JEE Mains 2019 Chapter wise Question Bank

Solid State - Questions

Q1

At 100°C, copper (Cu) has FCC unit cell structure with cell edge length of x Å. What is the approximate density of Cu (in g cm^{-3}) at this temperature?
[Atomic Mass of Cu = 63.55 u]

(1) $\frac{205}{x^3}$ (2) $\frac{105}{x^3}$

(3) $\frac{211}{x^3}$ (4) $\frac{422}{x^3}$

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Q2

Which primitive unit cell has unequal edge lengths (a ≠ b ≠ c) and all axial angles different from 90°?

(1) Triclinic (2) Hexagonal

(3) Monoclinic (4) Tetragonal

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Q3

A compound of formula A_2B_3 has the hcp lattice. Which atom forms the hcp lattice and what fraction of tetrahedral voids is occupied by the other atoms:

(1) hcp lattice – A, $\frac{2}{3}$ Tetrahedral voids – B

(2) hcp lattice – A, $\frac{1}{3}$ Tetrahedral voids – B

(3) hcp lattice – B, $\frac{2}{3}$ Tetrahedral voids – A

(4) hcp lattice – B, $\frac{1}{3}$ Tetrahedral voids – A

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Q4

A solid having density of 9×10^3 kg m^{-3} forms face centred cubic crystals of edge length $200\sqrt{2}$ pm. What is the molar mass of the solid?

[Avogadro constant ≈ 6×10^{23} mol^{-1}, $\pi \approx 3$]

(1) 0.0432 kg mol^{-1} (2) 0.0216 kg mol^{-1}

(3) 0.0305 kg mol^{-1} (4) 0.4320 kg mol^{-1}

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Q5

The radius of the largest sphere which fits properly at the centre of the edge of a body centred cubic unit cell is :

(Edge length is represented by 'a')

(1) 0.027 a (2) 0.047 a

(3) 0.134 a (4) 0.067 a

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Q6

Element 'B' forms ccp structure and 'A' occupies half of the octahedral voids, while oxygen atoms occupy all the tetrahedral voids. The structure of bimetallic oxide is :

(1) A_2BO_4 (2) AB_2O_4 (3) A_2B_2O (4) A_4B_2O

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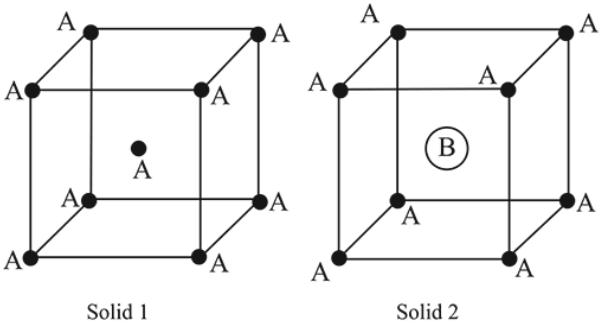
Q7

Consider the bcc unit cells of the solids 1 and 2 with the position of atoms are shown below. The radius of atom B is twice that of atom A. The unit cell edge length is 50% more in solid 2 than in 1. What is the approximate packing efficiency in solid 2?



(1) 45% (2) 75% (3) 90% (4) 65%

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Q8

An element has a face-centred cubic (fcc) structure with a cell edge of a. The distance between the centres of two nearest tetrahedral voids in the lattice is :

(1) $\sqrt{2a}$ (2) a (3) $\frac{a}{2}$ (4) $\frac{3}{2}a$

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Q9

The ratio of number of atoms present in a simple cubic, body centered cubic and face centered cubic structure are, respectively :

(1) 8 : 1 : 6 (2) 1 : 2 : 4
(3) 4 : 2 : 1 (4) 4 : 2 : 3

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Solid State - Answers

Q1

(4) We know that, density $= \frac{Z\,(M)}{N_A \times a^3}$

Given that: $Z = 4\ (fcc)$

$M = 63.5$ g

$N_A = 6 \times 10^{23}$

$a = x \times 10^{-8}$cm

After putting the values, we get

$$d = \frac{4 \times 63.5}{6 \times 10^{23} \times x^3 \times 10^{-24}}$$

$$= \frac{422\ \text{g cm}^{-3}}{x^3}$$

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Q2

(1) For triclinic crystal

$a \neq b \neq c$ Edge lengths

$\alpha \neq \beta \neq \gamma$ Axial angle

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Q3

(4) Here, A_2B_3 can also be written as A_4B_6.

Thus, hcp has six atoms so, 'B' forms hcp lattice and 'A' is present in tetrahedral void.

Total tetrahedral voids = 12

$\therefore$ Fraction of tetrahedral voids occupied by A $= 4/12 = \frac{1}{3}$

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Q4

(3) $\text{Density} = \frac{Z \times M}{N_A \times a^3}$

$$9 \times 10^3 = \frac{4 \times M}{\left(200 \times \sqrt{2} \times 10^{-12}\right)^3 6 \times 10^{23}}$$

$M = 305.4 \times 10^{-4} = 0.0305$ kg/mol

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Q5

(4) For BCC

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

$\therefore$ Empty space at edge $= a - 2R = a - \frac{\sqrt{3}\,a}{2}$

= diameter of sphere.

$$\therefore \quad r_{\text{sphere}} = \frac{a - \frac{\sqrt{3}}{2}a}{2} = \left(\frac{2-\sqrt{3}}{4}\right)a = 0.067\,a$$

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Q6

(2) No. of lattice points = No. of Oh voids

$= \frac{1}{2} \times$ No. of *Td* voids in *ccp* structure

$\therefore$ No. of atoms of $B = 4$

No. of atoms of $A = \frac{1}{2} \times$ No. of Oh voids

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

No. of atoms of O = No. of all Td voids

$= 2 \times$ No. of lattice points

$= 2 \times 4 = 8$

Hence, A : B : O = 1 : 2 : 4

Therefore, the formula of the compound is AB_2O_4

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Q7

(3) Volume occupied by atoms in solid 2

$= \frac{4}{3}\pi r^3 + \frac{4}{3}\pi(2r)^3 = 12\ \pi r^3$

Relationship between body diagonal and radius of atom (r),

$6r = \sqrt{3}\ a$

$\Rightarrow\ a = \frac{6r}{\sqrt{3}}$

$\text{Packing efficiency} = \frac{\text{vol. of particles}}{\text{vol. of unit cells}}$

$\text{Packing efficiency} = \frac{12\pi r^3}{\left(\frac{6r}{\sqrt{3}}\right)^3} \times 100 = 90\%$

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Q8

(3) In FCC, tetrahedral voids are located on the body diagonal at a distance of $\frac{\sqrt{3}a}{4}$ from the corner. Together they form a smaller cube of edge length $\frac{a}{2}$. Therefore, distance between centres of two nearest tetrahedral voids in the lattice is also $\frac{a}{2}$.

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Q9

(2) Unit cell	**No. of atoms**
Simple cubic	$\frac{1}{8}\times 8 = 1$
BCC	$\frac{1}{8}\times 8 + 1\times 1 = 2$
FCC	$\frac{1}{8}\times 8 + \frac{1}{2}\times 6 = 4$

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