PRAADIS EDUCATION

CHEMISTRY XII

1- SOLID STATE

WORKSHEET 3

PYQs

Question 1.
Which point defect in crystals does not alter the density of the relevant solid? (Delhi) 2009
Answer:
Frenkel defect.

Question 2.
Which point defect in its crystal units alters the density of a solid? (Delhi) 2009
Answer:
Schottky defect.

Question 3.
Which point defect in its crystal units increases the density of a solid? (Delhi) 2009
Answer:
Metal excess defect increases the density of a solid. It is due to presence of extra cations in the interstitial sites.

Question 4.
How do metallic and ionic substances differ in conducting electricity? (All India) 2009
Answer:

The electrical conductivity in metallic substances is due to free electrons while in ionic substances the conductivity is due to presence of ions.

Question 5.
Which point defect of its crystals decreases the density of a solid? (Delhi & All India) 2009
Answer:
Schottky defect.

Question 6.
What is the number of atoms in a unit cell of a face-centred cubic crystal? (All India) 2009
Answer:
The number of atoms in a unit cell of fcc-crysta! is 4 atoms.

Question 7.
Write a feature which will distinguish a metallic solid from an ionic solid. (Delhi) 2010
Answer:
The electrical conductivity in metallic solid is due to free electrons while in ionic solid the conductivity is due to presence of ions.

Question 8.
Which point defect in crystals of a solid does not change the density of the solid? (Delhi) 2010
Answer:
Frenkel defect.

Question 9.
Which point defect in crystals of a solid decreases the density of the solid? (Delhi) 2010
Answer:
Schottky defect.

Question 10.
What type of interactions hold the molecules together in a polar molecular solid? (All India) 2010
Answer:
Dipole-dipole forces of attractions hold the molecules together in a polar molecular solid.

Question 11.
What type of semiconductor is obtained when silicon is doped with arsenic? (All India) 2010
Answer:
n-type semiconductor.

Question 12.
Write a distinguishing feature of metallic solids. (All India) 2010
Answer:
Metallic solids possess high electrical and thermal conductivity due to presence of free electrons.

Question 13.
'Crystalline solids are anisotropic in nature.' What does this statement mean? (Delhi) 2011
Answer:
It means that crystalline solids show different values of their some properties like electrical conductivity, refractive index, thermal expansion etc. in different directions.

Question 14.
Which stoichiometric defect in crystals increases the density of a solid? (Delhi) 2011
Answer:
Interstitial defect in crystals increases the density of a solid.

Question 15.
What is meant by ‘doping’ in a semiconductor? (Delhi) 2012
Answer:
Addition of a suitable impurity to a semiconductor to increase its conductivity is called doping.

Question 16.
Write a point of distinction between a metallic solid and an ionic solid other than metallic lustre. (Delhi) 2012
Answer:
Metallic solid conducts electricity in solid state but ionic solids do so only in molten state or in solution or metals conduct electricity through electrons and ionic substances through ions. Metallic solids are malleable and ductile while ionic solids are hard and brittle.

Question 17.
How may the conductivity of an intrinsic semiconductor be increased? (All India) 2012
Answer:
The conductivity is increased by adding an appropriate amount of suitable impurity. This process is called as intrinsic doping.

Question 18.
Which stoichiometric defect increases the density of a solid? (All India) 2012
Answer:
Interstitial defect increases the density of a solid.

Question 19.
What are n-type semiconductors? (All India) 2012
Answer:
n-type semiconductor : They are obtained by doping silicon with an element of group15, like P, As etc.

Question 20.
What type of stoichiometric defect is shown by AgBr and Agl ? (Comptt. All India) 2012
Answer:
AgBr shows both Frenkel defect and Schottky defect whereas Agl shows Frenkel defect.

Question 21.
What type of defect can arise when a solid is heated ? (Comptt. All India) 2012
Answer:
Vacancy defects can arise when a solid is heated.

Question 22.
Why does LiCl acquire pink colour when heated in Li vapours? (Comptt. All India) 2012
Answer:
This is due to metal excess defect due to anionic vacancies in which the anionic sites are occupied by unpaired electrons (F-centres).

Question 23.
How many atoms constitute one unit cell of a face-centered cubic crystal? (Delhi) 2013
Answer:
4 atoms constitute one unit cell of a fee crystal.

Question 24.
What type of stoichiometric defect is shown by AgCl? (Delhi) 2013
Answer:
Frenkel defect is shown by AgCl.

Question 25.
What type of substances would make better Permanent Magnets: Ferromagnetic or Ferrimagnetic? (Delhi) 2013

Answer:
Ferromagnetic substances would make better I permanent magnets
Example : Fe, Co, Ni etc.

Question 26.
Calculate the number of atoms in a face centred cubic unit cell. (Comptt. Delhi) 2013
Answer:
In face centered cubic arrangement, number of lattice points are : 8 + 6.
∴ Lattice points per unit cell = $8\times18+6\times12 = 4$
Question 27.
On heating a crystal of KC1 in potassium vapour, the crystal starts exhibiting a violet colour. What is this due to? (Comptt. Delhi) 2013
Answer:
The Cl ions diffuse to the surface and combine j with atoms which get ionized by losing electrons. ! These electrons are trapped in anions vacancies j and act as F-centre which imparts violet colour to the crystal.

Question 28.
Which type of ionic substances show Schottky defect in solids? (Comptt. Delhi) 2013
Answer:
Highly ionic compounds with high coordination number and small difference in size of cations and anions show schottky defect.

Question 29.
How many atoms per unit cell (z) are present in bcc unit cell? (Comptt. Delhi) 2014
Answer:
Number of atoms in a unit cell of a body centred cubic structure :
Contribution by 8 atoms on the corners
$= 18 \times 8 = 1$
Contribution by the atom presents within the body = 1
∴ Total number of atoms present in the unit cell = 1 + 1 = 2 atoms

Question 30.
What type of stoichiometric defect is shown by NaCl? (Comptt. Delhi) 2014
Answer:
Schottky defect is shown by NaCl.

Question 31.
Write a distinguishing feature between a metallic solid and an ionic solid. (Comptt. Delhi) 2014
Answer:
The electrical conductivity in metallic substances is due to free electrons while in ionic substances the conductivity is due to presence of ions.

Question 32.
Why are crystalline solids anisotropic? (Comptt. All India) 2014
Answer:
Crystalline solids show different values of their some properties like electrical conductivity, refractive index, thermal expansion etc. in different directions.

Question 33.
What is meant by 'antiferromagnetism'? (Comptt. All India) 2014
Answer:
Antiferromagnetism : These substances possess zero net magnetic moment because of presence of equal number of electrons with opposite spins.

Question 34.
Write a distinguishing feature of a metallic solid compared to an ionic solid. (Comptt. All India) 2014
Answer:
Metallic solid conducts electricity in solid state but ionic solids do so only in molten state or in solution or metals conduct electricity through

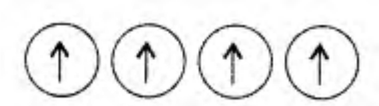
electrons and ionic substances through ions. Metallic solids are malleable and ductile while ionic solids are hard and brittle.

Question 35.
What is the formula of a compound in which the element Y forms ccp lattice and atoms of X occupy 1/3rd of tetrahedral voids? (Delhi) 2015
Answer:
Formula is X_2Y_3.

Question 36.
What is the formula of a compound in which the element Y forms ccp lattice and atoms of X occupy 2/3rd of tetrahedral voids? (All India) 2015
Answer:
Y atoms are N (No. of tetrahedral voids are 2N), No. of tetrahedral voids occupied by X are
23 × 2N = 4N3
X : Y = 4N : 3N
Formula : X_4Y_3
Question 37.
What is the no. of atoms per unit cell (z) in a body-centred cubic structure? (Comptt. Delhi) 2015
Answer:
Contribution by the atoms present at eight comers = 8 × 18 = 1
Contribution by the atoms present at centre = 1
Total number of atoms present in unit cell = 1 + 1 = 2
Question 38.
What type of stoichiometric defect is shown by AgCl? (Comptt. All India) 2015
Answer:
AgCl shows Frenkel defect.

Question 39.
What type of magnetism is shown by a substance if magnetic moments of domains are arranged in same direction? (Delhi) 2016

Answer:
Ferromagnetism is shown by a substance if magnetic moments of domains are arranged in same direction.



Question 40.
Give an example each of a molecular solid and an ionic solid. (All India) 2016
Answer:
Molecular solid → Iodine (I_2)
Ionic solid → Sodium chloride (NaCl)

Question 41.
A metallic element crystallises into a lattice having a pattern of AB AB … and packing of spheres leaves out voids in the lattice. What type of structure is formed by this arrangement? (Comptt Delhi) 2017
Answer:
Tetrahedral void is formed in AB AB … pattern. The hexagonal close packing (hep) is formed in this arrangement.

Question 42.
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 arrangement? (Comptt. Delhi) 2017
Answer:
Octahedral voids are formed in ABC ABC … pattern. The cubic close packing (ccp) is formed in this arrangement.

Question 43.
What type of Stoichiometric defect is shown by AgCl? (Comptt. Delhi) 2017
Answer:
Frenkel defect.

Question 44.
What type of stoichiometric defect is shown by NaCl? (Comptt. All India) 2017
Answer:
Schottky defect is shown by NaCl.

Question 45.
Which ionic compound shows both Frenkel and Schottky defects? (Comptt. All India) 2017
Answer:
Silver bromide (AgBr) shows both Schottky and Frenkel defect.

The Solid State Class 12 Important Questions Short Answer Type – I (SA – 1)

Question 46.
Explain how you can determine the atomic mass of an unknown metal if you know its mass density and the dimensions of unit cell of its crystal. (All India) 2011
Answer:
Suppose edge of the unit cell = a pm
Number of atoms present per unit cell = Z
∴ Volume of unit cell = $(a \text{ pm})^3$
$= (a \times 10^{-10} \text{cm})^3 = a^3 \times 10^{-30} \text{ cm}^3$
Density of unit cell = Mass of unit cell Volume of unit cell ……………… (i)
Mass of unit cell = Number of atoms in the unit cell × mass of each atom = Z × m
Mass of each atom = Atomic mass Avogadro’s no. =MN0
Substituting these values in equation (i), we get
Density of unit cell = Z×Ma3×10−30×N0
If a is in cm, d = Z×Ma3×N0 g/cm^3
∴ Molar mass can be calculated as
M = d×a3×N0Z

Question 47.
Calculate the packing efficiency of a metal crystal for a simple cubic lattice. (All India) 2011
Answer:
Percentage efficiency of packing of simple cubic lattice = 52.4%.

Question 48.
Define the following terms in relation to crystalline solids :
(i) Unit cell (ii) Coordination number Give one example in each case. (All India) 2011
Answer:
(i) Unit cell : The smallest three dimensional portion of a complete space lattice which when repeated over and again in different directions produces the complete space lattice is called the unit cell.
Example: Cubic unit cell, Hexagonal unit cell etc.
(ii) Coordination number : The number of nearest spheres with which a particular sphere is in contact is called co-ordination number.
Example : Co-ordination number of hexagonal (hep) structures is 12.

Question 49.
The unit cell of an element of atomic mass 108 u and density 10.5 g cm-3 is a cube with edge length, 409 pm. Find the type of unit cell of the crystal. [Given: Avogadro's constant = 6.023×10^{23} mol^{-1}] (Comptt. Delhi) 2012
Answer:

We know that $Z = \frac{a^3 \rho \times N_A}{M}$

$$\therefore \quad Z = \frac{(409 \times 10^{-10})^3 \times 10.5 \times 6.023 \times 10^{23}}{108}$$

$$= \frac{409 \times 409 \times 409 \times 10^{-30} \times 10.5 \times 6.023 \times 10^{23}}{108}$$

$$= \frac{423.68}{108} = 4$$

So it forms cubic- closed packed (ccp) lattice or fee structure.

Question 50.
Explain the following terms with suitable examples : Ferromagnetism and Ferrimagnetism (Comptt. Delhi) 2012
Answer:
Ferromagnetic solids : The solids which are strongly attracted by external magnetic field and do not lose their magnetism when the external field is removed are called ferromagnetic solids. The property, thus exhibited, is termed as ferromagnetism.
Example: Fe, Co and Ni show ferromagnetism at room temperature.

Ferrimagnetic solids : The solids which are expected to show large magnetism due to the presence of unpaired electrons but in fact have small net magnetic moment, are called ferrimagnetic solids.
Example : Fe_3O_4 and ferrites.

Question 51.
An element X crystallizes in f.c.c structure. 208 g of it has 4.2832×10^{24} atoms. Calculate the edge of the unit cell, if density of X is 7.2 g cm^{-3}. (Comptt. Delhi) 2012
Answer:
Z = 4(fcc) A = 7,2 g/cm^3 a = ?
4.2832×10^{24} atoms have mass = 208 g
6.022×10^{23} atoms have mass
$= 2084.2832 \times 1024 \times 6.022 \times 10^{23} = 29.24$ (at. mass)
$a^3 = Z \times Md \times NA = 4 \times 29.247.2 \times 6.022 \times 1023$
$= 269.6 \times 10^{-24}\ cm^3$
$\therefore a = 6.46 \times 10^{-8}\ cm = 6.46$ Å
Question 52.
What is a semiconductor? Describe the two main types of semiconductors. (Comptt. Delhi) 2012
Answer:
Semiconductor : The solid materials whose electrical conductivity lies between those of the typical metallic conductors and insulators are termed as semiconductors. The semiconductors possess conductivity in the range of 10^2 to 10^{-9} $ohm^{-1}\ cm^{-1}$.

These are of two types :
(a) n-type semiconductors : Doping of higher group element impurity forms n-type semiconductors, e.g. when ‘As’ is doped in ‘Ge’.
(b) p-type semiconductors : Impurity of lower groups forms electron deficient bond in the structure. Electron deficiency develops to p-hole.

Question 53.
Account for the following:
(i) Schottky defects lower the density of related solids.
(ii) Conductivity of silicon increases on doping it with phosphorus. (All India) 2013
Answer:
(i) Schottky defect produced due to missing of equal number of cation and anion from lattice as a result of which the density of the lattice solid decreases.
(ii) The conductivity of silicon increases due to negatively charged extra electron of doped pentavalent phosphorus.

Question 54.
Aluminium crystallizes in an fee structure. Atomic radius of the metal is 125 pm. What is the length of the side of the unit cell of the metal? (All India) 2013
Answer:
For fee, Formula : r = a22√
Given: r = 125 pm
∴ a = 22–√r ÷ a = 22–√ × 125
⇒ a = 2 × 1.414 × 125 = 353.5 pm
Question 55.
(a) Why does presence of excess of lithium makes LiCl crystals pink?
(b) A solid with cubic crystal is made of two elements P and Q. Atoms of Q are at the corners of the cube and P at the body-centre. What is the formula of the compound? (All India) 2013
Answer:
(a) This is due to metal excess defect due to anionic vacancies in which the anionic sites are occupied by unpaired electrons (F-centres).

(b) As atoms of Q are present at the 8 centres of the cube, therefore, number of atoms of Q in the unit cell = 18 × 8 = 1
The atom P is at the body centre .-. Number of atoms = 1
Ratio of atoms P : Q = 1 : 1
Hence, the formula of the compound is PQ.
Question 56.
(a) What change occurs when AgCl is doped with $CdCl_2$?
(b) What type of semiconductor is produced when silicon is doped with boron? (All India) 2013
Answer:
(a) Impurity defect of ionic solids is produced when AgCl is doped with CdCl2. Due to this defect vacancies are created that result in higher electrical conductivity of the solid.
(b) p-type semi-conductor is obtained when silicon is doped with boron.

Question 57.
If NaCl is doped with 10^{-3} mole percent $SrCl_2$, what will be the concentration of cation vacancies? ($N_A = 6.02 \times 10^{23}$ mol^{-1}) (Comptt. All India) 2013
Answer:
10^{-3} mol percent means 100 moles of NaCl are doped with 10^{-3} moles of $SrCl_2$
∴ 1 mole of NaCl is doped with $SrCl_2$
= 10−3100 = 10^{-5} mole
Since each Sr^{2+} ion introduces one cation vacancy
∴ Concentration of cation vacancies
= 10^{-5} mol/mol of NaCl
= $10^{-5} \times 6.02 \times 10^{23}$ mol^{-1}
= 6.02×10^{18} mol^{-1}
Question 58.
What is a semiconductor? Describe the two main types of semiconductors and contrast their conduction mechanism. (Comptt. All India) 2013
Answer:
Semiconductor : The solids which have intermediate conductivities

between metals and non-metals i,e. between 10^{-6} to 10^{4} π^{-1} m^{-31} are called semiconductors.
Example : Germanium and Silicon.
Main types of semiconductors are of two types :
(i) Intrinsic semiconductor : These are insulators at room temperature and become semiconductors when temperature is raised
(ii) Extrinsic semiconductor :
p-type semiconductor
n-type semiconductor
These are formed by doping impurity of lower or higher group.
These are subdivided into two types :
• **p-type semiconductor :** When a silicon crystal is doped with atoms of group-13 elements like B, Al, Ga etc., the atom forms only 3 covalent bonds with the Si atom and 4^{th} missing electron creates a hole which conducts electricity.
• **n-type semiconductor :** When a silicon crystal is doped with atoms of group-15 elements like P, As etc., then only four of the five valence electrons of each impurity atom, participate in 4 covalent bond formation and 5^{th} e^{-} conducts electricity.

Question 59.
A compound forms hcp structure. What is the total number of voids in 0.5 mol of it? How many of these are tetrahedral voids? (Comptt. All India) 2013
Answer:
No. of atoms in the hcp = $0.5 \times 6.022 \times 10^{23}$
$= 3.011 \times 10^{23}$
No. of octahedral voids
= No. of atoms in packing = 3.011×10^{23}
No. of tetrahedral voids
= 2 × No. of atoms in packing
$= 2 \times 3.011 \times 10^{23} = 6.022 \times 10^{23}$
∴ Total no. of voids
$= 3.011 \times 10^{23} + 6.022 \times 10^{23} = 9.033 \times 10^{23}$

Question 60.
An element crystallizes in a structure having fee unit cell of an edge 200 pm. Calculate the density if 200 g of this element contains 24 × 10^{23} atoms. (Comptt. All India) 2013

Answer:
24 × 10^{23} atoms of an element have mass = 200 g
∴ 6.022 × 10^{23} atoms of an element have mass
= 20024×1023 × 6.022 × 10^{23} = 50.18 g
Given : a = 200 pm = 200 × 10^{-12} cm,
Z = 4 (For fee), M = 50.18 g

Using the formula : $\rho = \dfrac{Z \times M}{a^3 \times N_A}$

$$\Rightarrow \quad \rho = \frac{4 \times 50.18}{(200 \times 10^{-10})^3 \times 6.022 \times 10^{23}}$$

$$\therefore \quad \rho = \frac{200.72}{8 \times 6.022 \times 10^{-1}} = \frac{2007.2}{48.176} = \mathbf{41.66\ g/cm^3}$$

Question 61.
An element with density 11.2 g cm^{-3} forms a f.c.c. lattice with edge length of 4 × 10^{-8} cm. Calculate the atomic mass of the element. (Given : N_A = 6.022 × 10^{23} mol^{-1}) (Delhi) 2014

Answer:
Given : p = 11.2 g cm^{-3}, a = 4 × 10^{-8} cm
For fee lattice, Z = 4
Using formula,

$$M = \frac{\rho \times a^3 \times N_A}{Z}$$

$$M = \frac{(11.2)(4 \times 10^{-8})^3 (6.022 \times 10^{23})}{4}$$

$$= \frac{4316.56 \times 10^{-1}}{4}$$

$$= \mathbf{107.91\ g/mol^{-1}}$$

Question 62.
Examine the given defective crystal 2014

A^+	B^-	A^+	B^-	A^+
B^-	0	B^-	A^+	B^-
A^+	B^-	A^+	0	A^+
B^-	A^+	B^-	A^+	B^-

Answer the following questions :

(i) What type of stoichiometric defect is shown by the crystal?

(ii) How is the density of the crystal affected by this defect?

(tii) What type of ionic substances show such defect? (Delhi)

Answer:

(i) Schottky defect

(ii) Density of the crystal decreases

(iii) NaCl (Ionic solids having approximate equal size of cations and anions)

Question 63.

An element with density 2.8 g cm^{-3} forms a f.c.c. unit cell with edge length 4×10^{-8} cm. Calculate the molar mass of the element.

(Given : $N_A = 6.022 \times 10^{23} mol^{-1}$) (All India) 2014

Answer:

Using formula : $\rho = \frac{Z \times M}{a^3 \times N_0}$ for f.c.c., Z = 4

$$M = \frac{\rho \times a^3 \times N_0}{Z}$$

$$\therefore M = \frac{(2.8 g\ cm^{-3})(4 \times 10^{-8} cm)^3 (6.022 \times 10^{23} atoms\ mol^{-1})}{4}$$

$$\therefore \textbf{Molar mass, } M = \frac{1079.1424}{40} = \textbf{26.978 g/mol}$$

Question 64.

(i) What type of non-stoichiometric point
defect is responsible for the pink colour of LiCl?

(ii) What type of stoichiometric defect is shown by NaCl? (All India) 2014

Answer:

(i) This is due to metal excess defect due to anionic vacancies in which the anionic sites are occupied by unpaired electrons (F-centres).

(ii) Schottky defect is shown by NaCl.

Question 65.
How will you distinguish between the following pairs of terms :
(i) Tetrahedral and octahedral voids
(ii) Crystal lattice and unit cell (All India) 2014
Answer:

	Tetrahedral voids	Octahedral voids
1.	It is much smaller than the size of spheres in the packing.	Size is much larger than tetrahedral voids.
2.	Each tetrahedral void is surrounded by 4 spheres. Hence, coordination no. is 4.	Each octahedral void is surrounded by 6 spheres. Hence, its coordination no. is 6.

(ii) A regular arrangement of the constituent particles of a crystal in a three dimensional space is called crystal lattice.
The smallest three dimensional portion of a complete crystal lattice, which when repeated over and again in different directions produces the complete crystal lattice is called the unit cell.

Question 66.
(i) Write the type of magnetism observed when the magnetic moments are oppositively aligned and cancel out each other.
(ii) Which stoichiometric defect does not change » the density of the crystal? (All India) 2014
Answer:

1. Diamagnetism is observed when the magnetic moments are oppositively aligned and cancel out each other.
2. Frenkel defect does not change the density of the crystal.

Question 67.
(i) Write the type of magnetism observed when the magnetic moments are aligned in parallel and anti-parallel directions in unequal numbers.

(ii) Which stoichiometric defect decreases the density of the crystal? (All India) 2014
Answer:

1. Ferrimagnetism is observed.
2. Schottky defect decreases the density of the crystal.

68. Define the following terms: (Comptt. Delhi) (2016)
(i) n-type semiconductor
(ii) Ferrimagnetism
Answer:
(i) n-type semiconductor : When Si/Ge is doped with group 15 element.
(ii) Ferrimagnetism : When magnetic domains are aligned in parallel and anti-parallel directions in unequal numbers.

Question 69.
Explain the following terms with suitable examples : (Comptt. All India) (2016)
(i) Frenkel defect (ii) F-centres
Answer:
(i) Frenkel defect : The defect in which the smaller ion/cation is dislocated to a nearby interstitial site.
Example : Silver halides, ZnS.
(ii) F-centres : The anion vacancy occupied by an electron is called F-centre in Alkali metal halides.
Example : NaCl, KC1, Li Cl.

Question 70.
Calculate the number of unit cells in 8.1 g of aluminium if it crystallizes in a face-centered cubic (f.c.c.) structure. (Atomic mass of Al = 27 g mol^{-1}) (Comptt. All India) 2017
Answer:
1 mole of Aluminium = 27 g = 6.022×10^{23}
Hence, No. of atoms present in 27 g of Al

= 6.022×102327
As f.c.c. unit cell contains 4 atoms
∴ No. of f.c.c. unit cells present
= 6.022×1023×8.127×4
= $0.45165 \times 10^{23} = 4.5165 \times 10^{22}$

The Solid State Class 12 Important Questions Short Answer Type – II [SA II]

Question 71.
Iron has a body centred cubic unit cell with a cell edge of 286.65 pm. The density of iron is 7.87 g cm^{-3}. Use this information to calculate Avogadro's number (At. mass of Fe = 56 g mol^{-1}). (Delhi & All India) 2009
Answer:
Given :
$a = 286.65$ pm $= 286.65 \times 10^{-10}$,
$d = 7.87$ g cm^{-3}, $M = 56$ g mol^{-1}
$Z = 2$ $N_A = ?$

Using formula : $d = \frac{ZM}{a^3 N_A}$ or $N_A = \frac{ZM}{a^3 d}$

$$\text{or} \quad N_A = \frac{2 \times 56}{(286.65 \times 10^{-10})^3 \times 7.87}$$

$$\text{or} \quad N_A = \frac{112}{(2.87 \times 10^{-8})^3 \times 7.87}$$

$$\text{or} \quad N_A = \frac{112}{23.63 \times 7.87 \times 10^{-24}}$$

$$\text{or} \quad N_A = \frac{112}{185.97 \times 10^{-24}}$$

$$\text{or} \quad N_A = \frac{112}{18.597} \times 10^{23}$$

∴ Avogadro's number $N_A = 6.022 \times 10^{23}$

Question 72.
Silver crystallises with face-centred cubic unit cells. Each side of the unit cell has a length of 409 pm. What is the radius of an atom of silver?

(Assume that each face atom is touching the four comer atoms.) (All India) 2009
Answer:
Given : a = 409 pm r = ?
For fee unit cell, the formula is a
r = a22√
or r = 40922√=4092×1.414=4092.828
∴ r = 144.62
∴ Radius of an atom of silver = 144.62 pm
Question 73.
The well-known mineral fluorite is chemically calcium fluoride. It is known that in one unit cell of this mineral there are 4 Ca^{2+} ions and 8 F^- ions and that Ca^{2+} ions are arranged in a fee lattice. The F^- ions fill all the tetrahedral holes in the face centred cubic lattice of Ca^{2+} ions. The edge of the unit cell is 5.46×10^{-8} cm in length. The density of the solid is 3.18 g cm^{-3}. Use this information to calculate Avogadro's number (Molar mass of CaF_2 = 78.08 g mol^{-1}). (Delhi) 2010
Answer:
Given
Edge of the unit cell (a) = 5.46×10^{-8} cm
Density (P) = 3.18 g cm^{-3}
According to the formula ;

$$N_A = \frac{Z \times M}{a^3 \times P} \quad \therefore N_A = \frac{4 \times 78.08}{(5.46 \times 10^{-8})^3 \times 3.18}$$

$$\therefore N_A = \frac{3123.2}{517.612 \times 10^{-23}} = \mathbf{6.033 \times 10^{23}}$$

Question 74.
The density of copper metal is 8.95 g cm^{-3}. If the radius of copper atom is 127.8 pm, is the copper unit cell a simple cubic, a body-centred cubic or a face centred cubic structure?
(Given : At. mass of Cu = 63.54 g mol^{-1} and $N_A = 6.02 \times 10^{23}$ mol^{-1})
(Delhi & All India) 2010
Answer:
If copper atom were simple cubic :

a = 2 × r = 2 × 127.8 pm = 255.6 pm
= 255.6 pm = 255.6 × 10^{-10} cm
Z = 1
p = Z×Ma3×NA=1×63.54(255.6×10−10)3×(6.02×1023)
∴ P = 6.34 g cm^{-3}
Actual density = 8.95 g cm^{-3}
Hence copper atom is not simple cubic.
If copper atom were body-centred :

$$a = \frac{4r}{\sqrt{3}} = \frac{4 \times 127.8}{1.732} \text{ pm} = 295.15 \text{ pm}$$

$$Z = 2$$

$$P = \frac{Z \times M}{a^3 \times N_A} = \frac{2 \times 63.54}{(295.15 \times 10^{-10})^3 \times 6.02 \times 10^{23}}$$

∴ P = 8.21 g cm^{-3}
Hence, copper atom is not body centered
If copper atom were face-centered
a = 22–√
or a = 2 × 1.414 × 127.8 pm
= 361.4 pm = 361.4 × 10^{-10} cm
P = Z×Ma3×NA=4×63.54(361.4×10−10)3×6.02×1023
∴ P = 8.94 cm^{-3}
Hence, copper is face-centred cubic.
Question 75.
Silver crystallises in face-centred cubic unit cells. Each side of the unit cell has a length of 409 pm. What is the radius of silver atom? (All India) 2010
Answer:
Refer to Q. 72, Page 9
Given : a = 409 pm r = ?
For fee unit cell, the formula is a
r = a22√
or r = 40922√=4092×1.414=4092.828
∴ r = 144.62
∴ Radius of an atom of silver = 144.62 pm

Question 76.

Silver crystallizes in face-centered cubic unit cell. Each side of this unit cell has a length of 400 pm. Calculate the radius of the silver atom. (Assume the atoms just touch each other on the diagonal across the face of the unit cell. That is each face atom is touching the four comer atoms.) (Delhi) 2011

Answer:

Given : a = 400 pm, r = ?

For fee unit cell : r = a22√

or r = 4002×1.4142=4002.828 ∴ r = 141.4

∴ Radius of the silver, r = 141.4 pm

Question 77.

The density of lead is 11.35 g cm^{-3} and the metal crystallizes with fee unit cell. Estimate the radius of lead atom.

(At. Mass of lead = 207 g mol^{-1} and $N_A = 6.02 \times 10^{23}$ mol^{-1}) (Delhi) 2011

Answer:

Given : d = 11.35 g cm^{-3}

According to the formula

$$d = \frac{Z \times M}{a^3 \times N_A} \quad \text{or} \quad a^3 = \frac{Z \times M}{d \times N_A}$$

For *fcc* lattice, Z = 4

$$a^3 = \frac{4 \times 207 \text{ g mol}^{-1}}{11.35 \text{ g cm}^{-3} \times 6.02 \times 10^{23} \text{ mol}^{-1}}$$

$$\text{or} \quad a^3 = \frac{828}{68.327 \times 10^{23}} = 12.118 \times 10^{-23}$$

$$\text{or} \quad a^3 = 1.212 \times 10^{-22} \text{ cm}^3$$

$$\text{or} \quad a = \sqrt[3]{1.212 \times 10^{-22}} \text{ cm}^3$$

$$\therefore \quad a = 4.95 \times 10^{-8} \text{ cm}$$

For *fcc* unit cell, $r = \frac{a}{2\sqrt{2}}$

$$\text{or} \quad r = \frac{4.95 \times 10^{-8}}{2 \times 1.414} = \frac{4.95 \times 10^{-8}}{2.828}$$

∴ **Radius,** $r = 1.75 \times 10^{-8}$ cm = **175 pm**

Question 78.
Tungsten crystallizes in body centred cubic unit cell. If the edge of the unit cell is 316.5 pm, what is the radius of tungsten atom? (Delhi) 2012
Answer:
For bee, unit cell : radius, r = 3√a4 (∵ a = 316.5 pm)
= 3√×316.5pm4=1.732×316.5pm4 = 137 pm
Question 79.
Iron has a body centred cubic unit cell with a cell dimension of 286.65 pm. The density of iron is 7.874 g cm_{-3}. Use this information to calculate Avogadro's number. (At mass of Fe = 55.845 u) (Delhi) 2012
Answer:

Formula : $d = \frac{Z \times M}{a^3 \times N_A}$

For bcc, lattice Z = 2 [bcc = body centred cubic]

$$7.874 \text{ g cm}^{-3} = \frac{2 \times 55.845 \text{ g mol}^{-1}}{(286.65 \times 10^{-10} \text{ cm})^3 \times N_A}$$

$$N_A = \frac{2 \times 55.845 \text{ g mol}^{-1}}{(286.65 \times 10^{-10} \text{ cm})^3 \times 7.874 \text{g cm}^{-3}}$$

∴ Avogadro's number, $N_A = 6.02 \times 10^{23}$ mol^{-1}

Question 80.
Copper crystallises with face centred cubic unit cell. If the radius of copper atom is 127.8 pm, calculate the density of copper metal.
(Atomic mass of Cu = 63.55 u and Avogadro's number N_A = 6.02 × 102^{23} mol^{-1}) (All India) 2012
Answer:

In fee, lattice, Z = 4 atoms [fee = face centred cubic]

$$\text{Formula}: d = \frac{Z \times M}{a^3 \times N_A}$$

fcc lattice for copper $a = 2\sqrt{2}\,r$

$\therefore\ a^3 = (2\sqrt{2}\,r)^3$

$\Rightarrow\ a^3 = 8 \times 2\sqrt{2}\,(1.278 \times 10^{-8}\ \text{cm})^3$

$\Rightarrow\ a^3 = 4.723 \times 10^{-23}\ \text{cm}^3$

$$d = \frac{4 \times 63.55\ \text{g mol}^{-1}}{4.723 \times 10^{-23}\ \text{cm}^3 \times 6.02 \times 10^{23}\ \text{mol}^{-1}}$$

$$\Rightarrow\ d = \frac{254.2\ \text{g mol}^{-1}}{28.43} = \mathbf{8.94\ g\ cm^{-3}}$$

Question 81.

Iron has a body centred cubic unit cell with the cell dimension of 286.65 pm. Density of iron is 7.87 g cm^{-3}. Use this information to calculate Avogadro's number. (Atomic mass of Fe = 56.0 u) (All India) 2012

Answer:

$$\text{Formula}: d = \frac{Z \times M}{a^3 \times N_A}, \qquad Z \text{ for bcc} = 2$$

$$N_A = \frac{Z \times M}{a^3 \times d} = \frac{2 \times 56\ \text{g mol}^{-1}}{(286.65 \times 10^{-10})^3 \times 7.87\ \text{cm}^{-3}}$$

$$= \mathbf{6.043 \times 10^{23}\ mol^{-1}}$$

Question 82.

(a) Some of the glass objects recovered from ancient monuments look milky instead of being transparent. Why?

(b) Iron (II) oxide has a cubic structure and each side of the unit cell is 5Å. If density of the oxide is 4 g cm^{-3}, calculate the number of Fe^{2+} and O^{2-} ions present in each unit cell. [Atomic mass : Fe = 56 u, O = 16 u; Avagadro's number = 6.023×10^{23} mol^{-1}]

(Comptt. All India) 2012

Answer:

(a) Some of the glass objects found from ancient monuments look to be milky in appearance because of crystallisation of glass.

(b) Volume of unit cell = a^3 = (5 A) = $(5 \times 10^{-8})^3$

= 1.25×10^{-22} cm

Density of FeO = 4g cm^{-3}
Mass of unit cell = Volume × Density
= $1.25 \times 10^{-22} \times 4$ g
= 5×10^{-22} g
Mass of FeO molecule per unit cell
= 5×10−22g1.195×10−22g = 4.19 ≈ 4
Thus $4Fe^{+2}$, $4O^{-2}$ will be present in each unit cell.
Question 83.
(a) What are intrinsic semi-conductors? Give an example.
(b) What is the distance between Na^+ and Cl^- ions in NaCl crystal if its density is 2.165 g cm^{-3}? [Atomic Mass of Na = 23u, Cl = 35.5u; Avogadro's number = 6.023×10^{23}] (Comptt. All India) 2012
Answer:
(a) Intrinsic semi-conductors : These are insulators at room temperature and become semi-conductors when temperature is raised, Example : silicon and germanium.
(b) Applying the formula

$$\rho = \frac{ZM}{a^3 \times N_A}, \text{ Z for NaCl is 4 (fcc)}$$

$$\text{or } a^3 = \frac{ZM}{\rho \times N_A} = \frac{4 \times 58.5}{2.165 \times 6.023 \times 10^{23}}$$

$$a = \sqrt[3]{\frac{4 \times 58.5}{2.165 \times 6.023 \times 10^{23}}} = 564 \times 10^{-10} \text{ cm}$$

$a = 2 \times$ distance between Na^+ and Cl^{-1} ions

∴ Distance between Na^+ and Cl^{-1} ion

$$= \frac{564 \times 10^{-10}}{2} = \textbf{282 pm.}$$

Question 84.
(a) What type of semiconductor is obtained when silicon is doped with boron?
(b) What type of magnetism is shown in the following alignment of magnetic moments?

↑ ↑ ↑ ↑ ↑ ↑

(c) What type of point defect is produced when AgCl is doped with $CdCl_2$? (Delhi) 2013
Answer:
(a) p-type semi-conductor is obtained when silicon is doped with boron.
(b) Ferromagnetism is shown when the alignment of magnetic movements will be

$\uparrow \uparrow \uparrow \uparrow \uparrow \uparrow$

(c) Impurity defect of ionic solids is produced when AgCl is doped with $CdCl_2$. Due to this defect vacancies are created that result in higher electrical conductivity of the solid.

Question 85.
An element occurs in bcc structure. It has a cell edge length of 250 pm. Calculate the molar mass if its density is 8.0 g cm^{-3}. Also calculate the radius of an atom of this element. (Comptt. Delhi) 2013
Answer:
Given : For bcc structure, Z = 2
Edge of the unit cell, a = 250 pm
Density of the element, p = 8.0 g/ cm^3
M = ? r = ?
Using the formula

$$\rho = \frac{Z \times M}{a^3 \times N_0} \Rightarrow M = \frac{\rho \times a^3 \times N_0}{Z}$$

$$\Rightarrow M = \frac{(8.0 \text{g cm}^{-3}) \times (250 \times 10^{-10} \text{cm})^3 \times (6.022 \times 10^{23}) \text{atoms}}{2}$$

$$\Rightarrow M = \frac{752750000 \times 10^{-7}}{2} \quad \therefore M = \mathbf{37.6 \ g \ mol^{-1}}$$

$$\text{For, bcc, } a = \frac{4r}{\sqrt{3}} \quad \Rightarrow 250 = \frac{4r}{\sqrt{3}}$$

$$\therefore \quad r = \frac{250 \times 1.73}{4} = \mathbf{108.25 \ pm}$$

Question 86.
Iron (II) oxide has a cubic structure and each unit cell has a size of 5 Å. If density of this oxide is 4 g cm^{-3}, calculate the number of Fe^{2+} and O^{2-} ions present in each unit cell.

(Atomic mass of Fe = 56, O = 16, $N_A = 6.023 \times 10^{23}$ and $1\ \text{Å} = 10^{-8}$ cm)
(Comptt. Delhi) 2013
Answer:
Given : p = 4g cm^{-3}
a = 5Å = 5×10^{-8} cm M = 72 g/'mol, Z = ?
Using the formula for cubic crystals

$$\rho = \frac{Z \times M}{a^3 \times N_0} \quad \Rightarrow Z = \frac{\rho \times a^3 \times N_0}{M}$$

$$\Rightarrow \quad Z = \frac{4\text{g cm}^{-3} \times (5 \times 10^{-8}\text{cm})^3 \times 6.022 \times 10^{23}}{72}$$

$$\therefore \quad Z = \frac{3011 \times 10^{-1}}{72} = 4.18 \approx 4$$

There are four formula units of FeO present per unit cell. Hence it has face-centred cubic lattice where each Fe^{2+} and O^{2-} are four in number.

Question 87.
Niobium crystallizes in body-centred cubic structure. If its density is 8.55 g cm^{-3}, calculate atomic radius of niobium, given its atomic mass 93u. (Comptt. Delhi) 2013
Answer:
Given : p = 8.55 g cm^3,
M = 93 g/mol^{-1}
Z = 2 (For bcc) a = ?
Using formula

$$a^3 = \frac{M \times Z}{\rho \times N_0 \times 10^{-30}}$$

$$\left[\begin{array}{l} x = (36.1)^{1/3} \\ \log x = {}^1/_3 \log 36.1 = {}^1/_3 \times 1.1575 = 0.519 \\ \Rightarrow x = \text{antilog } 0.519 = 3.304 \end{array}\right.$$

$$\Rightarrow \quad a^3 = \frac{93\text{g mol}^{-1} \times 2}{8.55\text{ g cm}^{-3} \times 6.022 \times 10^{23}\text{mol}^{-1} \times 10^{-30}}$$

$$= 3.61 \times 10^7 = 36.1 \times 10^6$$

a = $(36.1)^{1/3} \times 10^2$ ρm
∴ a = 3.304×10^2 ρm = 330.4 ρm
For bcc r_1 = 3√4 a = 3√4 × 330.4 = 143.1 ρm

Question 88.
The density of copper is 8.95 g cm^{-3}. It has a face centred cubic structure. What is the radius of copper atom?
(Atomic mass Cu = 63.5 g mol^{-1}, $N_A = 6.02 \times 10^{23}$ mol^{-1}) (Comptt. Delhi) 2014
Answer:

Using $\rho = \frac{Z \times M}{a^3 \times N_A}$

[**Given** : ρ = 8.95 g cm^{-3}, For FCC; Z = 4

$$a^3 = \frac{Z \times M}{\rho \times N_A}$$

or $$a^3 = \frac{4 \times 63.5}{8.95 \times 6.02 \times 10^{23}} = \frac{254}{53.879 \times 10^{23}}$$

or $$a = \sqrt[3]{4.714 \times 10^{-23}} = \sqrt[3]{47.14 \times 10^{-24}}$$

$$= \mathbf{3.613 \times 10^{-8}\ cm}$$

Question 89.
Iron has a body centred cubic unit cell with a cell dimension of 286.65 pm. The density of iron is 7.874 g cm^{-3}. Use this information to calculate Avogadro's number.
(Atomic mass of Fe = 55.84 g mol^{-1}) (Comptt. Delhi) 2014
Answer:
Given :
a = 286.65 pm = 286.65×10^{-10},
d = 7.87 g cm^{-3}, M = 56 g mol^{-1}
Z = 2 N_A =?

Using formula : $d = \frac{ZM}{a^3 N_A}$ or $N_A = \frac{ZM}{a^3 d}$

or $N_A = \frac{2 \times 56}{(286.65 \times 10^{-10})^3 \times 7.87}$

or $N_A = \frac{112}{(2.87 \times 10^{-8})^3 \times 7.87}$

or $N_A = \frac{112}{23.63 \times 7.87 \times 10^{-24}}$

or $N_A = \frac{112}{185.97 \times 10^{-24}}$

or $N_A = \frac{112}{18.597} \times 10^{23} = 6.022 \times 10^{23}$

∴ Avogadro's number $N_A = 6.022 \times 10^{23}$

Question 90.
Iron has a body centred cubic unit cell with a cell dimension of 286.65 pm. The density of iron is 7.874 g cm^{-3}. Use this information to calculate Avogadro's number.
(Gram atomic mass of Fe = 55.84 g mol^{-1}). (Comptt. All India) 2014

Answer:
Given :
a = 286.65 pm = 286.65×10^{-10},
d = 7.87 g cm^{-3}, M = 56 g mol^{-1}
Z = 2 N_A = ?

Using formula : $d = \frac{ZM}{a^3 N_A}$ or $N_A = \frac{ZM}{a^3 d}$

or $N_A = \frac{2 \times 56}{(286.65 \times 10^{-10})^3 \times 7.87}$

or $N_A = \frac{112}{(2.87 \times 10^{-8})^3 \times 7.87}$

or $N_A = \frac{112}{23.63 \times 7.87 \times 10^{-24}}$

or $N_A = \frac{112}{185.97 \times 10^{-24}}$

or $N_A = \frac{112}{18.597} \times 10^{23}$

∴ Avogadro's number $N_A = 6.022 \times 10^{23}$

Question 91.
An element with molar mass 27 g mol^{-1} forms a cubic unit cell with edge length 4.05×10^{-8} cm. If its density is 2.7 g cm^{-3}, what is the nature of the cubic unit cell? (Delhi) 2015
Answer:

$$d = \frac{Z \times M}{N_A \times a^3}$$

$$Z = \frac{d.N_A \times a^3}{M}$$

$$= \frac{2.7 g\ cm^{-3} \times 6.022 \times 10^{23} mol^{-1} \times (4.05 \times 10^{-8} cm)^3}{27 g\ mol^{-1}}$$

$$= \frac{6.022 \times 10^{23} \times (4.05)^3 \times 10^{-24}}{10}$$

$= 6.022 \times 10^{-2} \times 66.43 = 4.0004 = 4$
It has Face centred cubic cell/fee.

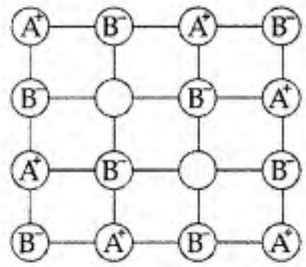
Question 92.
Examine the given defective crystal :

X^+ Y^- X^+ Y^- X^+
Y^- O Y^- X^+ Y^-
X^+ Y^- X^+ O X^+
Y^- X^+ Y^- X^+ Y^-

Answer the following questions :
(i) Is the above defect stoichiometric or non- stoichiometric?
(ii) Write the term used for this type of defect. Give an example of the compound which shows this type of defect.
(iii) How does this defect affect the density of the crystal? (All India) 2015
Answer:
(i) It is stoichiometric defect.
(ii) Schottky defect, e.g. NaCl.
(iii) Density of crystal decreases.

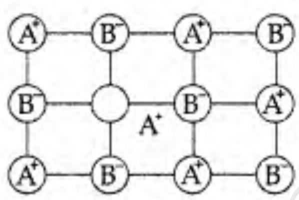
Question 93.
Define the following :
(i) Schottky defect

(ii) Frenkel defect
(iii) F-centre (Comptt. Delhi) 2015
Answer:
(i) Schottky defect: If in an ionic crystal of type A B , equal number of cations and anions are missing from their lattice sites so that the electrical neutrality is maintained, it is called Schottky defect.



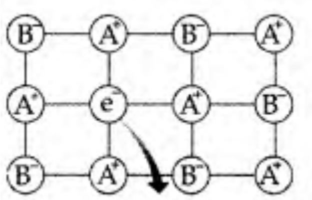
Schottky defect

(ii) Frenkel defect : If an ion leaves its site from its lattice site and occupies the interstitial site and maintains electrical neutrality, then it is called Frenkel defect.



Frenkel defect

(iii) F-centre : The centres which are created by trapping of electrons in anionic vacancies



F-centre

and which are responsible for imparting colour to the crystals are called F-centres. (F = Fabre)

Question 94.
Silver crystallises in fee lattice. If edge length of the unit cell is 4.077 × 10^{-8} cm, then calculate the radius of silver atom. (Comptt. All India) 2015

Answer:
Given : $a = 4.077 \times 10^{-8}$ cm r = ? for fee lattice
Using formula,
Radius (r) = a22√
r = 4.077×10−82×1.414cm=4.077×10−82.828
∴ $r = 1.441 \times 10^{-8}$ cm
Question 95.
An element crystallizes in a f.c.c. lattice with cell edge of 250 pm. Calculate the density if 300 g of this element contains 2×10^{24} atoms. (Delhi) 2015
Answer:
Given: $a = 250$ pm $= 250 \times 10^{-10}$ cm
z = 4 (for fee)
M = ? d = ?
Using formula : d = z×Ma3NA
∵ 2×10^{24} atoms of an element have mass = 300g
∴ 6.022×10^{23} atoms of an element have mass
= 300×6.022×10232×1024 = 90.33 g
Now M = 90.33 g
Question 96.
An element crystallizes in a b.c.c. lattice with cell edge of 500pm. The density of the element is 7.5g cm^{-3}. How many atoms are present in 300 g of the element? (All India) 2015
Answer:
Given: For b.c.c. structure, z = 2
Edge of the unit cell, $a = 500$ pm $= 500 \times 10^{10}$ cm
Density $d = 7.5$ g cm^{-3}
Using the formula,

$$d = \frac{z \times M}{a^3 \times N_0}$$

$$M = \frac{d \times a^3 \times N_0}{z}$$

or $$M = \frac{7.5 \times (500 \times 10^{-10})^3 \times 6.022 \times 10^{23}}{2}$$

or $$M = \frac{7.5 \times 125 \times 10^6 \times 10^{-30} \times 6.022 \times 10^{23}}{2}$$

$$M = \frac{7.5 \times 125 \times 10^{-1} \times 6.022}{2}$$

$$\therefore \quad M = \frac{5645.625}{20} = 282.28 \text{ g mol}^{-1}$$

∵ 282.28 g of the element contains = 6.022×10^{23} atoms
∴ 300 g of the element contains
= 6.022×1023282.28 × 300
= 1806.6282.28×1023 × 10^{23} = 6.40×10^{23} atoms

Question 97.
If NaCl is doped with 10^{-3} mol % of $SrCl_2$, what is the concentration of cation vacancies? (Comptt. Delhi) 2015
Answer:
Concentration of $SrCl_2$ = 10^{-3} mol% = 10^{-3}/100 mol = 10^{-5} mol
1 mol of NaCl on doping produces = 6.022×10^{23} cation vacancies
Therefore, 10^{-5} mol of NaCl on doping produces = $6.022 \times 10^{23} \times 10^{-5}$ = 6.022×10^{18} cation vacancies

Question 98.
Silver crystallises in f.c.c. lattice. If edge length of the cell is 4.07×10^{-8} cm and density is 10.5 g cm^{-3}, calculate the atomic mass of silver. (Comptt. All India) 2015

Answer:

$$d = \frac{z \times M}{a^3 \times N_A}$$

$$\Rightarrow \quad M = \frac{d \times N_A \times a^3}{z} \qquad \text{where} \quad \begin{cases} d = 10.5 \text{g cm}^3 \\ N_A = 6.022 \times 10^{23} \\ a = 4.07 \times 10^{-8} \\ z = 4 \end{cases}$$

$$\Rightarrow \quad M = \frac{10.5 \times 6.022 \times 10^{23} \times (4.07 \times 10^{-8})^3 \text{g cm}^{-3}}{4}$$

$$\Rightarrow \quad \mathbf{M = 106.6 \text{ g mol}^{-1}}$$

Question 99.
(a) Based on the nature of intermolecular forces, classify the following solids: Silicon carbide, Argon
(b) ZnO turns yellow on heating. Why?
(c) What is meant by groups 12-16 compounds? Give an example. (All India) 2017
Answer:
(a) Silicon carbide is a covalent or network solid while Argon is a non-polar molecular solid.
(b) ZnO shows metal excess defect due to presence of extra cations, i.e., Zn^{2+} ions in interstitial sites which on heating changes into yellow due to loss of oxygen.
ZnO⟶ΔZn2++12O2+2e−
(c) Group 12-16 compounds are imperfect covalent compounds in which the ionic character depends on the electronegativities of the two elements, e.g., ZnS, CdS, etc.
Question 100.
(a) Based on the nature of intermolecular forces, classify the following solids: Benzene, Silver
(b) AgCl shows Frenkel defect while NaCl does not. Give reason.
(c) What type of semiconductor is formed when Ge is doped with Al? (All India) 2017
Answer:
(a) Benzene — Molecular solid (non-polar)
Silver — Metallic solid

(b) Due to intermediate radius of AgCl, the size of Ag^+ is smaller than larger Na^+ ion of NaCl so it can easily occupy interstitial spaces and shows Frenkel defect.
(c) p-type semiconductor is formed when Ge is doped with Al.

Question 101.
(a) Based on the nature of intermolecular forces, classify the following solids: Sodium sulphate, Hydrogen
(b) What happens when $CdCl_2$ is doped with AgCl?
(c) Why do ferrimagnetic substances show better magnetism than antiferromagnetic substances? (All India) 2017
Answer:
(a) Sodium sulphate — Ionic solid
Hydrogen — Molecular solid (non-polar)
(ib) Cd^{2+} ion is dipositive and therefore addition of one Cd^{2+} ion results in the loss of two Ag^+ ions from the lattice. But out of 2 holes obtained, one is occupied by Cd^{2+} ion and one left empty. Hence, addition of $CdCl_2$ results in an impurity defect with cation vacancy.
(c) In ferrimagnetism, domains /magnetic moments are aligned in opposite direction in unequal numbers while in antiferromagnetic substances, the domains align in opposite direction in equal numbers so they cancel magnetic moments completely, i.e., net magnetism is zero.

Question 102.
An element crystallises in b.c.c. lattice with cell edge of 400 pm. Calculate its density if 500 g of this element contains 2.5×10^{24} atoms. (Comptt. Delhi) 2017
Answer:
Given : $a = 400$ pm $= 400 \times 10^{-10}$ cm
$Z = 2$ (for bcc) $M = ?$ $d = ?$
Using formula, $d = Z \times Ma3 \times NA$
$\because 2.5 \times 10^{24}$ atoms of an element have mass = 500 g
$\therefore 6.022 \times 20^{23}$atoms of an element have mass

$$= \frac{500 \times 6.022 \times 10^{23}}{2.5 \times 10^{24}}$$

$\therefore \quad M = 120.44$ g

Substituting all values in the formula :

$$d = \frac{2 \times 120.44}{(400 \times 10^{-10})^3 \times N_A}$$

$$= \frac{240.88}{(400)^3 \times 6.022 \times 10^{23} \times 10^{-30}}$$

$$= \frac{240.88}{64 \times 10^6 \times 10^{23} \times 10^{-30} \times 6.022}$$

= 240.886.4×6.022=240.8838.5408

∴ d = 6.25 g cm^{-3}

Question 103.

An element crystallises in fee lattice with cell edge of 400 pm. Calculate its density if 250 g of this element contain 2.5 × 10^{24} atoms. (Comptt. Delhi) 2017

Answer:

Given : a = 400 pm = 400 × 10^{-10} cm

Z = 4 (for fee), M = ?, d = ?

Using formula, d = Z×Ma3×NA

∵ 2.5 × 10^{24} atoms of an element have mass = 250 g

∴ 6.022 × 10^{23} atoms of an element have mass

= 250×6.022×10232.5×1024

∴ M = 60.22 g

Substituting all values in formula :

d = 4×60.22(400×10−10)3×6.022×1023=240.8838.5408

∴ d = 6.25 g cm^{-3}

Question 104.

An element crystallises in bcc lattice with cell edge of 400 pm. Calculate its density if 250 g of this element contains 2.5 × 10^{24} atoms.

(Comptt. Delhi) 2017

Answer:

Given : a = 400 pm = 400 × 10^{-10} cm

Z = 2 (for bcc), M = ?, d = ?

Using formula, d = Z×Ma3×NA

∵ 2.5 × 10^{24} atoms of an element have mass = 250g
∴ 6.022 × 10^{23} atoms of an element have mass
= 250×6.022×10232.5×1024
∴ M = 60.22 g
Substituting all values in formula : .
d = 2×60.22(400×10−10)3×6.022×1023=120.4438.5408
∴ d = 3.125 g cm^{-3}
Question 105.
An element exists in bcc lattice with a cell edge of 288 pm. Calculate its molar mass if its density is 7.2 g/cm^3. (Comptt. All India) 2017
Answer:
Given : Cell edge, a = 288 pm = 288 × 10^{-10} cm
Density, d = 7.2 g/cm^3
For bcc formula, units per cell Z = 2, M = ?
Using formula and substituting values,

$$M = \frac{d \times N_A \times a^3}{Z}$$

$$= \frac{7.2\, g / cm^3 \times (6.022 \times 10^{23}) \times (288 \times 10^{-10} cm)^3}{2}$$

$$= \frac{7.2\, g / cm^3 \times 6.022 \times 10^{23} \times 2.39 \times 10^{-23}}{2}$$

$$= \frac{103.626}{2}$$

$$\therefore \quad \mathbf{M = 51.8\, g\, mol^{-1}}$$

The Solid State Class 12 Important Questions Long Answer Type (LA)

Question 106.
(a) An element has an atomic mass 93 g mol^{-1} and density 11.5 g cm^{-3}. If the edge length of its unit cell is 300 pm, identify the type of unit cell.
(b) Write any two differences between amorphous solids and crystalline solids. (Delhi) (2017)
Answer:
(a) Given:
M = 93 g mol^{-1}; ρ = 11.5 g cm^{-3};
a = 300 pm = 300 × 10^{-10} cm = 3 × 10^{-8} cm

Using formula,

Amorphous solids	**Crystalline solids**
(i) They are isotropic, i.e., they will show same value of physical properties in directions.	They are anisotropic, i.e., tropic, i.e., value of physical properties will be different when measured along different directions.
(ii) They have short range order.	(ii) They have long range order.

$Z = \rho \times a3 \times NAM$

$= 11.5 \times (3 \times 10-8)3 \times 6.022 \times 102393$

$= 2.01$ (approx.)

As the number of atoms present in given unit cells are coming nearly equal to 2, hence the given units cell is body centered cubic unit cell (BCC).

Question 107.

(a) Calculate the number of unit cells in 8.1 g of aluminium if it crystallizes in a f.c.c. structure. (Atomic mass of Al = 27 g mol^{-1})

(b) Give reasons:

(i) In stoichiometric defects, NaCl exhibits Schottky defect and not Frenkel defect.

(ii) Silicon on doping with Phosphorus form n-type semiconductor.

(iii) Ferrimagnetic substances show better magnetism than antiferromagnetic substances. (Delhi) 2017

(a) Given:
Mass of Al = 8.1,
Atomic mass of Al = 27 g mol^{-1}
No. of atoms = $\eta \times 6.022 \times 10^{23}$
$= 8.127 \times 6.022 \times 10^{23}$
$= 0.3 \times 6.022 \times 10^{23}$
$= 1.8066 \times 10^{23}$
Since one f.c.c. unit cell has 4 atoms
∴ No. of unit cells = 1.8066×10234
$= 4.5 \times 10^{22}$ unit cells
(b) (i) Schottky defect is shown by the ionic solids having very small difference in their cationic and anionic radius whereas Frenkel defect is shown by ionic solids having large difference in their cationic and anionic radius. NaCl exhibits Schottky defect because radius of both Na^+ and Cl^- have very small difference.
(ii) Phosphorus is pentavalent that is it has 5 valence electrons, an extra electron results in the formation of n-type semi-conductors on doping with Silicon. The conductivity is due to presence of extra electrons.
(iii) In antiferromagnetic substances the magnetic moments of domains are half aligned in one direction and remaining half in opposite direction in the presence of magnetic field so magnetic moment will be zero while in ferrimagnetic substances the magnetic moments of domains are aligned in parallel and anti-parallel directions in unequal numbers, hence shows some value of magnetic moment.