UNIT- 6 SOLID STATE

I. Choose the best answer:

1. Graphite and diamond are
   a) Covalent and molecular crystals b) ionic and covalent crystals
   c) both covalent crystals d) both molecular crystals

2. An ionic compound AxBy crystallizes in fcc type crystal structure with B ions at the centre of each face and A ion occupying entre of the cube. the correct formula of A_xB_y is
   a) AB b) AB_3 c) A_3B d) A_8B_6

3. The ratio of close packed atoms to tetrahedral hole in cubic packing is
   a) 1:1 b) 1:2 c) 2:1 d) 1:4

4. Solid CO_2 is an example of
   a) Covalent solid b) metallic solid c) molecular solid d) ionic solid

5. **Assertion :** monoclinic sulphur is an example of monoclinic crystal system
Reason: for a monoclinic system, $a \neq b \neq c$ and $\alpha = \gamma = 90^0$, $\beta \neq 90^0$
   a) Both assertion and reason are true and reason is the correct explanation of assertion.
   b) Both assertion and reason are true but reason is not the correct explanation of assertion.
   c) Assertion is true but reason is false.
   d) Both assertion and reason are false.

6. In calcium fluoride, having the flurite structure the coordination number of Ca^{2+} ion and F^- Ion are
   a) 4 and 2 b) 6 and 6 c) 8 and 4 d) 4 and 8

7. The number of unit cells in 8 gm of an element X (atomic mass 40) which crystallizes in bcc pattern is (NA is the Avogadro number)
   a) $6.023 x 10^{23}$ b) $6.023 \text{ x } 10^{22}$ c) $60.23 \text{ x } 10^{23}$ d) [$6.023 x 10^{23}$ / 8 x 40]

8. In a solid atom M occupies ccp lattice and (1/3) of tetrahedral voids are occupied by atom N. find the formula of solid formed by M and N.
   a) MN b) M_3N c) MN_3 d) M_3N_2

9. The ionic radii of A^+ and B^- are $0.98 \text{ x } 10^{-10}$m and $1.81 \text{ x } 10^{-10}$m. the coordination number of each ion in AB is
   a) 8 b) 2 c) 6 d) 4

10. CsCl has bcc arrangement, its unit cell edge length is 400pm, its inter atomic distance is
   a) 400pm b) 800pm c) $\sqrt{3} \times 100$pm d) $(\sqrt{3}/ 2)$ x 400pm

11. A solid compound XY has NaCl structure. if the radius of the cation is 100pm , the radius of the anion will be
   a) (100/ 0.414) b) (0.732/ 100) c) 100 x 0.414 d) (0 .414/100)

12. The vacant space in bcc lattice unit cell is
   a) 48% b) 23% c) 32% d) 26%

13. The radius of an atom is 300pm, if it crystallizes in a face centered cubic lattice, the length of the edge of the unit cell is
   a) 488.5pm b) 848.5pm c) 884.5pm d) 484.5pm

14. The fraction of total volume occupied by the atoms in a simple cubic is
   a) $(\pi / 4\sqrt{2})$ b) $(\pi /6)$ c) $(\pi/4)$ d) $(\pi/ 3\sqrt{2})$

15. The yellow colour in NaCl crystal is due to
   a) excitation of electrons in F centers b) reflection of light from Cl^- ion on the surface
   c) refraction of light from Na^+ ion d) all of the above

16.if ‘a’ stands for the edge length of the cubic system ; sc , bcc, and fcc. Then the ratio of radii of spheres in these systems will be respectively.

a) ½ a: $\frac{\sqrt{3}}{2}a$: $\frac{\sqrt{3}}{2}a$ b) ($\sqrt{1}a$: $\sqrt{3}a$: $\sqrt{2}a$)

c) (½ a : $\frac{\sqrt{3}}{4}$ a : 1/2 $\sqrt{2}a$) d) (½ a : $\sqrt{3}a$: 1/ $\sqrt{2}\,a$)

17.if ‘a’ is the length of the side of the cube, the distance between the body centered atom and one corner atom in the cube will be

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

18.Potassium has a bcc structure with nearest neighbor distance 4.52 A^0 . Its atomic weight is 39. Its density will be

a) 915 kg m^{-3} b) 2142 kg m^{-3} c) 452 kg m^{-3} d) 390 kg m^{-3}

19.Schottky defect in a crystal is observed when

a) unequal number of anions and anions are missing from the lattice
b) equal number of anions and anions are missing from the lattice
c) an ion leaves its normal site and occupies an interstitial site
d) no ion is missing from its lattice.

20.The cation leaves its normal position in the crystal and moves to some interstitial position, the defect in the crystal is known as

a) Schottky defect b) F center c) Frenkel defect d) non-stoichiometric defect

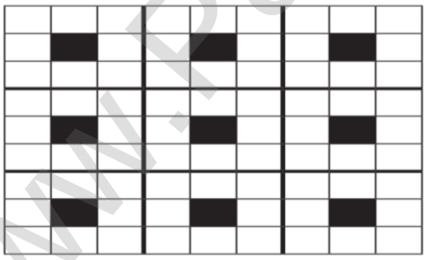
21.**Assertion:** due to Frenkel defect, density of the crystalline solid decreases.
Reason: in Frenkel defect cation and anion leaves the crystal.

a) Both assertion and reason are true and reason is the correct explanation of assertion.
b) Both assertion and reason are true but reason is not the correct explanation of assertion.
c) Assertion is true but reason is false.
d) Both assertion and reason are false

22.The crystal with a metal deficiency defect is

a) NaCl b) FeO c) ZnO d) KCl

23.A two dimensional solid pattern formed by two different atoms X and Y is shown below. The black and white squares represent atoms X and Y respectively. The simplest formula for the compound based on the unit cell from the pattern is



a) XY_8 b) X_4Y_9 c) XY_2 d) XY_4

ANSWER

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
c	***b***	***b***	***c***	***a***	***c***	***b***	***d***	***c***	***d***
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
a	***c***	***b***	***b***	***a***	***a***	***d***	***a***	***b***	***c***
21	**22**	**23**							
d	***b***	***a***							

ONE MARK FROM INSIDE THE LESSON

1.An example for metal deficiency defect is
a) NaCl b) AgCl c) FeO d) CsCl
2. An ion leaves its regular site and occupies a position in the space between the lattice sites. This defect is
a) Schottky defect b) Frenkel defect c) impurity defec d) vacancy defect
3. In a simple cubic cell, each point on a corner is shared by
a) one unit cell b) two unit cells c) eight unit cells d) four unit cells
4.In Bragg's equation 'n' represent
a) number of moles b) Avogadro number c) quantum number d) order of reflection
5.The co-ordination number of ZnS is
a) 3 b) 4 c) 6 d) 8
6. The crystal structure of CsCl is
a) simple cube b) face-centred cube c) body-centred cube d) edge-centred cube
7. An example for Frenkel defect is
a) NaCl b) AgBr c) CsCl d) FeS
8. The Coordination number of each atom in Simple Cubic , Face centered cubic , Body centered cubic are
a) 6 , 2 , 8 b)2 , 6 , 8 c)2 , 6 , 2 d)6 , 2 , 6
9. The solid in which its constituents have an orderly arrangement extending over a long range
a) Ionic solid b) Molecular solids c) Crystalline solids d) Amorpous solids
10. The solids which are good conductors of electricity and heat are
a) Ionic solids b) Molecular solids c) Metallic solids d) Covalent solids
11. Which one is Non Stoichiometric defect
a) Metal excess effect b) Frenkel defect c) Metal deficiency defect d)Both a and c
12. Percentage of free space (vacant) in Simple cubic, Body centered, Face centered cubic unit cell (Cubic close packing) are
a) 47..69 % , 32 % , 26 % b) 47..69 % , 30 % , 26 %
c) 48..69 % , 32 % , 26 % d) 47..69 % , 32 % , 28 %
13. In AAA type each sphere is arranged in contact with ----------- of its neighbours
a)six b)four c)two d)none of these
14. In ABAB… type each sphere is arranged in contact with ----------- of its neighbours
a)six b)four c)two d)none of these
15. Three atoms P , Q , R crystallize in a cubic solid lattice having P atoms at corners , Q atom at body centre , R atom at face centre .Identify the formula of the compound
a)PQR b)PQR_2 c)PQ_2R d)PQR_3
16. Co-ordination number of B_20_3 is
a) 2 b) 3 c) 4 d) 6
17. Of all the metals in the periodic table, only polonium crystallizes in .... pattern.
a) Simple cubic b) Body centered cubic c) Face centered d) All of these
18. Bragg's equation
a) $2 \sin\theta \lambda = n$ b) $2d \sin\theta = n$ c) $2 \sin\theta \lambda = n$ d) $2d \sin\theta = n \lambda$
19.Non-primitive unit cell from the following is
a) Simple cubic b) Body centered cubic c) Both a and b d) None of these
20. The number of octahedral voids generated is equal to n and the number of tetrahedral voids generated is
a) 2n b) 2n-1 c) 2n+1 d) 2

ANSWER

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
c	***b***	***c***	***d***	***b***	***c***	***b***	***a***	***c***	***c***
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
d	***a***	***b***	***a***	***d***	***b***	***a***	***d***	***b***	***a***

Answer the following questions:

1. Define unit cell.

A basic repeating structural unit of a crystalline solid is called a unit cell.

2. Give any three characteristics of ionic crystals.

Ionic solids have high melting points.
They do not conduct electricity in solid state.
They conduct electricity in molten state (or) when dissolved in water.
They are hard and brittle.

3. Differentiate crystalline solids and amorphous solids.

S.NO	CRYSTALLINE SOLIDS	AMORPHOUS SOLIDS
1	Long range orderly arrangement of constituents	Short range random arrangement of constituents
2	Definite shape	Irregular shape
3	Anisotropic in nature	Isotropic in nature
4	They are true solids	They are pseudo solids (or) super cooled liquids
5	Definite Heat of fusion	Heat of fusion is not definite
6	They have sharp melting points	They do not have sharp melting points

4. Classify the following solids

a. P_4 b. Brass c. diamond d. NaCl e. Iodine

a. P_4 : Covalent Solid
b. Brass : Metallic Solid
c. diamond : Covalent Solid
d. NaCl : Ionic Solid
e. Iodine : Molecular Solid

5. Explain briefly seven types of unit cell.

S.NO	NAME OF THE UNIT CELL	EDGE LENGTH	ANGLES
1	Cubic	a=b=c	$\alpha=\beta=\gamma=90^o$
2	Rhombohedral	a=b=c	$\alpha=\beta=\gamma\neq90^o$
3	Hexagonal	a=b≠c	$\alpha=\beta=90^o, \gamma=120^o$
4	Tetragonal	a=b≠c	$\alpha=\beta=\gamma=90^o$
5	Orthorhombic	a≠b≠c	$\alpha=\beta=\gamma=90^o$
6	Monoclinic	a≠b≠c	$\alpha=\gamma=90^o, \beta\neq90^o$
7	Triclinic	a≠b≠c	$\alpha\neq\beta\neq\gamma\neq90^o$

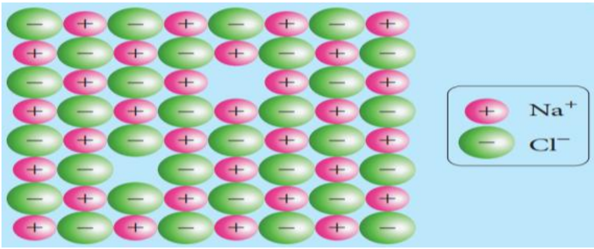
8. What are point defects?

Point defects are the deviations from ideal arrangement that occurs at some points or atoms in a crystalline substance.

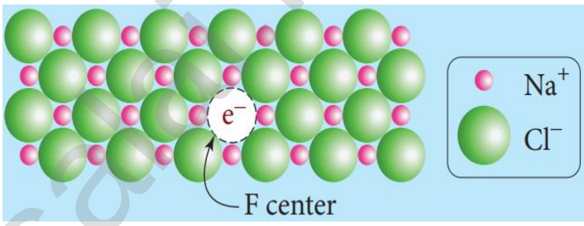
9. Explain Schottky defect.

Schottky defect arises due to the missing of equal number of cations and anions from the crystal lattice .Hence stoichiometry of the crystal is not changed.

Ionic solids in which the cation and anion are of almost of similar size show schottky defect. Example: **NaCl**. Presence of large number of schottky defects in a crystal lowers its density.



10. Write short note on metal excess and metal deficiency



Metal excess defect:

Metal excess defect arises due to the presence of more number of metal ions as compared to anions. Alkali metal halides NaCl, KCl show this type of defect.

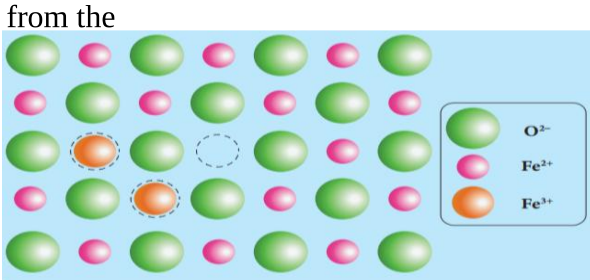
The electrical neutrality of the crystal can be maintained by the presence of anionic vacancies equal to the excess metal ions (or) by the presence of extra cation and electron present in interstitial position.

For example, when NaCl crystals are heated in the presence of sodium vapour, Na^+ ions are formed and are deposited on the surface of the crystal. Chloride ions (Cl^-) diffuse to the surface from the lattice point and combines with Na^+ ion. The electron lost by the sodium vapour diffuse into the crystal lattice and occupies the vacancy created by the Cl^- ions. Such anionic vacancies which are occupied by unpaired electrons are called F centers. Hence, the formula of NaCl which contains excess Na+ ions can be written as $Na_{1+x}Cl$.

Metal deficiency defect:

Metal deficiency defect arises due to the presence ofless number of cations than the anions. This defect is observedin a crystal in which, the cations have variable oxidation states.

For example, in FeO crystal, some of the Fe^{2+} ions are missing from the crystal lattice. To maintain the electrical neutrality, twice the number of other Fe^{2+} ions in the crystal is oxidized to Fe^{3+} ions. In such cases, overall number of Fe^{2+} and Fe^{3+} ions is less than the O^{2-} ions. It was experimentally found that the general formula of ferrous oxide is Fe_xO, where x ranges from 0.93 to 0.98.



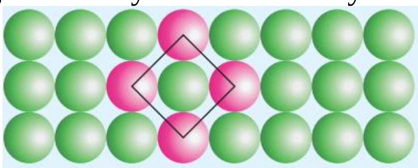
11. Calculate the number of atoms in a FCC unit cell.

Number of atoms in fcc unit cell = Nc/8 + Nf/2 = 8/8+6/2 =1+3=4

12. Explain AAAA and ABABA packing with the help of neat diagram.

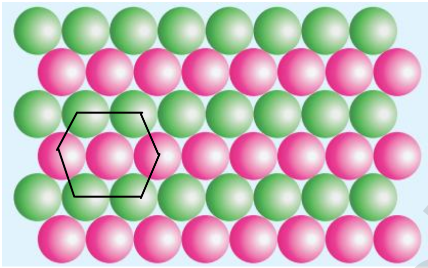
a) AAAA close packing type

The spheres are Linearly arranged in one direction and repeated in two dimension.
All the spheres of different rows align vertically and horizontally.
Each sphere has 4 neighbours.



b) ABABAB packing type

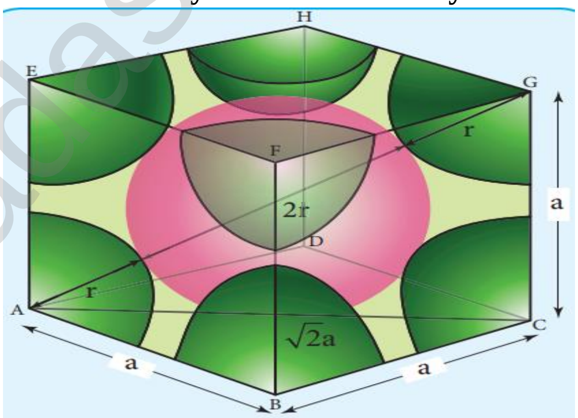
The second row of spheres is arranged such a way that they fit in the depression of the first row.
The third row of spheres is arranged similar to the first row.
Each sphere has 6 neighbours.



13. Why ionic crystals are hard and brittle?

Ionic crystal are hard due to strong electrostatic force of attraction between cations and anions.
They are brittle because ionic bonds are non directional.

14. Calculate the percentage efficiency of packing in case of body centered cubic crystal.



In ΔABC

$AC^2 = AB^2 + BC^2$

$AC = \sqrt{AB^2 + BC^2}$

$AC = \sqrt{a^2 + a^2} = \sqrt{2a^2}$

In Δ ACG

$AG^2 = AC^2 + CG^2$

$AG = \sqrt{AC + CG}$

$AG = \sqrt{(\sqrt{2a^2}) + a^2}$

$AG = \sqrt{2a^2 + a^2}$

$AG = \sqrt{3}\ a^2$

$\mathbf{AG = \sqrt{3}\ a}$

.ie, $\mathbf{\sqrt{3}\ a = 4\ r}$

$\mathbf{r = \sqrt{3}\ a / 4}$

Volume of the sphere with radius 'r '

$= 4/3\ \Pi\ r^3$

$= 4/3\ \Pi\ (\sqrt{3}\ a / 4)^3$

$= (\sqrt{3} / 16)\ \Pi\ a^3$

Number of spheres belong to a unit cell in bcc arrangement is equal to two and hence the total volume of all spheres.

$= 2 \times (\sqrt{3} / 16)\ \Pi\ a^3 = (\sqrt{3}\Pi\ a^3) / 8$

Packing Fraction = $\frac{(\sqrt{3}\Pi a^3) / 8}{(a^3)} \times 100$

$= (\sqrt{3}\Pi / 8) \times 100 = \sqrt{3}\Pi \times 12.5$

= 1.732 x 1.314 x 12.5

Packing Fraction = 68 %

i.e., 68 % of the available volume is occupied. The available space is used more efficiently than in simple cubic packing.

15. What is the two dimensional coordination number of a molecule in square close packed layer?

The two dimensional coordination number of a molecule in square close packed layer is 4.
In this arrangement each sphere is in contact with four of its neighbours.

17. What is meant by the term "coordination number"? What is the coordination number of atoms in a bcc structure?

The neighbouring atoms surrounded by each atom is called coordination number.
In the body centre, each atom is surrounded by eight nearest neighbours and coordination number is**8.**

18. An element has 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.

Given:

Edge of bcc (a) = 288pm
= 2,88 x 10^{-8} cm (since density is given as gcm^{-3}, the edge length should be converted to cm).

For bcc, Z = 2
Density = 7.2 gcm^{-3}
Mass of element = 208g

Solution:

M = $(a^3\rho \times N_A) / n = (2.88 \times 10^{-8})^3 \times 7.2 \times 6.023 \times 10^{23} / 2$
$= 1035.9 \times 10^{-24} \times 10^{23} / 2$
$= 51.795 g.mol^{-1}$

Number of atoms of an element = (mass / atomic mass) x 6.023 x 10^{23}
Number of atoms present in 208g = (208 / 51.795) x 6.023 x 10^{23}
= **2.418 x 10^{24} atoms**

20. If NaCl is doped with 10^{-2} mol percentage of strontium chloride, what is the concentration of cation vacancy?

100 moles of NaCl is dopped with 10^{-2} moles of $SrCl_2$
Therefore 1 mole of NaCl is dopped with $10^{-2} / 100 = 10^{-4}$ moles of $SrCl_2$
Each Sr^{2+} ion will create 1 cation vacancy in NaCl.
Numberof cationic vacancy produced by 10^{-4} mol Sr^{2+} ion = 6.023 x 10^{23} x 10^{-4}
= 6.023 x 10^{19}
Number of cation vacancies produced by $SrCl_2$ = **6.023 × 10^{19} per mol**

21. KF crystallizes in fcc structure like sodium chloride. calculate the distance between K^+ and F^- in KF.(given : density of KF is 2 4 . 8 *g cm*$^{-3}$)

Molar mass of KF = 39.1 + 19 = 58.1g / mol
$a^3 = n \times M / N_A \times \rho = (4 \times 58.1) / (6.023 \times 10^{23} \times 2.48)$
$= 15.56 \times 10^{-23} = 1.56 \times 10^{-24}$
$a = \sqrt[3]{1.563 \times 10^{-8}} = 1.1597 \times 10^{-8}$ cm
Inter ionic distance (d) $= a / \sqrt{2} = 1.1597 \times 10^{-8} / 1.414 = 0.8202 \times 10^{-8} = 8.202 \times 10^{-9}$cm

22. An atom crystallizes in fcc crystal lattice and has a density of 10 gcm^{-3} with unit cell edge length of 100pm. calculate the number of atoms present in 1 g of crystal.

Given: Density =10 gcm^{-3}: a = 100 pm = 100 x 10^{-10}cm

Mass = 1g

Number of atoms in fcc unit cell = 4

Solution:

M = ($a^3 \rho$ x NA) / n

= $(100 \times 10^{-10})^3$x 10 x 6.023 x 10^{23} / 4

= $(1 \times 10^{-8})^3$x 10 x 6.023x 10^{23} / 4

M =6.0234

M =1.505 $g.mol^{-1}$

Number of atoms of an element = (mass / atomic mass) x 6.023 x 10^{23}

Number of atoms in 1 g of crystal =1/ 1,505 x 6.023 x10^{23} = **4 x 10^{23}atoms**

23. Atoms X and Y form bcc crystalline structure. Atom X is present at the corners of the cube and Y is at the centre of the cube. What is the formula of the compound?

Number of corner atoms (X) = N_C/ 8=8 /8=1

Number of body centre atoms(Y) = N_b / 1= 1 / 1= 1

Formula of the compound = **XY**

24. Sodium metal crystallizes in bcc structure with the edge length of the unit cell 4.3×10^{-8}*cm* . calculate the radius of sodium atom.

Given: a = 4.3 ×10^{-8}*cm*.

Solution:

For bcc, r = ($\sqrt{3}$/ 4)a= 1.732 x 4.3 ×10^{-8} / 4

r =**1.86 ×10^{-8} cm**

25. Write a note on Frenkel defect.

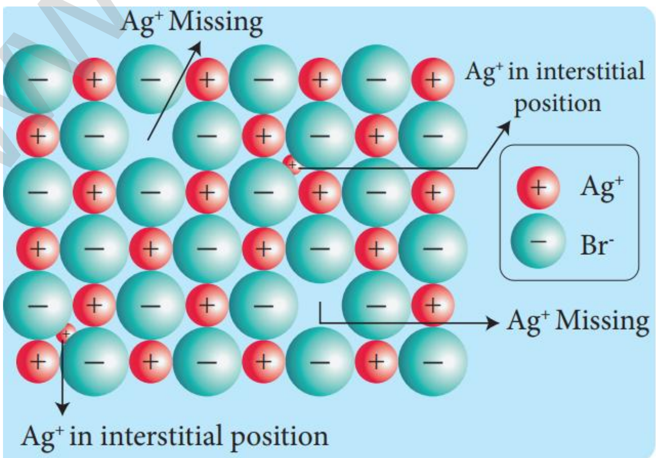
Frenkel defect arises due to the dislocation of ions from its crystal lattice.

The ion which is missing from the lattice point occupies an interstitial position.

This defect occurs when cation and anion differ in size.

Unlike Schottky defect, this defect does not affect the density of the crystal.

Ex: AgBr



ADDITIONAL QUESTIONS AND ANSWERS

1. What are primitive and non-primitive unit cell?

A unit cell that contains only one lattice point is called a primitive unit cell,

A unit cell that contains additional lattice points, either on a face or within the unit cellis called a non-primitive unit cells.

2. How solids are classified?

Solids are classified into two types

(i) Crystalline solids (ii) Amorphous solids..**Ex: glass, rubber**

Crystalline solids are further classified depending upon nature of their constitutents.

(a) Ioniccrystals. Ex: NaCl, KCl
(b) Covalent crystals Ex: Diamond, SiO_2
(c) Molecular crystals. Ex: Naphthalene, Anthracene, Glucose
(d) Metallic crystals. Ex: Na,Mg,Au,Ag
(e) Atomic solids. Ex: Frozen elements of group 18

3. What are isotropy and anisotropy ?

Isotropy means having identical values of physical properties (refractive index, electrical conductance) in all directions. **Ex-amorphous solids.**

Anisotropy means having different values of physical properties when measured along different directions. **Ex- crystalline solids.**

4. Give a note on covalent solids ?

The constituents (atoms) are bound together in a three dimensional network entirely by covalent bonds. Such covalent network crystals are very hard, and have high melting point.

They are usually poor thermal and electrical conductors

Examples: Diamond, silicon carbide etc.

5. What are molecular crystals?

In molecular solids, the constituents are neutral molecules.

They are held together by weak Vanderwaals forces.

Generally, molecular solids are soft and they do not conduct electricity.

Example: Ice

6. Explain metallic solids.

The lattice points are occupied by positive metal ions and a cloud of electrons pervades the space.

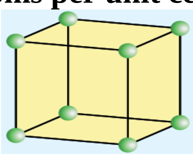
They are hard, and have high melting point.

Metallic solids possess excellent electrical and thermal conductivity. They possess bright lustre.

Examples: Metals and metal alloys belong to this type of solids. (Cu,Fe,Zn,Ag , Au, Cu- Zn etc.)

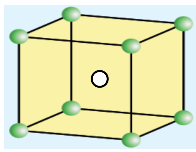
7. Sketch i.SC ii.BCC iii.FCC & calculate its numberof atoms per unit cell

i . SC



Number of atoms in scunit cell = Nc / 8= 8 / 8=1

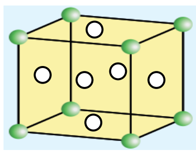
ii. BCC



Number of atoms in bcc unit cell = Nc / 8+N*b* / 1= 8 / 8+1 / 1 =1+1=2

iii.FCC

Number of atoms in fcc unit cell = Nc / 8+Nf / 2= 8 / 8+6 / 2 =1+3=4



8. State Bragg's Equation

$$n\lambda = 2d\sin\theta$$

where,

λ - wavelength of X-ray
θ - angle of diffraction
n – order of refraction
d - Interplanar distance

9. How electrical neutrality is maintained in stoichiometric ionic crystals?

In stoichiometric ionic crystals, a vacancy of one ion must always be associated with either by the absence of another oppositely charged ion (or) the presence of same charged ion in the interstitial position so as to maintain the electrical neutrality.

10. What is meant by the term "coordination number"?

The neighbouring atoms surrounded by each atom is called coordination number.
In BCC is **8.**

11. Radius ratio of an ionic solid is found to be 0.415. Where the cations are occupied?

Cations occupies the octahedral voids.
{Hint: radius ratio <0.4 – tetrahedral voids radius ratio >0.4 – octahedral voids}

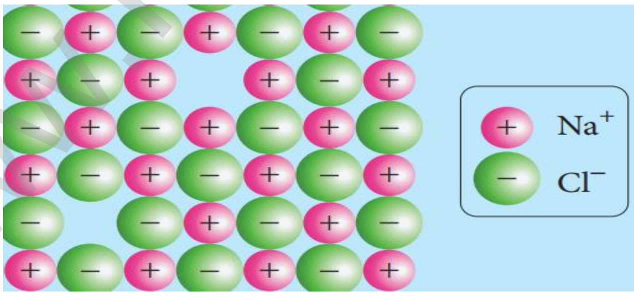
12. Explain how vacancies are introduced in an ionic solid when a cation of higher valence is added as impurity in it. (Impurity defect)

Due to the presence of impurity, ions in ionic solids causes vacancies in the crystal lattice of the host.
For example, Addition of $CdCl_2$ to silver chloride yields solid solutions where the divalent cation Cd^{2+} occupies the position of Ag^+.
This disturbs the electrical neutrality of the crystal.
In order to maintain the same, proportional number of Ag^+ ions leaves the lattice.
This produces a cation vacancy in the lattice, such kind of crystal defects are called impurity defects.

13. Explain Schottky defect.

Schottky defect arises due to the missing of equal number of cations and anions from the crystal lattice .Hence stoichiometry of the crystal is not changed.

Ionic solids in which the cation and anion are of almost of similar size show schottky defect.
Example: **NaCl**. Presence of large number of schottky defects in a crystal lowers its density.



14. Why Frenkel defect is not found in alkali halides?

Larger size of alkali metal ions does not allow them to fit in interstitial sites.

15. Schottky defect lowers the density of the ionic solid. Why?

The total number of ions in a crystal with this defect is less than the theoretical value of ions. Thus the density of the solid crystal is less than expected.

16. What happens when ZnO is heated?

ZnO is colourless at room temperature.

When it is heated, it becomes yellow in colour.

On heating, it loses oxygen and thereby forming free Zn^{2+} ions.

The excess Zn^{2+} ions move to interstitial sites and the electrons also occupy the interstitial positions.

18. Barium has a body centered cubic unit cell with a length of 508pm along an edge. What is the density of barium in g cm-3?

Given: M=137.3 $gmol^{-1}$, a= 508pm = 5.08x 10^{-8}cm , Z=2

$\rho = n M / a^3 N_A$

$=2 \times 137.3 / (5.08 \times 10^{-8})^3 \times 6.023 \times 10^{23}$

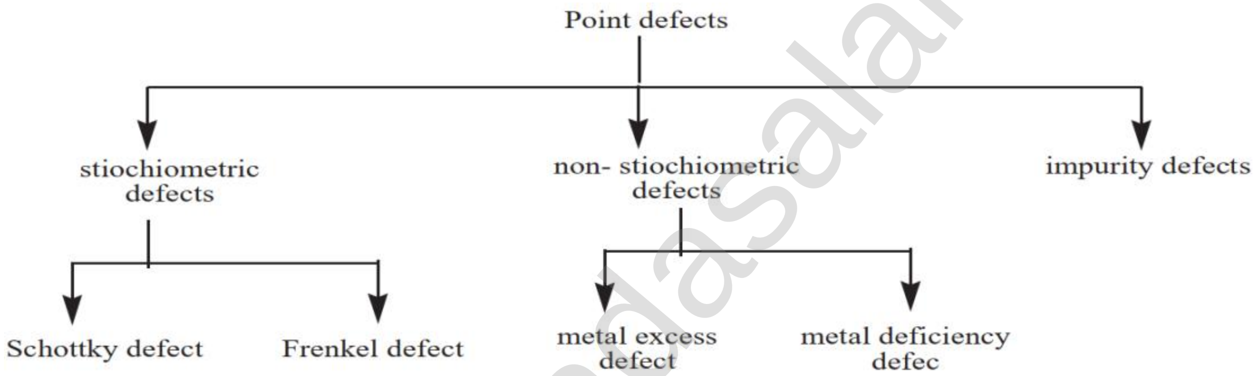
$= 3.478$ g cm^{-3} = **3.5 g cm^{-3}**

19.Define the terms crystal lattice and unit cell

Crystalline solid is characterised by a definite orientation of atoms, ions or molecules, relative to one another in a three dimensional pattern. The regular arrangement of these species throughout the crystal is called a **crystal lattice**.

A basic repeating structural unit of a crystalline solid is called a **unit cell**.

20. Draw the classification chart about point defects.



BY

S.JOSEPH SURESH, MSc,MEd., 9994342531

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