and anions missing from their normal lattice sites.

A. If both (A) and (R) are correct, and (R) is the correct explanation of (A)

B. If both (A) and (R) are correct, but (R) is not the correct explanation of (A)

C. If (A) is correct, but (R) is incorrect.

D. If both (A) is incorrect, but (R) is correct.

Answer: A

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5. Assertion (A) : In sodium chloride crystal, $Na^{\oplus}$ ions occupy OVs while $Cl^{\ominus}$ ions occupy vertices of octahedron.

Reason (R) : The radius ratio of $Na^{\oplus}:Cl^{\ominus}$ lies between 0.4 and 0.7.

A. If both (A) and (R) are correct, and (R) is the correct explanation of (A)

B. If both (A) and (R) are correct, but (R) is not the correct explanation of (A)

C. If (A) is correct, but (R) is incorrect.

D. If both (A) is incorrect, but (R) is correct.

Answer: D

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6. Assertion (A) : Solids containing F centres are paramagnetic.

Reason (R) : Solids containing F centres conduct electricity and it is n-type semiconduction.

A. If both (A) and (R) are correct, and (R) is the correct explanation of (A)

B. If both (A) and (R) are correct, but (R) is not the correct explanation of (A)

C. If (A) is correct, but (R) is incorrect.

D. If both (A) is incorrect, but (R) is correct.

Answer: B

Watch Video Solution

7. STATEMENT -1 : Electrical consuctivity of semi - conductors incresase with increasing temperature .

STATEMENT -2: With increase in temperature , number of electrons which jumps from the valence bond to the conduction band in semi-condctors increase .

A. If both (A) and (R) are correct, and (R) is the correct explanation of (A)

B. If both (A) and (R) are correct, but (R) is not the correct explanation of (A)

C. If (A) is correct, but (R) is incorrect.

D. If both (A) is incorrect, but (R) is correct.

Answer: A

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8. Assertion (A) : Group-13-doped crystals of Si are called p-type semiconductors.

Reason (R) : Positive holes are reasponsible for the semiconducting properties.

A. If both (A) and (R) are correct, and (R) is the correct explanation of (A)

B. If both (A) and (R) are correct, but (R) is not the correct explanation of (A)

C. If (A) is correct, but (R) is incorrect.

D. If both (A) is incorrect, but (R) is correct.

Answer: A

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9. Assertion (A) : Group-15-doped crystal of Si are called n-type semiconductors.

Reason (R) : Neutrons are responsible for the semi-conducting properties.

(a)If both (A) and (R) are correct, and (R) is the correct explanation of (A)

(b)If both (A) and (R) are correct, but (R) is not the correct explanation of (A)

(c)If (A) is correct, but (R) is incorrect.

(d)If both (A) is incorrect, but (R) is correct.

A. If both (A) and (R) are correct, and (R) is the correct explanation of (A)

B. If both (A) and (R) are correct, but (R) is not the correct explanation of (A)

C. If (A) is correct, but (R) is incorrect.

D. If both (A) is incorrect, but (R) is correct.

Answer: C

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10. Assertion (A) : Non-stoichiometric compounds are called Bertholide compounds. $NaCl$ and KCl crystal, when heated in an atmosphere of Na and K varpours, respectively, they impart violet and yellow colours to $NaCl$ and KCl, respectively.

Reason (R) : Metal excess defect is due to the presence of extra cations atg the interstitial sites. The excess metal ions move to the interstitial sites and the electrons to the neighbouring sites. The colour results byt the excitation of these electrons by absorbing suitable energy from visible light. When the excited electroon comes back to the ground state, there is emission of radiation in the visible region and gives complimentary colour.

A. If both (A) and (R) are correct, and (R) is the correct explanation of (A)

B. If both (A) and (R) are correct, but (R) is not the correct explanation of (A)

C. If (A) is correct, but (R) is incorrect.

D. If both (A) is incorrect, but (R) is correct.

Answer: D

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11. Assertion (A) : Graphite is an example of tetragonal crystal system.

Reason (R) : For a tetragonal system, $a = b \neq c$ and $\alpha = \beta = 90^\circ, \gamma = 120^\circ$.

A. If both (A) and (R) are correct, and (R) is the correct explanation of (A)

B. If both (A) and (R) are correct, but (R) is not the correct explanation of (A)

C. If (A) is correct, but (R) is incorrect.

D. If both (A) and (R) are incorrect.

Answer: D

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12. Assertion (A) : The size of a cation is larger in TV than in OV.

Reason (R) : Cations occupy more space than anions is crystals packing.

A. If both (A) and (R) are correct, and (R) is the correct explanation of (A)

B. If both (A) and (R) are correct, but (R) is not the correct explanation of (A)

C. If (A) is correct, but (R) is incorrect.

D. If both (A) and (R) are incorrect.

Answer: D

Watch Video Solution

13. STATEMENT -1 : Antiferromagnetic subatance becomes paramagentic on heating to hight temperture .

STATEMENT -2 : Heating results in spins of electrons becoming random .

A. If both (A) and (R) are correct, and (R) is the correct explanation of (A)

B. If both (A) and (R) are correct, but (R) is not the correct explanation of (A)

C. If (A) is correct, but (R) is incorrect.

D. If both (A) is incorrect but (R) is correct.

Answer: A

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14. Assertion (A) : Zinc blende and wurtzite both have f arrangement of S^{2-} ions.

Reason (R) : A unit cell of both has four formula units of ZnS.

A. If both (A) and (R) are correct, and (R) is the correct explanation of (A)

B. If both (A) and (R) are correct, but (R) is not the correct explanation of (A)

C. If (A) is correct, but (R) is incorrect.

D. If both (A) and (R) are incorrect.

Answer: D

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15. Assertion (A) : Covalent crystals have higher melting point.

Reason (R) : Covalent bonds are stronger than ionic bonds.

A. If both (A) and (R) are correct, and (R) is the correct explanation of (A)

B. If both (A) and (R) are correct, but (R) is not the correct explanation of (A)

C. If (A) is correct, but (R) is incorrect.

D. If both (A) is incorrect but (R) is correct.

Answer: C

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16. Assertion (A) : hcp is more closely packed than ccp.

Reason (R) : hcp has a CN of 12, whereas ccp has a CN of 8.

A. If both (A) and (R) are correct, and (R) is the correct explanation of (A)

B. If both (A) and (R) are correct, but (R) is not the correct explanation of (A)

C. If (A) is correct, but (R) is incorrect.

D. If both (A) is incorrect but (R) is correct.

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17. Assertion (A) : Frenkel defects are shown by AgX

.

Reason (R) : $Ag^{\oplus}$ ions have small size.

A. If both (A) and (R) are correct, and (R) is the correct explanation of (A)

B. If both (A) and (R) are correct, but (R) is not the correct explanation of (A)

C. If (A) is correct, but (R) is incorrect.

D. If both (A) is incorrect but (R) is correct.

Answer: A

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18. Assertion (A) : Triclinic systeam is the most unsymmetrical systeam.

Reason (R) : No axial angle is equal to 90° in triclinic systeam.

A. If both (A) and (R) are correct, and (R) is the correct explanation of (A)

B. If both (A) and (R) are correct, but (R) is not the correct explanation of (A)

C. If (A) is correct, but (R) is incorrect.

D. If both (A) is incorrect but (R) is correct.

Answer: B

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19. Assertion (A) : In the rock salt type structure, all the OV_s are occupied by $Na^{\oplus}$ ions.

Reason (R) : Number of OV_s = Number of $Cl^{\ominus}$ ions in the packing.

A. If both (A) and (R) are correct, and (R) is the correct explanation of (A)

B. If both (A) and (R) are correct, but (R) is not the correct explanation of (A)

C. If (A) is correct, but (R) is incorrect.

D. If both (A) is incorrect but (R) is correct.

Answer: B

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Exercises (Interger)

1. If a solid $A^{\oplus}B^{\ominus}$ having ZnS Structure is heated so that the ions along two of the axis passing throgh the face centre particles are lost and bivalent ion (Z) enters herre to maintain the electrical neutrality, so that the new formula unit becomes $A_xB_yZ_c$, report the value of $x+y+c$.

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2. Metal M of radius $50nm$ is crystallized in fcc type and made cubical crystal such that face of unit cells aligned with face of cubical crystal. If the total number of metal atoms of M at all faces of cubical crystal is 6×10^{30}, then the area of one face of cubical crystal is $A \times 10^{16} m^2$. Find the value of A.

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3. $O_{2\,-}$ ions are arranged in p in spinel strructure. A^{2+} ions occupy $1/8$ of TV_s and $B^{\oplus}$ ions occupy half of OV. The void volume of unit cell $= 0.11Å$. Find the value of A.

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4. Find the coordination of $Na^{\oplus}$ in Na_2O.

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5. A body centered cubic lattice is made up of hollow sphere of B. Spheres of solid A are present in hollow spheres of B. Radius of A is half of radius of B . What is the ratio of total volume of spheres of B unocupied by A in a unit cell and volume of unit cell ?

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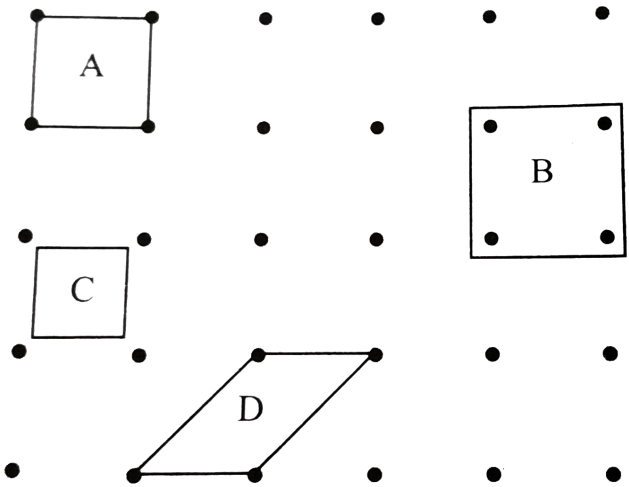
6. In the figure given below, four parallelograms are shown. How many parallelograms are a unit cells?



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7. Cesium atoms are the largest neturally occurring atoms. The radius of Cs atom is 2.6Å. The number

of moles of Cs atoms to be laid side by side to give a row of Cs atoms $2.5cm$ long is $x \times 10^{-17}$. Find the value of x.

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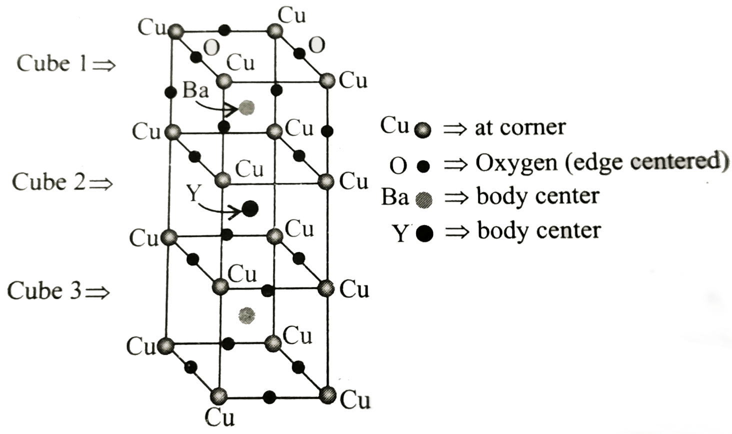
8. The following figure shows the unit cell of a compound, i.e., a mixed oxide of yttrium, bariym, and copper. The formula of mixed oxide is $Y_a Ba_b Cu_c O_d$.

Find the value of $(a+b+c+d)$.



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9. A solid has a structure in which X atoms are located at cubic corners of unit cell, O atom are at the edge centres and Y atoms at cube centre.

Then the formula of compound is $X_aY_bO_c$

If two atoms of O missing from any of two edge centres per unit cell, then the molecular formula is $X_aY_bO_z$. Then, find the value of $(x + y + z) - (a + b + c)$.

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Exercises (Fill In The Blanks)

1. Although amorphous solids do not posses the long range order of crystals, they do have .... just as liquids do.

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2. When a piezoeletric crystal is deformed by mechanical stress .... is produced due to the displacement of ions.

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3. Unlike paramagenetic substance, ferromagnetic substances show .... even if the external magnetic field is removed.

Watch Video Solution

4. The number of atoms touching a particular atom in a crystal is called its ....

Watch Video Solution

5. The number of atoms present per unit cell in simple, fcc and bcc are ...., ..., and ...., respectively.

Watch Video Solution

6. A metallic element crystallises into a lattice having a ABC ABC ...... pattern and packing of spheres leaves out voids in the lattice. What type of structure is formed by this arrrangement ?

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7. The compounds having the general molecular formula $A^{2+}Fe_{2.04}$ are called ....

Watch Video Solution

8. If $r_{\oplus} / r_{\ominus}$ for a crystal is 0.50, it has .... structure.

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9. Introducing a defect in a crystal by adding impurity is called ....

Watch Video Solution

10. When a substance conducts elecricity without any resistance, it is called a ....

Watch Video Solution

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

Watch Video Solution

12. In the sodium chloride structure each $Na_{\oplus}$ ion is surrounded by six $Cl^{\ominus}$ ions nearest neighbours and .... $Na^{\oplus}$ ions next nearest neighbours.

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13. For N atoms in a crystal with N_i interstitial position in its structure. If there are n Frenekel defects in the crystal, then $n =$ ....

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14. If a crystal a contains a total of N atoms and n Schottky defects are produced by removing n cations and r anions from the interior of the crystal, then $n =$ ....

Watch Video Solution

15. The distance between any two TV_s formed one any body diagonal of a closest packed structure is $= x \times a$, where a is the edge length of closest packed structure.

the value of `x = ...

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Exercises (True/False)

1. It is much more difficult to describe the crystal structure of compounds than those of elements.

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2. If the radius of the spheres in the close packing is R and the radius pf pctahedral voids is r, then $r = 0.414R$.

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3. Is the below statement correct or wrong

In crystals, the state of complete order and of lowest energy is formed at $0^\circ C$.

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4. Comment on below statement

Amorphous solids lack the repeact ordered arrangement of atoms or ions.

Watch Video Solution

5. Comment on below statement

In bcc lattice, the atoms at the corners of the unit cell are in contact with each other.

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6. The cubic close-packed structure is based on an fcc unit cell.

Watch Video Solution

7. In ZnS (zinc blende) strucutre, the CN of each ion ie 4.

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8. Solids with Schottky defects are electrical insulators.

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9. Platinum crystallizes in fcc crystal with a unit cell length a. The atomic radius of platinum is therefore $a\sqrt{2}/2$.

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10. There are four formula units in fluorite and antifluorite structure.

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11. In antifluorite structure, 50% of TVs are occupied by anion.

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12. In fluorite structure, 100% of TVs are occupied by cations.

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13. The number of carbon atoms per unit cell of diamond unit cell is

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14. ZnS exists in two different form: zinc blende and wurtzite. Both occur in $4:4$ coordination compounds. Zinc blende has an fcc structure and wurtizite has an hcp structure.

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15. $Fe^{III}(Fe^{II}Fe^{III})O_4$ represent an inverse $2:3$ spinel structre.True/False.

Watch Video Solution

16. The addition of $CaCl_2$ to a KCl crystal lowers the density of the KCl crystal.

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17. The maximum number of Bravais lattices is shown by tetragonal-type crystals.State whether the given statement is true or false.

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18. Comment on the below statement

Bragg reflection can occur only when $\gamma \leq 2d$.

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19. Comment on the below statement

TVs and OVs both are found is hcp and simple cube.

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Exercises (Archives) Linked Comprehension

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

The number of atom in this hcp unit cell is

(a)4

(b)6

(c)12

(d)17

A. 4

B. 6

C. 12

D. 17

Answer: B

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2. In a hexaonal system system of cycstals, a frequently encountered arrangement of atoms is described as a hexagonal prism. Here, the top and bottom of the cell are refular hexagons, and three atoms are sandwiched in between them. A space-cilling model of this structure, called hexagonal close-paked is constituted of a sphere on a flat surface surrounded in the same plane by six identical spheres as closely as possible. Three spherres are then placed overt the first layer so that they toych each other and represent the second layer so that they toych each other and present the second layer. Each one of the three spheres touches three spheres of the bottom layer. Finally, the second layer is convered with a third layer identical to the bottom layer in relative position. Assume the radius of every sphere to be r.

The voume of this hcp unit cell is

A. $24\sqrt{2}r^3$

B. $16\sqrt{2}r^3$

C. $12\sqrt{2}r^3$

D. $\frac{64}{3\sqrt{3}r^3}$

Answer: A

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3. In a hexaonal system system of cycstals, a frequently encountered arrangement of atoms is described as a hexagonal prism. Here, the top and bottom of the cell are refular hexagons, and three atoms are sandwiched in between them. A space-cilling model of this structure, called hexagonal close-paked is constituted of a sphere on a flat surface surrounded in the same plane by six identical spheres as closely as possible. Three spherres are then placed overt the first layer so that they toych each other and represent the second layer so that they toych each other and present the second layer. Each one of the three spheres touches three spheres of the bottom layer. Finally, the second layer is convered with a third layer identical to the bottom layer in relative position. Assume the radius of every sphere to be r.

The empty space in this hcp unit cell is

(a)$74\ \%$

(b)$48.6\ \%$

(c)$32\ \%$

(d)$26\ \%$

A. 74%

B. 48.6%

C. 32%

D. 26%

Answer: D

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Exercises (Archives) Multiple Correct

1. Which of the following statements is/are correct?

A. The coordination number of each type of ion in $CsCl$ crystal is 8.

B. A metal that crystallizes in bcc structure has a coordination number of 12.

C. A unit cell of an ionic crystal shares some of its ions with other unit cells.

D. The edge length of the unit cell in $NaCl$ is 552 pm $(r_{Na^{\oplus}} = 95$ pm, $r_{Cl^{\oplus}} = 181 \pm)$.

Answer: A::C::D

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2. Which of the following statement regarding defects in solids is/are correct?

A. Frenkel defect is usually favoured by a very small difference in the sizes of cation and anion.

B. Frenkel defect is a dislocation defect.

C. Trapping of an electron in the lattice leads to the formation of F-centre.

D. Schottky defects have no effect on the physical properties of solids.

Answer: B::C

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Exercises (Archives) Single Correct

1. $CsBr$ has b structure with edge length of $43 \pm$. The shortest interionic distance between cation and anion is

A. 37.2

B. 18.6

C. 74.4

D. 43

Answer: A

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2. The cordination number of a metal crystallising in a hexagonal close-packed structure is:

A. `12

B. 4

C. 8

D. 6

Answer: A

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3. In a solid 'AB' having the $NaCl$ structure, 'A' atoms occupy the corners of the cubic unit cell. If all the face centered atoms along one of the axes are removed, then the resultant stoichiometry of the solid is :

A. AB_2

B. A_2b

C. A_4B_3

D. A_3B_4

Answer: D

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4. A substance A_xB_y crystallizes in a face-centred cubic lattice in which atoms A occupy the centres of each face of the cube. Identify the correct composition of the substance A_xB_y.

A. AB_3

B. A_4B_3

C. A_3B

D. Cannot be specified

Answer: A

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5. In which of the following crystals, alternate tetrahedral voids are occupied?

A. $NaCl$

B. ZnS

C. CaF_2

D. Na_2O

Answer: B

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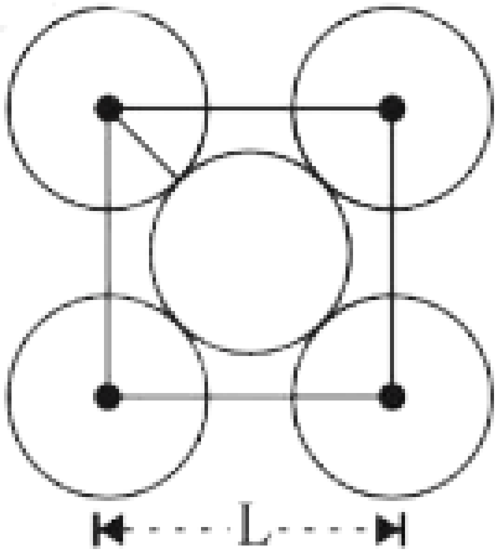
6. The packing efficiency of the two-dimensional square unit cell shown below is :



A. 39.27%

B. 68.02%

C. 74.05%

D. 78.54%

Answer: D

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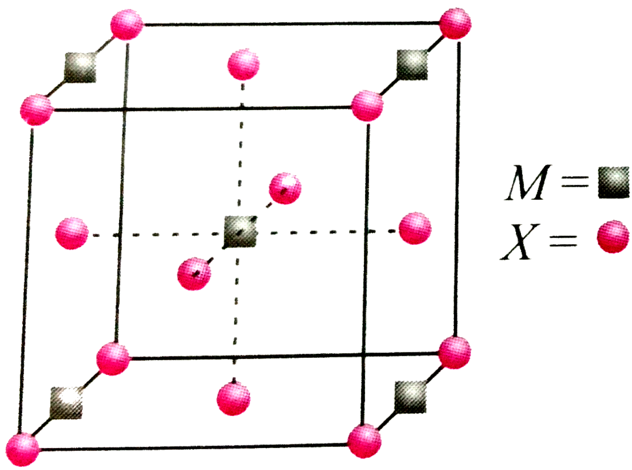
7. A compound M_pX_q has cubic close packing (ccp) arrangement of X. Its unit cell structure shown below . The empirical formula of the compound is



A. MX

B. MX_2

C. M_2X

D. M_5X_{14}

Answer: B

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8. Experimentally it was found that a metal oxide has formula $M_{0.98}O$. Metal M is present as M^{2+} and M^{3+} in its oxide ,Fraction of the metal which exists as M^{3+} would be

A. $4.08\ \%$

B. 6.05%

C. 5.08%

D. 7.01%

Answer: A

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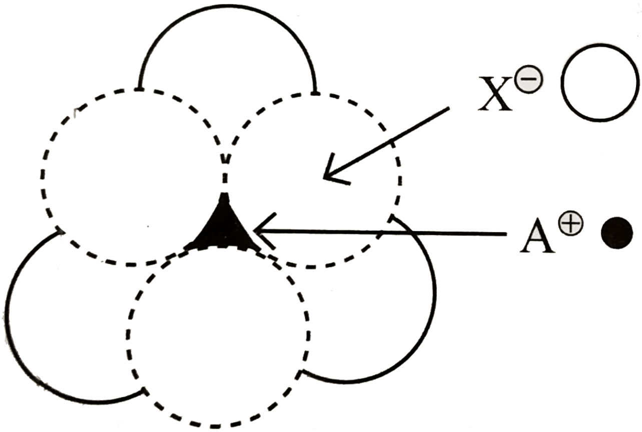
9. The arrangement of $X^{\ominus}$ ions around $A^{\oplus}$ ion in solid AX is given in the figure (not drawn to scale).

If the radius of $X^{\ominus}$ is $250 \pm$, the radius of $A^{\oplus}$ is



A. $104 \pm$

B. $125 \pm$

C. $183 \pm$

D. $57 \pm$

Answer: A

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10. CsCl crystallises in body centred cubic lattice. If 'a' is its edge length then which of the following expression is correct ?

A. $r_{Cs^{\oplus}}+r_{CI^{\ominus}}=\frac{\sqrt{3}}{2}a$

B. $r_{Cs^{\oplus}}+r_{CI^{\ominus}}=\sqrt{3}$

C. $r_{Cs^{\oplus}}+r_{CI^{\ominus}}=3a$

D. $r_{Cs^{\oplus}}+r_{CI^{\ominus}}=\frac{3a}{2}$

Answer: A

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Exercises (Archives) Assertion-Reasoning

1. STATEMENT -1: In any ionic solid [MX] with SCHOTTKY defects , the number of positive and negative ions are the same.

STATEMENT -2 : Equal number of cation and anion vacancies present .

A. Statement I is true, Statement II is true, Statement II is a correct explanation of Statement I.

B. Statement I is true, Statement II is true, Statement II is not a correct explanation of

Statement I.

C. Statement I is true, Statement II is false.

D. Statement I is false, Statement II is true.

Answer: A

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Exercises (Archives) Interger

1. Find the number of hexagonal faces that are present in a truncated octahedral.

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Exercises (Archives) Subjective

1. Sodium metal crystallizes in a body centred cubic lattice with a unit cell edge of 4.29 Å. The radius of sodium atom is approximately :

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2. A metal crystallises into a lattice containing a sequence of layers as AB AB AB ___ . What percentage of voids are left in the lattice ?

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3. The body centered cubic cell of chronium has an edge lenth of 0.288nm. Calculte the density of chromium $\left(g/cm^3\right)$: $(\text{Atomic mass} : Cr = 52.0)$

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4. A metal crystallises into two cubic phases , face centred cubic (fcc) and body centred cubic (bcc) , whose unit cell lengths are 3.5 Å and 3.0 Å , respectively. The ratio of densities of fcc and bcc is

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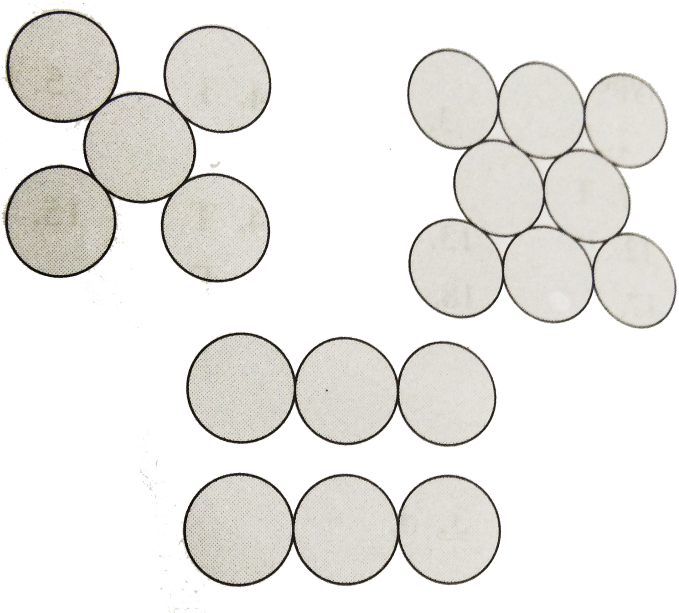
5. The figure below show the locations of atoms in three crystallographic planes in an fcc lattice. Draw the unit cells for these structure and identify these planes in your diagrams.



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6. You are given marbles of diameter $10mm$. They are to be placed such that their centres are laying in a square bound by four lines each of length $40mm$. What will be the arrangements of marbles in a plane so that maximum number of marbles can be placed inside the area? Sketch the diagram and derive expression for the number of molecules per unit area.

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7. The crystal AB(rock salt structure) has molecular weight $6.023 Y u$, where Y is an arbitrary number in u. If the minimum distance between cation and anion is $Y^{\frac{1}{3}} nm$. Find the density in kgm^{-3}.

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8. An element crystallises in $f.c.c.$ lattice having edge length $400 pm$. Calculate the maximum diameter, which can be placed in interstitial sites without disturbing the structure.

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9. The edge length of unit cell of a metal having molecular weight $75 g mol^{-1}$ is $5 \mathring{A}$ which crystallizes in cubic lattice. If the density is $2 g cm^{-3}$, then find the radius of metal atom $\left(N_A = 6 \times 10^{23}\right)$. Give the answer in pm.

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Ex 1.1 (Subjective)

1. A compound formed by element X and Y crystallizes in the cubic structure when Y atoms are at the corners of the cube and X atoms are at the

alternate faces. What is the formula of the compound?

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

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

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4. In a face centered cubic arrangement of A and B atoms whose A atoms are at the corner of the unit cell and B atoms at the face centers. One of the B atoms missing from one of the face in unit cell. The simplest formula of compounding is:

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5. A solid AB has $NaCl$ structure. If the radius of the cation A is 100 pm, what is the radius of anion B?

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6. In a crystallizes solid, anions B are arranged in cubic close packing, cations A are equally distributed between octahedral and tetrahedral voids, what is the formula of the solid?

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7. In sapphire, oxide ions are arranged in hexagonal close packing and aluminium ions occupy two-thirds of the octahedral voids. What is the formula of sapphire?

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8. The density of NH_4Cl is $1.534 g cm^{-3}$. It crystallizes in the $CsCl$ lattice.

a. Calculate the length of the length of the edge of NH_4Cl unit cell.

b. Calculate the shortest distance between a $NH_4^{\oplus}$ ion and a $Cl^{\ominus}$ ion.

c. Calculate the radius of $NH_4^{\oplus}$ ion if the radius of the $Cl^{\ominus}$ ion is 181 pm

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9. A solid $A^{\oplus}B^{\ominus}$ has $NaCl$-type close-packed structure. If the radius of the cation is 90 pm, calculate the probable range of the radius of the anion.

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10. A solid $A^{+}B^{-}$ has $NaCl$-type close-packed structure. If the anion has a radius of 250 pm, what should be the ideal radius for the cation? Can a cation C^{+} having radius of 180 pm be slipped into the tetrahedral site of the crystal $A^{+}B^{-}$? Give reason for your answer.

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11. In a close packed structure of mixed oxides , the lattice is composed of oxide ions, one-eighth of tetrahedral voids are occupied by divalent cations while one-half of octahedral voids are occupied by trivalent cations. The formula of the oxide is

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12. a. MgO has the structure of $NaCl$ and $TICI$ has the structure of $CsCl$. What are the coordiantion number of the ions in MgO and $TICI$?

If the closed-packed cations in an XY-type solid have a raidus of 73.2 pm, what would be the maximum and minimum sizes of the anions filling voids?

c. Fe_2O_3 (haematite) forms ccp arrangement of

O^{2-} ions with Fe_{3+} ions occupying initerstitial positions. Predict whether fe^{3+} ions are in the OV or TV. Given $r_{Fe^{3+}} = 0.7Å$ and $r_{O^{2-}} = 1.4Å$

d. A solid XY has $CsCl$-type structure. The edge length of the unit cell is $400 \pm$ Calculate the distance of closest approach between $X^{\oplus}$ and $Y^{\ominus}$ ions.

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Ex 1.1 (Objective)

1. Which of the following statement is correct in the zinc blende type structure of an ionic comound?

A. Coordination number of each cation and anion is 2.

B. Coordination number of each cation and union is 4.

C. Coordination number of each cation and union is 6.

D. Coordination number of each cation and union is 8.

Answer: B

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2. In the body centered cubic unit cell and simple unit cell, the radius of atoms in terms of edge length (a) of the unit cell is respectively:

A. $a/2$

B. $a/\sqrt{2}$

C. $a/2\sqrt{2}$

D. $\sqrt{3}a/4$

Answer: D

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3. Which of the following expression is correct in case of a sodium chloride cell (edge length, a)?

A. $r_{\oplus} + r_{\ominus} = a$

B. $r_{\oplus} + r_{\ominus} = a/2$

C. $r_{\oplus} + r_{\ominus} = 2a$

D. $r_{\oplus} + r_{\ominus} = \sqrt{2}a$

Answer: B

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4. In silicon crystal, Si atoms from fcc arrangement where 4 out $8TVs$ are alos occupied by Si atoms. Z_{eff} of unit cell is

A. 1

B. 2

C. 4

D. 8

Answer: D

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5. Which of the following crystal systems exist in bcc, end-centred, fcc, as well as primitive unit cell?

A. Hexagonal

B. Cubic

C. Triclinic

D. Orthorhombic

Answer: D

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6. In a cubic, A atoms are present on alternative corners, B atoms are present on alternate faces, and C atoms are present on alternalte edges and body centred of the cube. The simplest formula of the compound is

A. A_2BC_4

B. AB_2C_4

C. ABC_4

D. ABC_2

Answer: B

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7. The fraction of octahedral voids filled by Al^{3+} ion in $Al_2O_3(r_{Al^{3\oplus}} / r_{O^{2-}} = 0.43)$ is

A. 0.43

B. 0.287

C. 0.667

D. 1

Answer: C

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8. In the closet packing of atoms, there are:

A. One tetrahedral voids and two octahedral voids per atom

B. Two tetrahedral voids and one octahedral void per atom

C. Two of each tetrahedral and octahedral voids per atom

D. One of the each tetrahedral and octahedral void per atom

Answer: B

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9. Which of the following statements is correct in the body centred type of cubic structure of ionic compound?

A. Coordination number of each cation and anion is 2.

B. Coordination number of each cation and anion is 4.

C. Coordination number of each cation and anion is 6.

D. Coordination number of each cation and anion is 8.

Answer: D

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10. Aluminium metal has a density of $2.72 gcm^{-3}$ and crystallizes in a cubic lattice with an edge of 404 pm. Which is//are correct?

A. It forms bcc unit cell

B. It forms fcc unit cell

C. Its $CN = 8$

D. Its CN is 6

Answer: B

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11. If atoms are removed from half of the edge-centred OV_s in $RbBr$, then the molecular formula of unit cell is

A. Rb_2Br_2

B. $Rb_{1.5}Br_3$

C. $Rb_{2.5}Br_4$

D. $Rb_4Br_{2.5}$

Answer: C

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12. ThO_2 exists in fluorite structure, what is the effective number of bivalent ion in the unit cell of ThO_2?

A. 2

B. 4

C. 1

D. 8

Answer: D

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13. What is the coordination number of Th^{4+} in ThO_2?

A. 4

B. 8

C. 6

D. 12

Answer: C

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14. The coordination number Cs and Br in $CsBr$ are, respectively,

A. 8, 8

B. 6, 6

C. 8, 6

D. 6, 8

Answer: A

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15. The fraction of the total volume occupied by the atoms present in a simple cube is

A. $\sqrt{3}\pi / 8$

B. $\pi / 6$

C. $\pi / 3$

D. $\sqrt{2}\pi / 3$

Answer: B

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16. Xenon crystallises in face - centered cubic , and the edge of the unit cell is 620 pm .The radius of a xenon atom is

A. 219.20 pm

B. 438.5 pm

C. 290.3 pm

D. 318.53 pm

Answer: A

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17. In BeO (zinc blende structure), Mg^{2+} is introduced in available TV is. The coordination numbers of Be^{2+} and Mg^{2+} are, respectively,

A. $8, 8$

B. $6, 6$

C. $4, 4$

D. $8, 6$

Answer: C

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18. If the ions are removed from a single body diagonal in above case after doping, then the molecular formula of the unit cell would be

A. $Mg_2Be_{3.5}O_{2.5}$

B. $Mg_3Be_3O_{3.75}$

C. $Mg_3Be_3O_{3.5}$

D. $Mg_4Be_4O_{2.5}$

Answer: B

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19. In spinel, Mg^{2+} is present in one-eighth of TVs in an fcc lattice of oxide ions and Al^{3+} ions are present in half of the OVs. The Formula of spinel is

A. $MgAl_3O_3$

B. $MgAl_2O_3$

C. $MgAl_2O_4$

D. $MgAl_3O_4$

Answer: C

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Ex 1.2 (Subjective)

1. The number of Schottky defects (n) present in an ionic compound containing N ions at temperature T is given by $n = Ne^{-E/2KT}$, where E is the energy required to create n Schottky defects and K is the Boltzmann constant, If the mole fraction of Schottky defect in $NaCl$ crystal at $2900K$ is X, then calculate $-\ln(x)$,

Given: ΔH of Schottky defect $= 2eV$ and

$K = 1.38 \times 10^{-23} JK^{-1}$

$1eV = 1.608 \times 10^{-19} J$

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2. FeO crystallizes in $NaCl$-type of crystal lattice. The crystals of FeO are deficient in iron and are always non-stoichiometric. Some cationic sites are vacant and some contain Fe^{3+} ions but the combination is such that the structure is elctrically neutral. The formula approximates to $Fe_{0.95}O$. What is the ratio of Fe^{2+} to Fe^{3+} ions in the solid?

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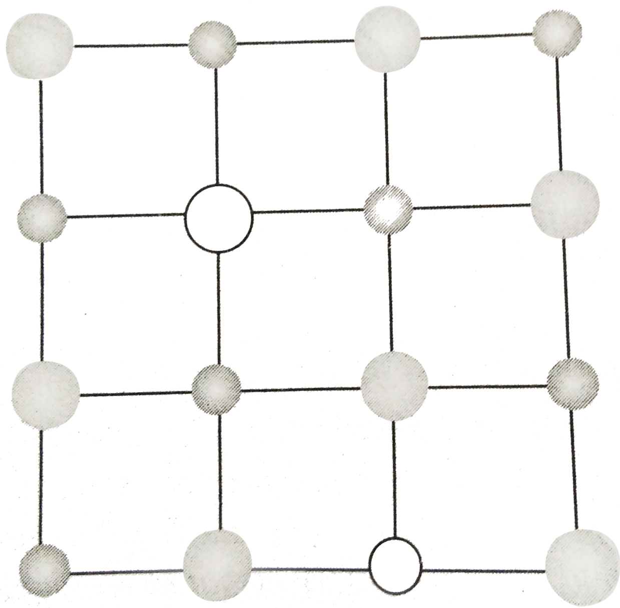
Ex 1.2 (Objective)

1. The structure shown here represents

3. The structure shown here represents



a. Sc

b. Frenkel

A. Schottky defect

B. Frenkel defect

C. Metal excess defect

D. None

Answer: A

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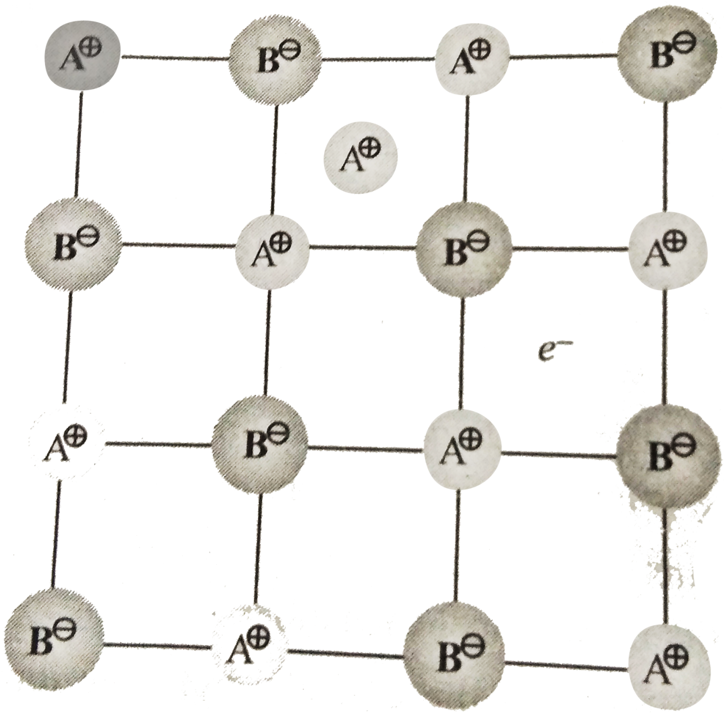
2. The structure shown here represents



A. Schottky defect

B. Frenkel defect

C. Metal excess defect because of absent anion

D. Metal excess defect because of excess cation

Answer: B

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3. In $AgCl$, the $Ag^{\oplus}$ ions are deisplaced from their lattice position to an interstitial position. Such a defect is called

A. Schottky defect

B. Frenkel defect

C. Wadsley defect

D. Colour centre

Answer: B

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4. NaCl shows Schottku defects and AgCl Frenkel defects. The electrical conductivity is due to the:

A. Motion of electrons and not the motion of ions

B. Motion of ions and not the motion of ions

C. Lower coordination number of $NaCl$

D. Higer coordination number of $AgCl$

Answer: B

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5. Amorphous solids are

A. Isotropic and supercooled liquids

B. Anisotropic and supercolled liquids

C. Isoenthalpic and supercooled liquids

D. Isotropic and supercooled solids

Answer: A

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6. Due to Frenkel defect, the density of ionic solids:

A. Density of the crystal increases

B. Conducation and increases

C. Conduction decreases

D. Crystal becomes charged electrically

Answer: B

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7. Which of the following statement is/are correct?

A. All ferroelectric solids are piezoelectric.

B. All piezoelectric solids are ferroelectric.

C. Lead zirconate (PbZ_rO_3) is a an antiferroelectric is an antiferroelectric crystal.

D. $BaTiO_3$, (barium titanate) is a ferroelectric crystal.

Answer: A::C::D

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8. Which of the following statement is//are correct?

A. A diode is a combination of p-and n-type semiconductors which is used as a rectifier.

B. Transistors are sandwich semiconductors of the type pnp or npn which are used to detect or amplify radio or audio signals.

C. Monoxides of transition metals, all of which posses $NaCl$ structures, show very large variations in electrical properties.

D. ReO_3 has the conductivity as well as appearance like that of copper.

Answer: A::B::C::D

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9. Identify the Acidic salt? NaCl,NaNO3,NH4Cl

A. Piezoelectric crystals are used as pick-ups in record players, they are also used in microphones, ultrasonic generators, and sonar detectors.

B. $BaTiO_3$, Rochelle salt, KH_2PO_4, and quartz are ferroelectric and piezoelectric solids.

C. The temperature above which no ferromagnetism is observed is called curie termperature.

D. The temperature at which the material shows super-conductivity is called transition termperature.

Answer: A::B::C::D

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