eVidyarthi
FREE Education

The solid state & surface chemistry-solutions

SUBJECTIVE PROBLEMS:

Sol 1.

Avogadro's number = $6.023 * 10^{23}$

At. wt. of mercury(Hg) = 200

∵ In 1 g of Hg, the total number of atom

$= 6.023 *10^{23}/200 = 6.023 *10^{23}/2 *10^2$

$= 3.0115 *10^{21} = 3.012 * 10^{21}$

∵ Density of Mercury (Hg) = 13.6 g/c.c.

∴ mass of $3.012 * 10^{21}$ atoms $= 1/3.012 *10^{21}$

Now volume of 1 atom of mercury (Hg)

$= 1/3.012 *10^{21} *13.6$ c.c. $= 10^3 *10/3012 *10^{21} * 136$ c.c.

$= 10^{-17}/3012 *136$ c.c. $10^{-17}/409632$ c.c. $= 1000000 *10^{-23}/409632$ c.c.

$= 2.44 *10^{23}$ c.c.

Since each mercury atom occupies a cube of edge length equal to its diameter, therefore,

Diameter of one Hg atom $= (2.44 * 10^{-23})^{1/3}$ cm

$= (24.4 * 10^{-24})^{1/3}$ cm.

$= 2.905 * 10^{-8}$ cm ≡ **2.91 Å**

Sol 2.

For bcc lattice, (radius), $r = \sqrt{3}a/4$

Solution

∴ $r = \sqrt{3} *4.29$ Å$/4 = 1.73 * 4.29$ Å$/4 =$ **1.86 Å**

Sol 3.

For a hcp unit cell, there are 6 atoms per unit cell. If r is the radius of the metal atoms, volume occupied by the metallic

Atoms $6 * 4/3 * \pi * r^3 = 6 * 1.33 * 22/7 * r^3 = 25.08 * r^3$

Geometrically it has been shown that the base area of hcp unit cell

$= 6 * \sqrt{3}/4 * 4r^2$ and the height $= 4r * \sqrt{2/3}$

∴ Volume of the unit cell

$= \text{Area} * \text{height} = 6 * \sqrt{3}/4 * 4r^2 * 4r * \sqrt{\frac{2}{3}} = 33.94\ r^3$

∴ Volume of the empty space of one unit cell

$= 33.94\ r^3 – 25.08\ r^3 = 8.86\ r^3$

∴ Percentage void $= 8.816\ r^3/33.94\ r^3 * 100 =$ **26.1%**

Sol 4.

Density of NaCl

$= n * \text{at. wt.}/\text{Av. No.} * a^3 = 4 * 58.5/6.023 * 10^{23} * (5.64 * 10^{-8})^3$

$= 2.16\ g/cm^3$

Sol 5.

For bcc lattice, $r = \sqrt{3} * a/4 = \sqrt{3}/4 * 287 =$ **124.27 pm**

Now Density = $n * \text{at. wt.}/V * \text{Av. No.}$. = $n * \text{at. wt.}/a^3 * \text{Av. No.}$

N = 2 for bcc; $a = 287 * 10^{-10}$ cm

∴ Density = $2 * 51.99/(287 * 10^{-10})^3 * 6.023 * 10^{23}$ = **7.30 g/ml**

Sol 6.

Density in fcc = $n_1 * \text{at.wt.}/V_1 * \text{No.}$

Density in bcc = $n_2 * \text{at.wt.}/V_2 * \text{No.}$

fcc unit cell length = 3.5 Å

bcc unit cell length = 3.0 Å

Density in fcc = $n_1 * \text{at.wt.}/V_1 * \text{Av.No.}$

Density in bcc = $n_2 * \text{at.wt.}/V_2 * \text{Av.No.}$

∴ $D_{fcc}/D_{bcc} = n_1/n_2 * V_2/V_1$

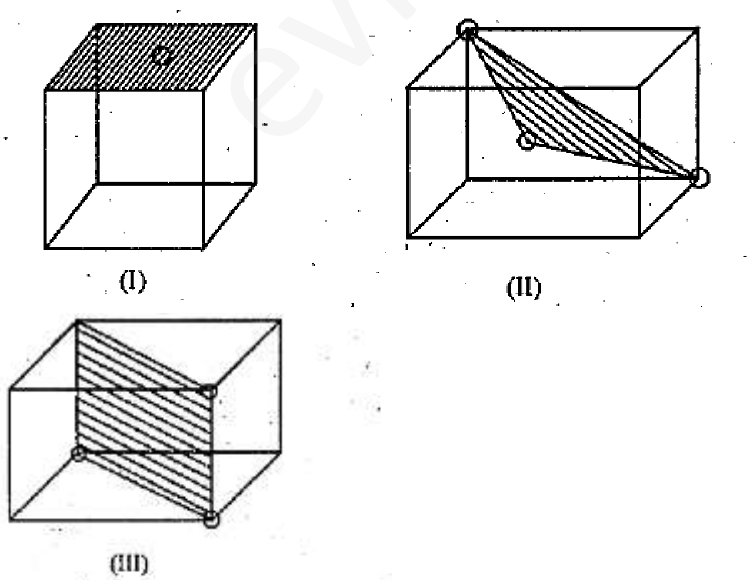
n_1 for fcc = 4; Also $V_1 = a^3 = (3.5 * 10^{-8})^3$

n_2 for fcc = 2; Also $V_2 = a^3 = (3.0 * 10^{-8})^3$

∴ $D_{fcc}/D_{bcc} = 4 * (3.0 * 10^{-8})^3/2 * (3.5 * 10^{-8})^3$ = **1.259**

Sol 7.

7.



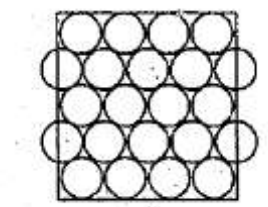
Sol 8.

The area of square = 4 * 4 = 16 cm^2

Again to have the maximum number of spheres the packing must be hcp.

Maximum number of spheres = 14 + 8 = 14 + 4 = 18

full half



Area = 16 cm^2

∴ Number of spheres cm^2 = 18/16

= 1.126

Sol 9.

Number of moles of acetic in 100 ml before adding charcoal = 0.05

Number of moles of acetic acid in 100 ml after adding charcoal = 0.049

Number of moles of acetic acid adsorbed on the surface of charcoal = 0.001

Number of molecules of acetic acid adsorbed on the surface of charcoal = 0.001 * 6.02 * 10^{23} = 6.02 * 10^{20}

Surface area of charcoal = 3.01 * 10^2 m^2 (given)

Area occupied by single acetic acid molecule on the surface of charcoal 3.01 *10^2/6.02 * 10^{20} = **5 *10^{-19} m^2**

Sol 10.

(a) Density of AB = Z *M/N_0 * a^3

Here, Z = 4 (for fcc), M = 6.023 Y,

A = 2 $Y^{1/3}$ nm = 2 $Y^{1/3}$ * 10^{-9} m

Thus,

Density = 4 *6.023/6.023 * 10^{23} *$(2Y^{1/3} * 10^{-9})^3$

= 5.0 kg m^{-3}

(b) Since the observed density (20 kg m^{-3}) of AB is higher than the calculated (5 kg m^{-3}), the compound must have metal excess **defect.** Non-stocheometric degect.

Sol 11.

For an octahedral void a = 2 (r + R) In fcc lattice the largest void present is octahedral void. If the radius of void sphere is R and of lattice sphere is r. Then,

r = √2 *400/5 = 141.12 pm (a = 400 pm)

applying condition for octahedral void, 2 (r + R) = a

∴ 2 R = a 2r = 400 – 2 * 141.12 ∴ Diameter of greatest sphere = **117.16 pm**

Sol 12.

P_{N_2} = 0.001 atm, T = 300 K, V = 2.46 cm^2

∴ Number of N_2 molecules

= PV/RT * N_{AV} = 0.001 *2.46 *10^{-3}/0.0821 *300 * 6.023 * 10^{23}

= 6.016 * 10^{16}

Now total number of surface sites

= Density * Total surface area

= 6.023 * 10^{14} * 1000 = 6.023 * 10^{17}

Sites occupied by N_2 molecules = 20/100 * 6.023 * 10^{17} = 12.04 * 10^{16}

∴ No. of sites occupied by each N_2 molecule

= 12.04 *10^{16}/6.016 * 10^{16} = **2**

Sol 13.

For bcc ; r = √3/2 a;

d = n * M/N_{AV} * a^3 or n = d *N_{AV} *a^3/M

=> n = 2 *6 *10^{23} (5 *10^{-8})^3/75 = 2

Therefore Metal crystallizes in BCC structure and for a BCC lattice √3a = 4r

r = √3/4 a = √3 *5/4 = 2.165 Å = 216.5 pm

so the required answer is **217** pm.