Solid State

Question1

Calculate the edge length of unit cell if metal having atomic radius 170 pm forms simple cubic unit cell.

MHT CET 2025 5th May Evening Shift

Options:

A.

1.17×10^{-8} cm

B.

3.40×10^{-8} cm

C.

5.12×10^{-8} cm

D.

6.81×10^{-8} cm

Answer: B

Solution:

Given:

- Atomic radius of metal, $r = 170\,\text{pm}$
- The crystal structure is **Simple Cubic (SC)**.

Step 1: Relation between edge length (a) and atomic radius (r) in SC

In a simple cubic lattice, atoms are present only at the corners.

Along the edge of the cube, two corner atoms touch each other.

$a = 2r$

Step 2: Calculate edge length

$a = 2 \times r = 2 \times 170\,\text{pm} = 340\,\text{pm}$

Step 3: Convert units

- $1\,\text{pm} = 10^{-12}\,\text{m}$

$a = 340\,\text{pm} = 340 \times 10^{-12}\,\text{m}$

$a = 3.40 \times 10^{-10}\,\text{m}$

Now, converting to **cm**:

$1\,\text{m} = 100\,\text{cm}$, so:

$a = 3.40 \times 10^{-10}\,\text{m} \times 100 = 3.40 \times 10^{-8}\,\text{cm}$

✅ **Final Answer:**

$\boxed{3.40 \times 10^{-8}\,\text{cm}}$

Correct Option: **B**

Question2

In an ionic solid anions are arranged in hcp array and cations occupy $\frac{2}{3}$ of octahedral voids.

What is the formula of ionic compound? [consider $\text{A} = \text{cation}$; $\text{B} = \text{anion}$]

MHT CET 2025 5th May Evening Shift

Options:

A.

AB

B.

$A_2 B_3$

C.

$A_3 B_2$

D.

AB_3

Answer: B

Solution:

Step 1. Relation between atoms and voids in hcp

- In **hcp arrangement**, number of anions (B) = N.
- Number of **octahedral voids** generated = N.
- Number of **tetrahedral voids** generated = $2N$, but here only octahedral voids matter.

Step 2. Occupied octahedral voids

- Cations occupy **2/3 of the octahedral voids**.
- Hence, number of cations (A) = $\frac{2}{3}N$.

Step 3. Ratio of cations to anions

$\text{Number of A : Number of B} = \frac{2}{3}N : N = 2 : 3$

Step 4. Formula

Thus the compound's formula is:

A_2B_3

✅ Correct Answer: **Option B (A_2B_3)**

Question3

Calculate the number of unit cells in 1 cm^3 of an element if unit cell edge length is 2.0×10^{-8} cm.

MHT CET 2025 26th April Evening Shift

Options:

A. 3.78×10^{23}

B. 2.61×10^{23}

C. 1.25×10^{23}

D. 4.61×10^{23}

Answer: C

Solution:

Step 1: Volume of the unit cell

$V_{\text{cell}} = a^3 = (2.0 \times 10^{-8}\,\text{cm})^3$

$= 2.0^3 \times (10^{-8})^3$

$= 8.0 \times 10^{-24}\,\text{cm}^3$

Step 2: Number of unit cells in $1\,\text{cm}^3$

$N = \frac{1\,\text{cm}^3}{V_{\text{cell}}} = \frac{1}{8.0 \times 10^{-24}}$

$= \frac{1}{8} \times 10^{24} = 0.125 \times 10^{24}$

$= 1.25 \times 10^{23}$

✅ **Final Answer:**

The number of unit cells in $1\,\text{cm}^3$ is

Option C: 1.25×10^{23}

Question4

Calculate the radius of an atom of an element in pm if it forms bcc unit cell structure having edge length 4.3×10^{-8} cm.

MHT CET 2025 26th April Evening Shift

Options:

A.

186.2

B.

215.0

C.

152.3

D.

282.8

Answer: A

Solution:

Step 1: Recall relation in BCC

In a **bcc lattice**, atoms touch along the **body diagonal**.

So,

Body diagonal $= 4r$

and

Body diagonal $= \sqrt{3}\,a$

Thus,

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

Step 2: Convert given edge length

$a = 4.3 \times 10^{-8}\,\text{cm}$

Convert cm $\rightarrow$ pm:

- $1\,\text{cm} = 10^{10}\,\text{pm}$
- So,

$a = 4.3 \times 10^{-8} \times 10^{10}\,\text{pm} = 430\,\text{pm}$

Step 3: Substitute in radius formula

$r = \frac{\sqrt{3}}{4}a$

$r = \frac{1.732}{4} \times 430$

First compute the factor:

$\frac{1.732}{4} = 0.433$

$r = 0.433 \times 430 \approx 186.2\,\text{pm}$

✅ **Final Answer:**

The atomic radius is:

Option A: 186.2 pm

Question5

The attractive interactions between cations and mobile electrons in metallic solid is called

MHT CET 2025 26th April Evening Shift

Options:

A.

ionic bond

B.

covalent bond

C.

weak dipole-dipole interactions

D.

metallic bond

Answer: D

Solution:

The attractive interactions between cations (metal ions) and the mobile "sea of electrons" in a metallic solid is called a **metallic bond**.

✅ Correct Answer: **Option D. Metallic bond**

Question6

What is the coordination number of a particle in simple cubic close packed structure?

MHT CET 2025 26th April Morning Shift

Options:

A. 12

B. 4

C. 6

D. 8

Answer: C

Solution:

Step 1: Recall the definition

- **Coordination number** = number of nearest neighbors a particle has in the structure.

Step 2: Simple cubic structure

- In **simple cubic (SC)**, atoms are located at the corners of the cube only.
- Any one atom has **nearest neighbors along the three axes** (±x, ±y, ±z).
- So each atom has **6 nearest neighbors**.

Step 3: Compare with other structures

- Body-centered cubic (BCC): coordination number = 8
- Face-centered cubic (FCC or cubic close packed, CCP): coordination number = 12
- Hexagonal close packed (HCP): coordination number = 12

But for **simple cubic**, it is **6**.

✅ **Answer: Option C (6)**

Question7

The compound forming ccp structure contains 9.6×10^{23} atoms. Find the number of tetrahedral voids formed in it.

MHT CET 2025 26th April Morning Shift

Options:

A. 1.00×10^{24}

B. 1.68×10^{24}

C. 1.92×10^{24}

D. 1.56×10^{24}

Answer: C

Solution:

Step 1: Recall the relation between atoms and voids in ccp

- In a **ccp (fcc)** unit cell:
- Number of atoms per unit cell = 4.
- Number of tetrahedral voids per unit cell = 8.
- Hence, **number of tetrahedral voids = 2 × (atoms in the lattice).**

Step 2: Given number of atoms

Total atoms present =

9.6×10^{23}

Step 3: Find tetrahedral voids

No. of tetrahedral voids $= 2 \times (9.6 \times 10^{23})$

$= 1.92 \times 10^{24}$

✅ Final Answer:

The number of tetrahedral voids is

Option C: 1.92×10^{24}

Question8

Calculate the edge length of bcc unit cell if radius of a particle present in it is 186 pm .

MHT CET 2025 26th April Morning Shift

Options:

A.

4.296×10^{-8} cm

B.

7.301×10^{-8} cm

C.

3.715×10^{-8} cm

D.

5.419×10^{-8} cm

Answer: A

Solution:

Step 1: Relation between atomic radius and edge length in BCC

- In a bcc unit cell, atoms touch along the **body diagonal**.
- Body diagonal of cube = $\sqrt{3}\,a$ (where a = edge length).
- Along body diagonal, there are one atom at the corner, one at body center, and another corner atom.

  $\Rightarrow$ Total $4r$ along body diagonal.

So:

$\sqrt{3}\,a = 4r$

$a = \frac{4r}{\sqrt{3}}$

Step 2: Substitute radius

Radius $r = 186 \text{ pm} = 186 \times 10^{-12} \text{ m} = 186 \times 10^{-10} \text{ cm}.$

$a = \frac{4 \times 186}{\sqrt{3}} \text{ pm}$

$a = \frac{744}{1.732} \text{ pm}$

$a \approx 429.6 \text{ pm}$

Step 3: Convert pm to cm

$1 \text{ pm} = 10^{-12} \text{ m} = 10^{-10} \text{ cm}.$

$429.6 \text{ pm} = 429.6 \times 10^{-10} \text{ cm}$

$a \approx 4.296 \times 10^{-8} \text{ cm}$

✅ **Final Answer:**

Option A: $4.296 \times 10^{-8} \text{ cm}$

Question9

Calculate the number of unit cells in 1 cm^3 volume of metal if unit cell edge length is 1.25×10^{-8} cm.

MHT CET 2025 25th April Evening Shift

Options:

A. 1.40×10^{23}

B. 3.35×10^{23}

C. 5.12×10^{23}

D. 2.25×10^{23}

Answer: C

Solution:

Step 1: Volume of unit cell

Edge length $a = 1.25 \times 10^{-8}$ cm

$V_{\text{cell}} = a^3 = (1.25 \times 10^{-8})^3$

$(1.25)^3 = 1.953125$

$V_{\text{cell}} = 1.953125 \times 10^{-24}\ \text{cm}^3$

Step 2: Number of unit cells in $1\ \text{cm}^3$

$N = \frac{1\ \text{cm}^3}{V_{\text{cell}}} = \frac{1}{1.953125 \times 10^{-24}}$

$N \approx 5.12 \times 10^{23}$

✅ **Final Answer:**

Option C: 5.12×10^{23}

Question10

Calculate the total volume occupied by all particles in fcc unit cell if volume of unit cell is $6.4 \times 10^{-23}\ \text{cm}^3$

MHT CET 2025 25th April Evening Shift

Options:

A. $3.321 \times 10^{-23}\ \text{cm}^3$

B. $4.350 \times 10^{-23}\ \text{cm}^3$

C. $5.126 \times 10^{-23}\ \text{cm}^3$

D. $4.736 \times 10^{-23}\ \text{cm}^3$

Answer: D

Solution:

Packing efficiency is 74% for fcc unit cell.
$= 0.74a^3$
$= 0.74 \times 6.4 \times 10^{-23}\ cm^3$
$= 4.73 \times 10^{-23}\ cm^3$

Question11

What is the total number of unit cells shared by each corner particle of bcc unit cell?

MHT CET 2025 25th April Evening Shift

Options:

A. 4

B. 2

C. 8

D. 1

Answer: C

Solution:

Step 1: Recall unit cell geometry

- In any cubic unit cell (simple cubic, bcc, fcc), **corner atoms** always lie at cube corners.
- A cube corner is a point where **8 cubes (unit cells)** can meet (like stacking dice in 3D).
- So, each corner particle is shared by **8 adjacent unit cells**, no matter if it's sc, bcc, or fcc.

Step 2: Clarify possible confusion

- In **bcc**, there is an *extra atom inside at the body center.*
- However, that **does not change the sharing of corner atoms**. Sharing depends only on cube geometry.

✅ **Final Answer:**

Each corner particle of a bcc unit cell is shared by:

Option C: 8 ✅

Question12

Calculate the number of particles present per unit cell if mass of a particle is 8.0×10^{-23} g $\left[\rho \times a^3 = 3.2 \times 10^{-22} \text{ g}\right]$

MHT CET 2025 25th April Morning Shift

Options:

A. 1

B. 2

C. 4

D. 6

Answer: C

Solution:

$$\text{Density of unit cell } (\rho) = \frac{\text{Mass of unit cell}}{\text{Volume of unit cell} \qquad (a^3)}$$

$\rho \times a^3 = \text{ Mass of unit cell } = 3.2 \times 10^{-22}$ g

Mass of unit cell $=$ Number of particles in unit cell $(\text{n}) \times$ Mass of a single particle

$$3.2 \times 10^{-22} \text{ g} = \text{n} \times 8.0 \times 10^{-23}$$
$$\text{n} = \frac{3.2 \times 10^{-22} \text{ g}}{8.0 \times 10^{-23} \text{ g}} = 4$$

Question13

Calculate the edge length of unit cell if a metal with atomic radius 128 pm forming fcc unit cell structure.

Options:

A. 3.62×10^{-8} cm

B. 2.56×10^{-8} cm

C. 2.96×10^{-8} cm

D. 3.12×10^{-8} cm

Answer: A

Solution:

Step 1: Relation between edge length (a) and atomic radius (r) in FCC

For a **face-centered cubic (FCC)** unit cell:

$a = \frac{4r}{\sqrt{2}} = \sqrt{2} \cdot 2r$

Step 2: Substitute $r = 128\,\text{pm}$

$a = \frac{4 \times 128}{\sqrt{2}}\,\text{pm}$

$= \frac{512}{1.414}\,\text{pm}$

$= 362\,\text{pm}$

Step 3: Convert to cm

$1\,\text{pm} = 10^{-12}\,\text{m} = 10^{-10}\,\text{cm}$

$a = 362 \times 10^{-10}\,\text{cm}$

$= 3.62 \times 10^{-8}\,\text{cm}$

✅ **Correct Option: A** — $3.62 \times 10^{-8}\,\text{cm}$

Question14

Which of the following dopant is used in silicon to produce p-type semiconductor?

MHT CET 2025 25th April Morning Shift

Options:

A. Ga

B. Sb

C. As

D. P

Answer: A

Solution:

Group 13 element (Ga) is added to a group 14 element (Si) to produce p-type semiconductor.

Question15

Calculate the volume of bcc unit cell if radius of an atom present in it is 1.86×10^{-3} cm.

MHT CET 2025 23rd April Evening Shift

Options:

A. $5.391 \times 10^{-23} \mathrm{~cm}^3$

B. $8.995 \times 10^{-23} \mathrm{~cm}^3$

C. $7.951 \times 10^{-23} \mathrm{~cm}^3$

D. $6.453 \times 10^{-23} \mathrm{~cm}^3$

Answer: C

Solution:

For bcc unit cell,

$$a = \frac{4r}{\sqrt{3}} = \frac{4 \times 1.86 \times 10^{-8}\ \text{cm}}{\sqrt{3}} = 4.3 \times 10^{-8}\ \text{cm}$$

$$\begin{aligned} \text{Volume } &= a^3 \\ &= \left(4.3 \times 10^{-8}\ \text{cm}\right)^3 \\ &= 7.951 \times 10^{-23}\ \text{cm}^3 \end{aligned}$$

Question16

Which from following is nonconductor of electricity?

MHT CET 2025 23rd April Evening Shift

Options:

A. Solid sodium chloride

B. Aqueous potassium chloride

C. Graphite (s)

D. Copper metal (s)

Answer: A

Solution:

- **Option A: Solid sodium chloride**

  In solid state, NaCl's ions are fixed in the crystal lattice and cannot move, so it does not conduct electricity.

- **Option B: Aqueous potassium chloride**

  In water, KCl dissociates into K^+ and Cl^- ions, which move freely and conduct electricity.

- **Option C: Graphite (s)**

  Graphite conducts electricity due to its delocalized electrons.

- **Option D: Copper metal (s)**

  Metals conduct electricity due to the sea of delocalized electrons.

✅ **Correct answer: Option A – Solid sodium chloride**

Question17

Calculate the number of unit cells in 0.79 g metal if product of density and volume of unit cell is 1.58×10^{-22} g.

MHT CET 2025 23rd April Evening Shift

Options:

A. 3.96×10^{21}

B. 1.72×10^{21}

C. 4.46×10^{21}

D. 5.0×10^{21}

Answer: D

Solution:

- Mass of the metal sample = 0.79 g
- Product of density and volume of unit cell = 1.58×10^{-22} g

Step 1: Understanding the given product

$\text{Density} \times \text{Volume of unit cell} = \text{Mass of one unit cell}$

So,

$\text{Mass of one unit cell} = 1.58 \times 10^{-22}\text{ g}$

Step 2: Number of unit cells in the sample

$\text{Number of unit cells} = \frac{\text{Total mass of sample}}{\text{Mass of one unit cell}}$

Substitute values:

$= \frac{0.79}{1.58 \times 10^{-22}}$

Step 3: Calculate

$\frac{0.79}{1.58} = 0.5$

So,

Number of unit cells $= 0.5 \times 10^{22} = 5.0 \times 10^{21}$

✅ **Final Answer:**

Option D: 5.0×10^{21}

Question18

Calculate the number of atoms in 1 g metal if it forms fcc crystal structure. $\left[\rho \times \mathrm{a}^3 = 1.728 \times 10^{-22}\ \mathrm{g}\right]$

MHT CET 2025 23rd April Morning Shift

Options:

A. 2.315×10^{22}

B. 3.156×10^{22}

C. 4.108×10^{22}

D. 1.452×10^{22}

Answer: A

Solution:

For fcc unit cell, $\mathrm{n} = 4$.

No. of particles in x g $= \frac{x\mathrm{n}}{\rho \mathrm{a}^3}$

$\therefore$ Number of atoms in 1 g of metal

$= \frac{1 \times 4}{1.728 \times 10^{-22}} = 2.315 \times 10^{22}$ atoms

----

Question19

Calculate the volume occupied by all particles in bcc unit cell if the volume of unit cell is $8.0 \times 10^{-23}\ \mathrm{cm}^3$.

MHT CET 2025 23rd April Morning Shift

Options:

A. $3.19 \times 10^{-23}\ cm^3$

B. $2.72 \times 10^{-23}\ cm^3$

C. $5.44 \times 10^{-23}\ cm^3$

D. $1.48 \times 10^{-23}\ cm^3$

Answer: C

Solution:

BCC unit cell contains 2 particles.

$\therefore$ Volume occupied by particles in bcc unit cell

$$= 2 \times \frac{\sqrt{3}\pi a^3}{16} = \frac{\sqrt{3}\pi a^3}{8}$$
$$= 0.68 \times 8.0 \times 10^{-23} = 5.44 \times 10^{-23}\ cm^3$$

Question20

Which from following pair of compounds exhibits isomorphism?

MHT CET 2025 23rd April Morning Shift

Options:

A. Calcite and aragonite

B. α-quartz and cristobalite

C. Sodium nitrate and calcium carbonate

D. Diamond and fullerene

Answer: C

Solution:

$NaNO_3$ and $CaCO_3$ have the same atomic ratio (1 : 1 : 3) of the constituent atoms and same crystal structure.

Thus, they exhibit isomorphism.

Question21

Calculate the volume occupied by a particle in fcc unit cell if volume of unit cell is $1.6 \times 10^{-23}\ \text{cm}^3$.

MHT CET 2025 22nd April Evening Shift

Options:

A. $5.44 \times 10^{-24}\ \text{cm}^3$

B. $2.96 \times 10^{-24}\ \text{cm}^3$

C. $8.37 \times 10^{-24}\ \text{cm}^3$

D. $6.15 \times 10^{-24}\ \text{cm}^3$

Answer: B

Solution:

Volume occupied $=$ Packing efficiency $\times$vol. of a unit cell

Packing efficiency for FCC unit cell $= 74\%$

$V_{\text{occ}} \quad = 0.74 \times \left(1.6 \times 10^{-23}\right) \text{cm}^3$

V_{occ} is for 4 atoms in one FCC unit cell

$$\begin{aligned} \therefore \quad V_{\text{occ}} \text{ by 1 atom } &= \frac{0.74}{4} \times 1.6 \times 10^{-23} \\ &= 0.185 \times \left(1.6 \times 10^{-23}\right) = 2.96 \times 10^{-24}\ \text{cm}^3 \end{aligned}$$

Question22

Identify the type of defect in brass alloy.

MHT CET 2025 22nd April Evening Shift

Options:

A. Interstitial impurity defect

B. Schottky defect

C. Substitutional impurity defect

D. Metal deficiency defect

Answer: C

Solution:

Brass is an **alloy of copper and zinc**. In brass, some of the copper atoms are **substituted** by zinc atoms in the crystal lattice.

This corresponds to a **substitutional impurity defect**.

✅ **Correct Answer: Option C – Substitutional impurity defect**

Question23

Calculate the number of atoms present in 1 g of an element if it forms fcc unit cell structure. $\left[\rho \times \mathrm{a}^3 = 6.8 \times 10^{-22}\ \mathrm{g}\right]$

MHT CET 2025 22nd April Evening Shift

Options:

A. 7.125×10^{21}

B. 4.548×10^{21}

C. 6.815×10^{21}

D. 5.882×10^{21}

Answer: D

Solution:

We are tasked to calculate the number of atoms present in **1 g** of an element in an **fcc structure** given:

$\rho \times a^3 = 6.8 \times 10^{-22}$ g

Step 1: Recall formula for mass of unit cell

Mass of unit cell = Density × Volume of unit cell

$M_{\text{cell}} = \rho a^3$

We are told:

$M_{\text{cell}} = 6.8 \times 10^{-22}$ g

Step 2: Atoms per unit cell in FCC

For face-centered cubic (FCC):

$Z = 4$

So 4 atoms per unit cell.

Step 3: Mass per atom

$m_{\text{atom}} = \frac{M_{\text{cell}}}{Z} = \frac{6.8 \times 10^{-22}}{4}$

$m_{\text{atom}} = 1.7 \times 10^{-22}$ g

Step 4: Number of atoms in 1 g

$N = \frac{1}{m_{\text{atom}}} = \frac{1}{1.7 \times 10^{-22}}$

$N = 5.88 \times 10^{21}$

✅ **Final Answer:**

$\boxed{5.882 \times 10^{21}}$ (Option D)

Question24

Calculate the volume occupied by all particles in fcc unit cell if volume of unit cell is 1.6×10^{-23} cm^3.

MHT CET 2025 22nd April Morning Shift

Options:

A. 4.088×10^{-23} cm^3

B. 2.156×10^{-23} cm^3

C. 1.184×10^{-23} cm^3

D. 3.226×10^{-23} cm^3

Answer: C

Solution:

Step 1: Number of atoms in an fcc unit cell

In an **fcc structure**, the effective number of atoms in a unit cell = 4.

Step 2: Relation between atomic radius and edge length

For fcc,

$a = \frac{4r}{\sqrt{2}} = \sqrt{2} \cdot 2r$

So,

$r = \frac{a}{2\sqrt{2}}$

Step 3: Find edge length from unit cell volume

$a^3 = V_{\text{cell}} = 1.6 \times 10^{-23}$ cm^3

$a = (1.6 \times 10^{-23})^{1/3}$

Cube root of $1.6 \approx 1.17$.

Cube root of $10^{-23} = 10^{-7.667} \approx 2.15 \times 10^{-8}$.

So,

$a \approx 1.17 \times 2.15 \times 10^{-8} \approx 2.51 \times 10^{-8}$ cm

Step 4: Calculate radius

$r = \frac{a}{2\sqrt{2}} = \frac{2.51 \times 10^{-8}}{2 \times 1.414} = \frac{2.51 \times 10^{-8}}{2.828} \approx 8.88 \times 10^{-9}$ cm

Step 5: Volume of one atom (as a sphere)

$V_{\text{atom}} = \frac{4}{3}\pi r^3$

$r^3 = (8.88 \times 10^{-9})^3 \approx 7.0 \times 10^{-25}$

$V_{\text{atom}} \approx \frac{4}{3}\pi \times 7.0 \times 10^{-25}$

$V_{\text{atom}} \approx 2.93 \times 10^{-24}\ \text{cm}^3$

Step 6: Total volume of atoms in unit cell

4 atoms per cell:

$V_{\text{total}} = 4 \times V_{\text{atom}} = 4 \times 2.93 \times 10^{-24}$

$V_{\text{total}} \approx 1.17 \times 10^{-23}\ \text{cm}^3$

Step 7: Match with options

Closest value is

Option C: $1.184 \times 10^{-23}\ \text{cm}^3$ ✅

Final Answer:

$\boxed{1.184 \times 10^{-23}\ \text{cm}^3}$ (Option C)

Question25

Which from following dopants is used in germanium to produce p-type semiconductor?

MHT CET 2025 22nd April Morning Shift

Options:

A. B

B. P

C. As

D. Sb

Answer: A

Solution:

- **p-type** semiconductor → deficiency of electrons (holes as majority carriers).

→ This is achieved by doping with **trivalent atoms** (group III elements) like B (Boron), Al, Ga, In.

Now checking options:

- **B (Boron)** → group III element → produces p-type. ✅
- **P (Phosphorus)** → group V → produces n-type.
- **As (Arsenic)** → group V → produces n-type.
- **Sb (Antimony)** → group V → produces n-type.

✅ **Correct Answer: Option A: B (Boron)**

Question26

Calculate the number of unit cell in 1 cm^3 volume of metal if volume of unit cell is $3.448 \times 10^{-23} \text{ cm}^3$

MHT CET 2025 22nd April Morning Shift

Options:

A. 2.5×10^{22}

B. 3.2×10^{22}

C. 2.9×10^{22}

D. 3.7×10^{22}

Answer: C

Solution:

Step 1: Formula

Number of unit cells $= \frac{\text{Total volume}}{\text{Volume of 1 unit cell}}$

Step 2: Insert values

$N = \frac{1 \text{ cm}^3}{3.448 \times 10^{-23} \text{ cm}^3}$

$N = \frac{1}{3.448 \times 10^{-23}}$

Step 3: Simplify

$\frac{1}{3.448} \approx 0.29$

So:

$N \approx 0.29 \times 10^{23} = 2.9 \times 10^{22}$

✅ **Final Answer:**

Option C: 2.9×10^{22}

Question27

Calculate the volume of fcc unit cell in cm^3 if void volume of it is $4.16 \times 10^{-24} \text{ cm}^3$.

MHT CET 2025 21st April Evening Shift

Options:

A. 1.3×10^{-23}

B. 1.6×10^{-23}

C. 4.1×10^{-23}

D. 5.8×10^{-23}

Answer: B

Solution:

Step 1: Recall packing efficiency of FCC

- In face-centered cubic (FCC), packing efficiency = **74%**.

That means:

$$\frac{\text{Volume occupied by atoms}}{\text{Volume of unit cell}} = 0.74$$

So void fraction:

$$\frac{\text{Void volume}}{\text{Total cell volume}} = 0.26$$

Step 2: Express void volume

Void volume $= 0.26 \times V_{\text{cell}}$

We are told:

$0.26\, V_{\text{cell}} = 4.16 \times 10^{-24}$

Step 3: Solve for total cell volume

$V_{\text{cell}} = \frac{4.16 \times 10^{-24}}{0.26}$

$V_{\text{cell}} \approx 1.6 \times 10^{-23}\ \text{cm}^3$

Step 4: Match with options

Correct option:

Option B: $1.6 \times 10^{-23}\ \text{cm}^3$ ✅

Question28

Calculate the number of atoms present per unit cell if product of density and volume of unit cell is 1.8×10^{-22} g.

[Mass of an atom $= 4.5 \times 10^{-23}$ g]

MHT CET 2025 21st April Evening Shift

Options:

A. 1

B. 2

C. 4

D. 6

Answer: C

Solution:

Given:

- Product of density and volume of unit cell = $\rho \times V = 1.8 \times 10^{-22}$ g
- Mass of one atom = 4.5×10^{-23} g

Step 1: What does $\rho \times V$ represent?

$\rho \times V =$ Mass of unit cell

So, mass of unit cell = 1.8×10^{-22} g.

Step 2: Number of atoms per unit cell

$n = \frac{\text{Mass of unit cell}}{\text{Mass of one atom}}$

$n = \frac{1.8 \times 10^{-22}}{4.5 \times 10^{-23}}$

$n = \frac{1.8}{0.45} = 4$

✅ **Final Answer:**

Number of atoms per unit cell = **4**

Correct Option: C (4) ✓

Question29

Identify the defect developed when an ion of an ionic compound is missing from its regular site and occupies interstitial position between lattice points.

MHT CET 2025 21st April Evening Shift

Options:

A. Schottky defect

B. Frenkel defect

C. Substitutional impurity defect

D. Interstitial impurity defect

Answer: B

Solution:

The defect described is when an **ion is missing from its regular lattice site and instead occupies an interstitial position**.

- **Schottky defect** → Involves missing cations and anions, creating vacancies, but no interstitial occupation.
- **Frenkel defect** → In this defect, an ion (usually a smaller cation) leaves its normal lattice site and occupies an interstitial position.
- **Substitutional impurity defect** → Involves replacement of some ions by different ions of similar size.
- **Interstitial impurity defect** → Involves the introduction of foreign atoms/ions in interstitial sites.

✅ Correct Answer: **Option B: Frenkel defect**

Question30

Identify the defect that develops when the ratio of number of cations to anions become different from that indicated by its chemical formula.

MHT CET 2025 21st April Morning Shift

Options:

A. Schottky defect

B. interstitial defect

C. substitutional impurity defect

D. nonstoichiometric defect

Answer: D

Solution:

The correct answer is:

Option D: nonstoichiometric defect

Explanation (as per NCERT):

A **nonstoichiometric defect** occurs when the ratio of cations to anions in a crystal lattice is different from that indicated by its ideal chemical formula. This leads to a crystal composition that does not match the simple whole-number ratio of ions required by the formula, i.e., the compound is nonstoichiometric.

Other options:

- **Schottky defect** and **interstitial defect** are types of stoichiometric defects, which do not disturb the overall stoichiometry.
- **Substitutional impurity defect** involves the replacement of one type of ion by another of similar size, but does not necessarily change the stoichiometric ratio.

So, the answer is Option D: nonstoichiometric defect.

Question31

The mass of an atom present in unit cell is 4.4×10^{-23} g and the product of density and volume of unit cell is 1.792×10^{-22} g. What is the type of cubic unit cell?

MHT CET 2025 21st April Morning Shift

Options:

A. Body centred unit cell

B. Face centred unit cell

C. Base centred unit cell

D. Simple cubic unit cell

Answer: B

Solution:

Given:

- Mass of atom in the unit cell, $m = 4.4 \times 10^{-23}$ g
- Density $\times$ Volume of unit cell $= 1.792 \times 10^{-22}$ g

Let number of atoms per unit cell $= z$.

Step 1: Relation between mass, z, and unit cell

The total mass in a unit cell:

Total mass in unit cell $= z \times m$

Step 2: Density formula for a unit cell

For a cubic unit cell,

Density $= \frac{z \times m}{a^3}$

So,

Density $\times a^3 = z \times m$

But it is given that,

Density $\times a^3 = 1.792 \times 10^{-22}$ g

So,

$z \times m = 1.792 \times 10^{-22}$

Step 3: Calculate z

Given $m = 4.4 \times 10^{-23}$ g:

$z = \frac{1.792 \times 10^{-22}}{4.4 \times 10^{-23}}$

Divide numerator and denominator:

$z = \frac{1.792}{4.4} \times \frac{10^{-22}}{10^{-23}}$

$= 0.407 \times 10^1$

$= 4.07$

Since z must be a whole number and is closest to 4,

Step 4: Type of cubic unit cell

- Simple cubic: $z = 1$
- Body centred (BCC): $z = 2$
- Face centred (FCC): $z = 4$
- Base centred: $z = 2$

So, $z = 4$ indicates a **face centred cubic (FCC) unit cell**.

Final Answer:

$\boxed{\text{Face centred unit cell}}$

Option B is correct.

Question32

Calculate the total number of tetrahedral and octahedral voids in 0.4 mol compound having such voids in it.

MHT CET 2025 21st April Morning Shift

Options:

A. 2.4088×10^{23}

B. 7.2264×10^{23}

C. 4.8176×10^{23}

D. 9.6352×10^{23}

Answer: B

Solution:

No. of atoms in 0.4 mol $= 0.4 \times \mathrm{N_A}$

$= 0.4 \times 6.022 \times 10^{23} = 2.4088 \times 10^{23}$

No. of octahedral voids $=$ no. of atoms

$= 2.4088 \times 10^{23}$

No. of tetrahedral voids $= 2\times$ no. of atoms

$= 2 \times 2.4088 \times 10^{23} = 4.8176 \times 10^{23}$

$\therefore$ Total no. of voids in 0.4 mol compound

$= 2.4088 \times 10^{23} + 4.8176 \times 10^{23} = 7.2264 \times 10^{23}$.

Question33

Calculate the volume occupied by a particle in bcc unit cell if the volume of unit cell is $8.2 \times 10^{-23} \text{ cm}^3$.

MHT CET 2025 20th April Evening Shift

Options:

A. $5.576 \times 10^{-23} \text{ cm}^3$

B. $1.517 \times 10^{-23} \text{ cm}^3$

C. $2.788 \times 10^{-23} \text{ cm}^3$

D. $3.936 \times 10^{-23} \text{ cm}^3$

Answer: C

Solution:

In a **Body Centered Cubic (bcc)** unit cell:

- Number of atoms per unit cell, $n = 2$.

The **volume occupied by one particle (atom) in the unit cell:**

It is given by:

Volume occupied by one atom $= \frac{\text{Total volume occupied by atoms in unit cell}}{\text{Number of atoms}}$

First, find the total volume occupied by all particles in the unit cell.

Step 1: Relationship between edge length (a) and radius (r) in bcc

For bcc:

$a = \frac{4r}{\sqrt{3}}$

Step 2: Volume of unit cell

Volume of unit cell $= a^3 = 8.2 \times 10^{-23} \text{ cm}^3$

Step 3: Volume occupied by particles

In bcc, there are 2 atoms of radius r, so total volume occupied by atoms:

Total volume occupied by atoms $= 2 \times \frac{4}{3}\pi r^3$

Step 4: Express r in terms of a

From earlier:

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

So,

$$r^3 = \left(\frac{a\sqrt{3}}{4}\right)^3 = a^3 \times \frac{3\sqrt{3}}{64}$$

Step 5: Substitute r^3 into volume occupied

Total volume occupied $= 2 \times \frac{4}{3}\pi r^3 = \frac{8}{3}\pi r^3 = \frac{8}{3}\pi \cdot \frac{3\sqrt{3}}{64}a^3 = \pi \cdot \frac{8\sqrt{3}}{64}a^3 = \pi \cdot \frac{\sqrt{3}}{8}a^3$

Step 6: Volume occupied by 1 atom

Since there are 2 atoms,

Volume occupied by 1 atom $= \frac{1}{2}\left[\pi \cdot \frac{\sqrt{3}}{8}a^3\right] = \frac{\pi\sqrt{3}}{16}a^3$

Step 7: Substitute value of $a^3 = 8.2 \times 10^{-23}\ \text{cm}^3$

Volume occupied by 1 atom $= \frac{\pi\sqrt{3}}{16} \times 8.2 \times 10^{-23}$

Calculate value:

- $\pi \approx 3.14$
- $\sqrt{3} \approx 1.732$
- So, $\pi\sqrt{3} \approx 3.14 \times 1.732 \approx 5.44$
- Therefore,

$$\frac{\pi\sqrt{3}}{16} \approx \frac{5.44}{16} \approx 0.34$$

So,

Volume occupied by 1 atom $= 0.34 \times 8.2 \times 10^{-23} = 2.788 \times 10^{-23}\ \text{cm}^3$

Correct Answer:

$$\boxed{2.788 \times 10^{-23}\ \text{cm}^3}$$

Option C is correct.

Question34

Calculate the number of unit cells in 1 cm^3 volume of an element if unit cell edge length is 4.0×10^{-8} cm.

MHT CET 2025 20th April Evening Shift

Options:

A. 2.63×10^{22}

B. 1.56×10^{22}

C. 3.34×10^{22}

D. 4.50×10^{22}

Answer: B

Solution:

Given:

- Volume of sample, $V = 1 \text{ cm}^3$
- Edge length of unit cell, $a = 4.0 \times 10^{-8}$ cm

Step 1: Calculate volume of one unit cell

Volume of one unit cell $= a^3 = (4.0 \times 10^{-8} \text{ cm})^3$

$= 4.0^3 \times (10^{-8})^3 \text{ cm}^3$

$= 64 \times 10^{-24} \text{ cm}^3$

$= 6.4 \times 10^{-23} \text{ cm}^3$

Step 2: Calculate number of unit cells

Number of unit cells $= \frac{\text{Total volume of sample}}{\text{Volume of one unit cell}}$

$= \frac{1 \text{ cm}^3}{6.4 \times 10^{-23} \text{ cm}^3}$

$= \frac{1}{6.4} \times 10^{23}$

$= 0.15625 \times 10^{23}$

$= 1.5625 \times 10^{22}$

Step 3: Choose the correct option

Rounding to three significant figures, the answer is:

1.56×10^{22}

Correct option:

Option B 1.56×10^{22}

Question35

Which of the following dopants is used in germanium to form n-type semiconductor?

MHT CET 2025 20th April Evening Shift

Options:

A. As

B. B

C. In

D. Ga

Answer: A

Solution:

The correct answer is **Option A: As (Arsenic)**.

Explanation:

To form an **n-type semiconductor**, we need to dope germanium (Ge) with an element that has **more valence electrons** than germanium.

- Germanium (Ge) belongs to **group 14** and has **4 valence electrons**.
- An **n-type dopant** should have **5 valence electrons** (i.e., should be from group 15).

Now, let us check the options:

- **A. As (Arsenic)** — Group 15, has 5 valence electrons ✅
- **B. B (Boron)** — Group 13, has 3 valence electrons ❌
- **C. In (Indium)** — Group 13, has 3 valence electrons ❌

- **D. Ga (Gallium)** — Group 13, has 3 valence electrons ❌

Therefore, Arsenic (As) is used as a dopant to form an n-type semiconductor from germanium.

Question36

Identify the type of defect from following in stainless steel.

MHT CET 2025 20th April Morning Shift

Options:

A. Substitutional impurity defect

B. Interstitial impurity defect

C. Metal excess defect

D. Frenkel defect

Answer: B

Solution:

Stainless steel is an alloy in which smaller atoms like carbon or nitrogen occupy the interstitial sites of the iron lattice.

This is called an **interstitial impurity defect**, where foreign atoms occupy the voids (interstitial sites) between the host metal atoms.

Correct Option:

Option B

Interstitial impurity defect

Question37

Calculate the total number of tetrahedral and octahedral voids formed in 0.6 mol of a compound if it forms hcp structure.

Options:

A. 3.613×10^{24}

B. 7.226×10^{24}

C. 1.084×10^{24}

D. 2.913×10^{24}

Answer: C

Solution:

Number of atoms in 0.6 mol

$= 0.6 \times 6.022 \times 10^{23}$ atoms

$= 3.6132 \times 10^{23}$ atoms

Number of octahedral voids

$=$ Number of atoms

$= 3.6132 \times 10^{23}$

Number of tetrahedral voids

$= 2\times$ Number of atoms

$= 2 \times 3.6132 \times 10^{23}$

$= 7.2264 \times 10^{23}$

Total number of tetrahedral and octahedral voids

$= 7.2264 \times 10^{23} + 3.6132 \times 10^{23}$

$= 10.8396 \times 10^{23} \approx 1.084 \times 10^{24}$

Question38

Calculate the molar mass of an element if it forms fcc unit cell structure [mass of unit cell $= 1.8 \times 10^{-22}$ g, $N_A = 6.022 \times 10^{23}$ mol^{-1}]

MHT CET 2025 20th April Morning Shift

Options:

A. $27.0 \mathrm{~g} \mathrm{~mol}^{-1}$

B. $24.4 \mathrm{~g} \mathrm{~mol}^{-1}$

C. $21.0 \mathrm{~g} \mathrm{~mol}^{-1}$

D. $30.2 \mathrm{~g} \mathrm{~mol}^{-1}$

Answer: A

Solution:

In fcc lattice, no. of atoms per unit cell $= 4$

Mass of unit cell $= 1.8 \times 10^{-22} \mathrm{~g}$

Mass of 1 atom $= \frac{1.8 \times 10^{-22} \mathrm{~g}}{4}$

$= 0.45 \times 10^{-22} \mathrm{~g}$

Molar mass of the element

$$\begin{aligned} & = 0.45 \times 10^{-22} \times 6.022 \times 10^{23} \mathrm{~g} \mathrm{~mol}^{-1} \\ & = 2.709 \times 10 \mathrm{~g} \approx 27.0 \mathrm{~g} \mathrm{~mol}^{-1} \end{aligned}$$

Question39

The volume of simple unit cell is $x \times 10^{-23} \mathrm{~cm}^3$. Calculate the value of x if volume occupied by a particle in it is $2.1 \times 10^{-23} \mathrm{~cm}^3$.

MHT CET 2025 19th April Evening Shift

Options:

A. 3.0

B. 3.5

C. 4.0

D. 4.5

Answer: C

Solution:

Let's solve the problem step by step:

Step 1: Know the formula for "Volume occupied by particle in a simple cubic cell"

A simple cubic unit cell has 1 atom per unit cell. The atom is assumed to be a hard sphere and occupies part of the volume.

In a simple cubic unit cell:

- The atom touches the faces, not the diagonal.
- Volume occupied by atom = Volume of 1 atom

Let the volume of unit cell = V_{cell}

Let the volume occupied by a particle = V_{particle}

Given:

- $V_{\text{cell}} = x \times 10^{-23}\ \text{cm}^3$
- $V_{\text{particle}} = 2.1 \times 10^{-23}\ \text{cm}^3$

Step 2: Know the packing efficiency formula

Packing efficiency $= \frac{\text{Volume occupied by particle}}{\text{Volume of unit cell}} \times 100\%$

For a simple cubic unit cell, packing efficiency $= 52.4\%$

So:

Packing efficiency $= \frac{V_{\text{particle}}}{V_{\text{cell}}} \times 100 = 52.4$

Step 3: Substitute the values

Let's put the values (using units in $10^{-23}\ \text{cm}^3$ for easy cancellation):

$\frac{2.1}{x} \times 100 = 52.4$

Step 4: Rearranging the equation

$\frac{2.1}{x} \times 100 = 52.4$

$\frac{2.1}{x} = 0.524$

$x = \frac{2.1}{0.524}$

Step 5: Calculate the value of x

$x = \frac{2.1}{0.524} \approx 4.01$

Step 6: Find the closest value from the options

The closest value is **4.0**.

Final Answer:

Option C: 4.0

Question40

In ionic solid, anions are arranged in ccp array and cations occupy $1/3$ tetrahedral voids. What is the formula of ionic compound?

[Consider $\mathrm{A} = $ cation; $\mathrm{B} = $ anion]

MHT CET 2025 19th April Evening Shift

Options:

A. AB_3

B. $\mathrm{A}_2\,\mathrm{B}_3$

C. $\mathrm{A}_3\,\mathrm{B}_2$

D. AB_4

Answer: B

Solution:

Let the number of anions (B) be N.

Step 1: Number of Tetrahedral Voids

- For a close packed arrangement of anions (ccp or fcc), the number of tetrahedral voids $= 2N$.

Step 2: Cations Occupy $1/3$ of Tetrahedral Voids

- Number of cations $(A) = \frac{1}{3} \times 2N = \frac{2N}{3}$

Step 3: Ratio of Cations to Anions

- Number of $A : B = \frac{2N}{3} : N$
- Divide both sides by N:

$A : B = \frac{2}{3} : 1$

- Multiply both sides by 3 to get simple ratio:

$A : B = 2 : 3$

Step 4: Formula of Compound

- So, the formula is A_2B_3

Final Answer:

Option B: A_2B_3

Question41

Which of the following statements is NOT correct regarding voids in lattice structure?

MHT CET 2025 19th April Evening Shift

Options:

A. Four spheres are involved in the formation of a tetrahedral void.

B. The octahedral void is surrounded by six spheres.

C. There are two tetrahedral voids associated with each atom.

D. There is one octahedral void associated with two atoms.

Answer: D

Solution:

Let's check each option step by step, using the NCERT description of voids in close packing:

1. **Option A: Four spheres are involved in the formation of a tetrahedral void.**

- Correct. A tetrahedral void is formed when four spheres are arranged in such a way that they occupy the corners of a tetrahedron.

1. **Option B: The octahedral void is surrounded by six spheres.**

- Correct. An octahedral void is formed when six spheres occupy the corners of a regular octahedron.

1. **Option C: There are two tetrahedral voids associated with each atom.**

- Correct. If there are N atoms, the number of tetrahedral voids formed is $2N$.

1. **Option D: There is one octahedral void associated with two atoms.**

- This is **NOT correct**.
- Explanation: For a lattice containing N atoms, the number of octahedral voids formed is exactly N, i.e., one octahedral void per atom, not half.

✅ **Correct Answer: Option D**

Question42

Calculate the volume of unit cell having atomic radius 141.4 pm forming fcc unit cell.

MHT CET 2025 19th April Morning Shift

Options:

A. $9.3 \times 10^{-23} \text{ cm}^3$

B. $8.1 \times 10^{-23} \text{ cm}^3$

C. $6.4 \times 10^{-23} \text{ cm}^3$

D. $4.7 \times 10^{-23} \text{ cm}^3$

Answer: C

Solution:

For a face-centered cubic (fcc) unit cell, the relation between the edge length (a) and atomic radius (r) is:

$a = 2\sqrt{2}r$

Given, $r = 141.4$ pm.

Let's calculate step by step:

1. **Find the edge length a:**

   $a = 2\sqrt{2} \times 141.4\,\text{pm}$

   $\sqrt{2} \approx 1.414$

   $a = 2 \times 1.414 \times 141.4$

   $a = 2 \times 1.414 \times 141.4 = 2 \times 200.04 = 400.08$ pm

   So,

   $a = 400.08$ pm

2. **Convert a to cm:**

   $1\,\text{pm} = 10^{-12}\,\text{m} = 10^{-10}\,\text{cm}$

   $a = 400.08 \times 10^{-10}$ cm

3. **Find the volume of the unit cell:**

   $\text{Volume} = a^3$

   $\text{Volume} = (400.08 \times 10^{-10}\,\text{cm})^3$

   $= (400.08)^3 \times (10^{-10})^3\ \text{cm}^3$

   $= (64,064,000) \times 10^{-30}\ \text{cm}^3$

   $= 6.4064 \times 10^7 \times 10^{-30}\ \text{cm}^3$

   $= 6.4064 \times 10^{-23}\ \text{cm}^3$

   Rounding to two significant digits:

   $\boxed{6.4 \times 10^{-23}\ \text{cm}^3}$

Correct answer: Option C

Question43

Which from following solids is isotropic?

MHT CET 2025 19th April Morning Shift

Options:

A. Glass

B. Ceramics

C. Graphite

D. Ice

Answer: A

Solution:

Let us understand the term **isotropic** as per NCERT textbook:

- A solid is **isotropic** if its physical properties like refractive index, electrical conductivity, etc. are the same in all directions.

Step-by-step explanation of each option:

Option A: Glass

- Glass is an **amorphous solid**.
- Amorphous solids are **isotropic** because their arrangement of particles is random in all directions.
- Hence, properties are the same in all directions.

Option B: Ceramics

- Ceramics are mostly **crystalline** (some can have amorphous regions), but typically their overall structure is not uniform in all directions (depends on composition).
- Most ceramics are **not strictly isotropic**.

Option C: Graphite

- Graphite has a **layered structure**.
- Its properties are **anisotropic** (different in different directions)—for example, electrical conductivity varies between layers and within layers.

Option D: Ice

- Ice is a **crystalline solid**.
- Crystalline solids (except cubic crystals) are generally **anisotropic**.

Conclusion:

The solid that is isotropic from the given options is:

Option A: Glass

Question44

Calculate the number of atoms present in 1.58 g metal if it forms bcc structure.

$$\left[\rho \times \mathrm{a}^3 = 1.58 \times 10^{-22}\ \mathrm{g}\right]$$

MHT CET 2025 19th April Morning Shift

Options:

A. 1.0×10^{22}

B. 2.0×10^{22}

C. 3.0×10^{22}

D. 4.0×10^{22}

Answer: B

Solution:

Given:

- Mass of metal = 1.58 g
- Structure = **bcc** (body centred cubic)
- $\rho \times a^3 = 1.58 \times 10^{-22}$ g
- Avogadro's number (N_A) = 6.022×10^{23}

Step 1: Number of atoms in bcc unit cell

A bcc unit cell contains **2 atoms**.

Step 2: Mass of one unit cell

Given:

Mass of one unit cell $= \rho \times a^3 = 1.58 \times 10^{-22}$ g

Step 3: Number of unit cells in 1.58 g

Number of unit cells $= \frac{\text{Total mass}}{\text{Mass of one unit cell}} = \frac{1.58}{1.58 \times 10^{-22}} = 10^{22}$

Step 4: Total number of atoms

Each unit cell has 2 atoms:

Total atoms $= 2 \times$ (Number of unit cells) $= 2 \times 10^{22}$

Final Answer:

Option B

2.0×10^{22}

Question45

What is the total number of tetrahedral voids in 0.6 mole of compound that forms hcp structure?

MHT CET 2024 16th May Evening Shift

Options:

A. 3.6132×10^{23}

B. 7.2264×10^{23}

C. 4.8396×10^{23}

D. 5.0331×10^{23}

Answer: B

Solution:

$$\begin{aligned} &\text{1 mole of compound} &&= 6.023 \times 10^{23} \text{ atoms} \\ &\text{0.6 mole of compound} &&= 6.023 \times 10^{23} \times 0.6 \text{ atoms} \\ \therefore\ &\text{No. of tetrahedral voids} &&= 0.6 \times 6.023 \times 10^{23} \times 2 \\ & &&= 7.2264 \times 10^{23} \text{ voids} \end{aligned}$$

Question46

Calculate the number of unit cells in 0.4 g metal if the product of density and volume of unit cell is 1.2×10^{-22} g.

MHT CET 2024 16th May Evening Shift

Options:

A. 1.1×10^{21}

B. 2.2×10^{21}

C. 3.3×10^{21}

D. 4.4×10^{21}

Answer: C

Solution:

No. of unit cell in xg of metal

$$= \frac{\mathrm{x}}{\mathrm{pa}^3} = \frac{0.4 \mathrm{~g}}{1.2 \times 10^{-22} \mathrm{~g}}$$
$$= 3.3 \times 10^{21}$$

Question47

What is the total number of particles present in base centred unit cell?

MHT CET 2024 16th May Evening Shift

Options:

A. 1

B. 2

C. 4

D. 6

Answer: B

Solution:

In a base-centered unit cell, there are particles at each corner of the unit cell and additional particles at the center of each of the base faces.

Corner particles: Each corner of a unit cell is shared by eight adjacent unit cells, so each corner contributes $\frac{1}{8}$ of a particle to the unit cell.

Contribution from corners $= 8 \times \frac{1}{8} = 1$

Base face-centered particles: Each of the two base faces contributes half of a particle to the unit cell, as these particles are shared between two adjacent unit cells.

Contribution from base faces $= 2 \times \frac{1}{2} = 1$

Adding these contributions together gives the total number of particles in a base-centered unit cell:

$1(\text{from corners}) + 1(\text{from base face centers}) = 2$

Therefore, the total number of particles present in a base-centered unit cell is **2**.

Answer: Option B

Question48

Calculate the number of unit cells in 0.9 g metal if it forms bcc structure. $\left[\rho \times \mathrm{a}^3 = 3 \times 10^{-22} \text{ gram}\right]$

MHT CET 2024 16th May Morning Shift

Options:

A. 1.0×10^{21}

B. 2.0×10^{21}

C. 3.0×10^{21}

D. 4.0×10^{21}

Answer: C

Solution:

In order to calculate the number of unit cells for a metal forming a Body-Centered Cubic (BCC) structure in 0.9 grams, we start with the following information:

The density-volume relationship is given by:

$\rho \times a^3 = 3 \times 10^{-22}$ grams

The weight of the metal: 0.9 grams.

A BCC unit cell contains 2 atoms per unit cell.

To determine the number of unit cells, follow these steps:

Calculate the mass of one unit cell:

Mass of one unit cell $= \rho \times a^3 = 3 \times 10^{-22}$ grams

Calculate the number of unit cells in 0.9 grams of the metal by dividing the total mass by the mass of one unit cell:

Number of unit cells $= \frac{\text{Total mass}}{\text{Mass of one unit cell}} = \frac{0.9 \text{ grams}}{3 \times 10^{-22} \text{ grams}}$

Simplify the calculation:

Number of unit cells $= \frac{0.9}{3 \times 10^{-22}} = \frac{0.9 \times 10^{22}}{3} = 0.3 \times 10^{22}$

Convert this to a more standard scientific notation:

$0.3 \times 10^{22} = 3.0 \times 10^{21}$

Thus, option C is correct, with the number of unit cells being:

3.0×10^{21}

Question49

Find the void volume of fcc unit cell in cm^3 if the volume of fcc unit cell $1.25 \times 10^{-22}\ \mathrm{cm}^3$.

MHT CET 2024 16th May Morning Shift

Options:

A. 3.25×10^{-23}

B. 2.16×10^{-23}

C. 1.34×10^{-23}

D. 4.20×10^{-23}

Answer: A

Solution:

For fcc unit cell, packing efficiency $= 74\%$

$\therefore$ Percentage of unoccupied space (void volume)

$$= 100 - 74 = 26\%$$
$$= 1.25 \times 10^{-22}\ \text{cm}^3 \times \frac{26}{100}$$
$$= 3.25 \times 10^{-23}\ \text{cm}^3$$

Question50

What type of solid is the silica?

MHT CET 2024 16th May Morning Shift

Options:

A. Ionic

B. Molecular

C. Covalent

D. Metallic

Answer: C

Solution:

Silica is primarily found in the form of silicon dioxide, SiO_2, which forms a covalent network solid. In this structure, each silicon atom forms four strong covalent bonds with oxygen atoms, creating a three-dimensional lattice. Therefore, the type of solid that silica forms is:

Option C: Covalent

Question51

In a solid, B^-ions occupy corners of a cube forming ccp structure. If A^+ion occupy half the tetrahedral voids, formula of the solid is

MHT CET 2024 15th May Evening Shift

Options:

A. A_2B

B. AB_2

C. A_2B_3

D. AB

Answer: D

Solution:

In a cubic close-packed (ccp) structure, the ions at the corners contribute to the count of anions forming the lattice. Each of the eight corners is shared by eight adjacent unit cells, effectively contributing only $\frac{1}{8}$ of an ion per corner to a single unit cell.

Hence, total contribution from corner ions = $8 \times \frac{1}{8} = 1$.

Tetrahedral voids in a ccp structure are present in a ratio of 2:1 with respect to the lattice ions. This implies there are 2 tetrahedral voids for each lattice ion contributed.

Given that only half of these tetrahedral voids are occupied by the A^+ ions, the number of A^+ ions per unit cell is:

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

Therefore, for one B^- forming the corners and fully functioning within a single unit cell, and one A^+ occupying half the tetrahedral voids, the chemical formula of the solid can be established as:

AB

Thus, the correct option is:

Option D: AB

Question52

Unit cell of an element has edge length of 5$\overset{o}{A}$ with density 4 g cm^{-3}, if its atomic mass is 149, identify the crystal structure.

MHT CET 2024 15th May Evening Shift

Options:

A. Simple cubic close packed

B. Body centred cubic

C. Face centred cubic

D. Hexagonal close packed

Answer: B

Solution:

To identify the crystal structure of an element, we can use the formula for density related to crystal structures:

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

Where:

ρ is the density.

Z is the number of atoms per unit cell.

M is the molar mass (atomic mass) in grams per mole.

N_A is Avogadro's number (6.022×10^{23} atoms/mol).

a is the edge length of the unit cell.

Given:

$\rho = 4 \text{ g/cm}^3$

$a = 5\overset{o}{A} = 5 \times 10^{-8} \text{ cm}$

$M = 149 \text{ g/mol}$

First, solve for Z using the provided information:

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

Plugging in the given values:

$a^3 = (5 \times 10^{-8})^3 = 125 \times 10^{-24}\ \text{cm}^3$

$Z = \frac{4 \cdot 6.022 \times 10^{23} \cdot 125 \times 10^{-24}}{149}$

$Z = \frac{4 \cdot 6.022 \times 125 \times 10^{-1}}{149}$

$Z = \frac{301.1}{149}$

$Z \approx 2$

The number of atoms per unit cell (Z) is approximately 2, which corresponds to a Body-Centered Cubic (BCC) structure since BCC structures typically have 2 atoms per unit cell.

Therefore, the crystal structure is **Body Centered Cubic (BCC)**, corresponding to Option B.

Question53

What is the volume of one particle in BCC structure if ' a ' is edge length?

MHT CET 2024 15th May Evening Shift

Options:

A. $\frac{\pi a^3}{3\sqrt{2}}$

B. $\frac{\pi a^3}{12\sqrt{2}}$

C. $\frac{\sqrt{3}\pi a^3}{16}$

D. $\frac{\sqrt{3}\pi a^3}{8}$

Answer: C

Solution:

In a body-centered cubic (BCC) structure, the atoms are arranged such that an atom resides at each corner of a cube and one atom sits in the center of the cube. The relationship between the edge length, a, and the atomic radius, r, in a BCC structure is given by:

$a = \frac{4r}{\sqrt{3}}$

Since a BCC unit cell effectively contains two atoms (one from the center and 1/8 from each of the 8 corners), the volume of one atom can be calculated from its radius. The volume of a sphere (representing the atom) is:

$V = \frac{4}{3}\pi r^3$

Substituting for r in terms of a yields:

$r = \frac{\sqrt{3}a}{4}$

Plugging this into the formula for volume of a sphere:

$V = \frac{4}{3}\pi\left(\frac{\sqrt{3}a}{4}\right)^3$

Calculating further:

$V = \frac{4}{3}\pi\frac{3\sqrt{3}a^3}{64}$

$V = \frac{\sqrt{3}\pi a^3}{16}$

Therefore, the volume of one particle in a BCC structure when the edge length is a is given by:

Option C:

$\frac{\sqrt{3}\pi a^3}{16}$

Question54

Calculate the total volume occupied by all atoms in simple cubic unit cell if radius of atom is 3×10^{-8} cm.

MHT CET 2024 15th May Morning Shift

Options:

A. $1.13 \times 10^{-22}\ \mathrm{cm}^3$

B. $2.25 \times 10^{-22}\ \mathrm{cm}^3$

C. $3.15 \times 10^{-22}\ \mathrm{cm}^3$

D. $4.37 \times 10^{-22}\ \mathrm{cm}^3$

Answer: A

Solution:

In a simple cubic unit cell, each corner atom is shared among eight different unit cells, which means each unit cell contains only one atom in total. Therefore, the number of atoms per simple cubic unit cell is 1.

The volume of a single atom, assuming it is spherical, is given by the formula:

$V = \frac{4}{3}\pi r^3$

where r is the radius of the atom.

Given that the radius $r = 3 \times 10^{-8}$ cm, the volume of a single atom is:

$V = \frac{4}{3}\pi(3 \times 10^{-8}\,\text{cm})^3$

Starting with the calculations:

Calculate r^3:

$(3 \times 10^{-8})^3 = 27 \times 10^{-24}\,\text{cm}^3 = 2.7 \times 10^{-23}\,\text{cm}^3$

Now, find the volume of a single atom:

$V = \frac{4}{3}\pi \times 2.7 \times 10^{-23}\,\text{cm}^3$

Using the approximate value of $\pi \approx 3.14$:

$V \approx \frac{4}{3} \times 3.14 \times 2.7 \times 10^{-23}\,\text{cm}^3$

Calculate $\frac{4}{3} \times 3.14 \approx 4.19$.

Finally, compute the total volume:

$V \approx 4.19 \times 2.7 \times 10^{-23} = 11.313 \times 10^{-23}\,\text{cm}^3$

Convert into more standard form:

$V \approx 1.1313 \times 10^{-22}\,\text{cm}^3$

Thus, the total volume occupied by all atoms in the simple cubic unit cell is approximately $1.13 \times 10^{-22}\,\text{cm}^3$.

The correct answer is **Option A**: $1.13 \times 10^{-22}\,\text{cm}^3$.

Question55

A compound is formed by two elements A and B. The atoms of element B form ccp structure. The atoms of A occupy $\frac{1}{3}$ of tetrahedral voids. What is the formula of the compound?

MHT CET 2024 15th May Morning Shift

Options:

A. A_2B_3

B. AB

C. AB_2

D. AB_3

Answer: A

Solution:

In a cubic close-packed (ccp) structure, also known as face-centered cubic (fcc), there are 4 atoms of the element forming the ccp structure per unit cell. Each unit cell contains 8 tetrahedral voids. Therefore, the number of tetrahedral voids is twice the number of atoms of the element forming the ccp structure.

Given that element B forms the ccp structure, we have:

Number of B atoms per unit cell = 4

Number of tetrahedral voids per unit cell = 8

Element A occupies $\frac{1}{3}$ of these tetrahedral voids. So, the number of A atoms is:

Number of A atoms $= \frac{1}{3} \times 8 = \frac{8}{3}$

Considering a whole number ratio for the simplest formula of the compound, let's adjust the proportion by multiplying to clear the fraction:

Number of B atoms (per structure formula unit): 4

Number of A atoms (adjusted by multiplying by 3): 8

Thus, the formula ratio becomes:

$\mathrm{A} : \mathrm{B} = \frac{8}{3} : 4 = 8 : 12 = 2 : 3$

Therefore, the formula of the compound is:

A_2B_3

So, the correct answer is:

Option A: A_2B_3

Question56

Identify the instrument used to find crystal structure from following :

MHT CET 2024 11th May Evening Shift

Options:

A. X-ray diffractometer

B. UV-Visible spectrophotometer

C. Scanning electron microscope

D. Transmission electron microscope

Answer: A

Solution:

The instrument used to find crystal structure is the **X-ray diffractometer**.

X-ray diffraction (XRD) is a powerful technique employed to study the crystal structure of materials. It works by directing X-rays onto a crystalline material and measuring the angles and intensities of the X-rays that are diffracted by the crystal lattice.

When X-rays interact with a crystal, they are scattered in a specific pattern, and according to Bragg's law:

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

where:

n is the order of the diffracted ray,

λ is the wavelength of the incident X-ray,

d is the distance between crystal planes, also known as the interplanar spacing,

θ is the angle of incidence (Bragg angle).

By analyzing the diffraction pattern, information about the crystal's lattice parameters, phases, orientation, and other structural characteristics can be obtained. This makes XRD an indispensable tool in materials science, geology, chemistry, and physics for characterizing crystalline materials.

Question57

Which among the following is an example of one dimensional nanostructure?

MHT CET 2024 11th May Evening Shift

Options:

A. Nano rings

B. Nano tubes

C. Layers and coatings

D. Quantum dots

Answer: B

Solution:

Option B, **Nano tubes**, is an example of a one-dimensional nanostructure.

One-dimensional nanostructures are characterized by their length being significantly larger than their width and depth. These structures are typically measured in nanometers in terms of their cross-sectional dimensions. Examples include nanowires and nanotubes.

Nano tubes are hollow cylindrical structures that can be thought of as rolled sheets of graphene, with a very high length-to-diameter ratio. The most well-known type of nanotube is the carbon nanotube, which has remarkable electrical, mechanical, and thermal properties due to its unique structure.

In contrast, the other options are classified differently:

Nano rings are typically considered two-dimensional due to their ring shape.

Layers and coatings are also two-dimensional as they spread across surfaces in thin films or layers.

Quantum dots are zero-dimensional because they have all three dimensions confined on the nanometer scale.

Thus, in terms of dimensionality relevant to nanostructures:

0D refers to quantum dots,

1D refers to structures like nanotubes,

2D involves thin films and coatings,

3D covers complex, volumetric nano-architectures.

Question58

What type of unit cell from following is common to all seven types of crystal systems?

MHT CET 2024 11th May Evening Shift

Options:

A. Simple

B. Body-centred

C. Face-centred

D. Base-centred

Answer: A

Solution:

The simple unit cell is common to all seven crystal systems. In crystallography, there are seven crystal systems: cubic, tetragonal, orthorhombic, hexagonal, rhombohedral, monoclinic, and triclinic. Each of these systems can have a simple or primitive unit cell, which consists of lattice points at the corners of the unit cell only.

In summary:

A simple unit cell (also known as a primitive unit cell) is common to all the crystal systems, meaning it represents the most basic repeating unit without additional lattice points within the unit cell.

In contrast, body-centered, face-centered, and base-centered unit cells are not present in every crystal system and are specific to certain systems.

Therefore, the correct option is:

Option A: Simple

Question59

What is atomic radius of an element if it crystallises in BCC structure with edge length of unit cell 287 pm?

MHT CET 2024 11th May Evening Shift

Options:

A. 124 pm

B. 131 pm

C. 137 pm

D. 174 pm

Answer: A

Solution:

In a body-centered cubic (BCC) structure, the atomic radius (r) can be computed from the edge length (a) of the unit cell using the geometric relationship applicable to BCC structures. The relationship is derived from the fact that the body diagonal of the cube passes through the centers of two atoms plus one additional radius. For a BCC structure, the body diagonal $\sqrt{3}a$ is equal to 4 times the atomic radius:

$\sqrt{3}a = 4r$

Solving for r, we get:

$r = \frac{\sqrt{3}a}{4}$

Given that the edge length (a) of the unit cell is 287 pm, substitute into the formula:

$r = \frac{\sqrt{3} \times 287 \text{ pm}}{4}$

Calculating this gives:

$r = \frac{1.732 \times 287}{4} \approx \frac{497.684}{4} \approx 124.42 \text{ pm}$

Thus, rounding to the nearest whole number, the atomic radius is approximately 124 pm.

Option A: 124 pm is the correct choice.

Question60

A metal crystallises in bcc structure with edge length 4×10^{-8}. If density of unit cell is 10 g cm^{-3}. What is its molar mass?

MHT CET 2024 11th May Evening Shift

Options:

A. 60 g mol^{-1}

B. 120 g mol^{-1}

C. 152 g mol^{-1}

D. 193 g mol^{-1}

Answer: D

Solution:

For bcc unit cell, n = 2.

$$\text{Density}(\rho) = \frac{\text{M} \times \text{n}}{\text{a}^3 \text{N}_\text{A}}$$

$$10 \text{ g cm}^{-3} = \frac{\text{M} \times 2}{\left(4 \times 10^{-8} \text{ cm}\right)^3 \times 6.022 \times 10^{23} \text{ mol}^{-1}}$$

$$\text{M} = \frac{6.022 \times 10^{23} \text{ mol}^{-1} \times \left(4 \times 10^{-8} \text{ cm}^3 \times 10 \text{ g cm}^{-3}\right.}{2}$$

$$\therefore \quad M = 193 \text{ g mol}^{-1}$$

Question61

n-type of semiconductor is formed when

MHT CET 2024 11th May Morning Shift

Options:

A. Silicon doped with phosphorous

B. Silicon doped with boron

C. Germanium doped with boron

D. Germanium doped with aluminium

Answer: A

Solution:

n-type semiconductors are formed when silicon or germanium is doped with an element that has more valence electrons than they do. Typically, silicon and germanium, which have four valence electrons, are doped with pentavalent elements (i.e., elements with five valence electrons).

Option A: Silicon doped with phosphorous

Doping silicon with phosphorous introduces additional free electrons into the crystal lattice because phosphorous has five valence electrons. The extra electron is not required to form covalent bonds in the lattice and is, therefore, free to move, contributing to electrical conduction. This creates an n-type semiconductor, where the majority charge carriers are electrons.

Correct Answer: Option A

Silicon doped with phosphorous forms an n-type semiconductor.

Question62

Metallic silver has fcc structure. If radius of Ag atom is 144 pm . What is the edge length of unit cell?

MHT CET 2024 11th May Morning Shift

Options:

A. 4.07×10^{-8} cm

B. 3.22×10^{-8} cm

C. 2.63×10^{-8} cm

D. 2.23×10^{-8} cm

Answer: A

Solution:

In a face-centered cubic (fcc) structure, the relationship between the atomic radius (r) and the edge length of the unit cell (a) is given by:

$a = 2\sqrt{2} \cdot r$

Given that the atomic radius of silver (Ag) is 144 pm, we can calculate the edge length as follows:

Substitute the given radius into the formula:

$a = 2\sqrt{2} \cdot 144\,\text{pm}$

Calculate the value of a:

$a = 2 \cdot 1.414 \cdot 144\,\text{pm}$

$a = 288 \cdot 1.414\,\text{pm}$

$a \approx 407\,\text{pm}$

The edge length in centimeters can be converted by recognizing that:

$1\text{ pm} = 10^{-10}\text{ cm}$.

Thus:

$a \approx 407 \times 10^{-10}\,\text{cm}$

Simplifying gives:

$a \approx 4.07 \times 10^{-8}\,\text{cm}$

Therefore, the correct answer is:

Option A

4.07×10^{-8} cm

Question63

What is the number of octahedral voids present in 0.2 mol of a compound forming hcp structure?

MHT CET 2024 11th May Morning Shift

Options:

A. 1.204×10^{23}

B. 2.387×10^{23}

C. 3.011×10^{23}

D. 3.321×10^{23}

Answer: A

Solution:

In a hexagonal close-packed (hcp) structure, the number of octahedral voids is equal to the number of atoms. Therefore, to determine the number of octahedral voids in 0.2 mol of a compound forming an hcp structure, follow these steps:

Calculate the number of atoms in 0.2 mol:

The number of atoms in a mole is given by Avogadro's number, which is 6.022×10^{23}. For 0.2 mol:

Number of atoms $= 0.2 \times 6.022 \times 10^{23} = 1.2044 \times 10^{23}$

Since the number of octahedral voids is equal to the number of atoms in the structure, the number of octahedral voids is also 1.2044×10^{23}.

Thus, the answer is:

Option A

1.204×10^{23}

Question64

Calculate the volume of simple cubic unit cell if the radius of particle in it is 400 pm.

MHT CET 2024 10th May Evening Shift

Options:

A. $6.36 \times 10^{-22}\ \text{cm}^3$

B. $5.12 \times 10^{-22}\ \text{cm}^3$

C. $5.84 \times 10^{-22}\ \text{cm}^3$

D. $6.60 \times 10^{-22}\ \text{cm}^3$

Answer: B

Solution:

In a simple cubic unit cell, the particles sit at the corners of a cube. Each particle touches the neighboring particle directly along a cube edge. Therefore, the edge length of the cube (a) is equal to twice the radius of the particle.

Given that the radius (r) of the particle is 400 pm (picometers), the edge length of the cubic unit cell is:

$a = 2 \times 400\,\text{pm} = 800\,\text{pm}$

To calculate the volume of the cubic unit cell, use the formula for the volume of a cube:

$V = a^3$

First, convert the edge length from picometers to centimeters:

1 picometer (pm) = 1×10^{-12} meters

Thus, $800 \text{ pm} = 800 \times 10^{-12} \text{ m} = 8 \times 10^{-10} \text{ m}$.

Convert meters to centimeters (since $1 \text{ cm} = 0.01 \text{ m}$):

$8 \times 10^{-10} \text{ m} = 8 \times 10^{-8} \text{ cm}$

Now, calculate the volume in cubic centimeters:

$V = (8 \times 10^{-8} \text{ cm})^3 = 512 \times 10^{-24} \text{ cm}^3 = 5.12 \times 10^{-22} \text{ cm}^3$

Therefore, the volume of the simple cubic unit cell is:

Option B: $5.12 \times 10^{-22} \text{ cm}^3$

Question65

Calculate the density of a metal molar mass 197 g mol^{-1} if it forms fcc structure. $\left[\mathrm{a}^3 \times \mathrm{N_A} = 40 \text{ cm}^3 \text{ mol}^{-1}\right]$

MHT CET 2024 10th May Evening Shift

Options:

A. 23.5 g cm^{-3}

B. 21.2 g cm^{-3}

C. 17.5 g cm^{-3}

D. 19.7 g cm^{-3}

Answer: D

Solution:

To calculate the density of a metal with a face-centered cubic (fcc) structure, we can use the formula for density:

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

Where:

Z is the number of atoms per unit cell in an fcc structure, which is 4.

M is the molar mass of the metal, which is given as $197 \mathrm{~g/mol}$.

a^3 is the volume of the unit cell.

N_A is Avogadro's number, $6.022 \times 10^{23} \mathrm{~mol}^{-1}$.

Given that $a^3 \times N_A = 40 \mathrm{~cm}^3/\mathrm{mol}$, we can substitute directly into the density formula:

Density $= \frac{4 \times 197 \mathrm{~g/mol}}{40 \mathrm{~cm}^3/\mathrm{mol}}$

Calculating the above expression:

Density $= \frac{788 \mathrm{~g/mol}}{40 \mathrm{~cm}^3/\mathrm{mol}} = 19.7 \mathrm{~g/cm}^3$

The correct answer is:

Option D: $19.7 \mathrm{~g/cm}^3$

Question66

What is minimum number of spheres required of develop a tetrahedral void?

MHT CET 2024 10th May Evening Shift

Options:

A. 2

B. 4

C. 6

D. 3

Answer: B

Solution:

The minimum number of spheres required to develop a tetrahedral void is 4.

A tetrahedral void is formed when four spheres are arranged such that they touch each other. This configuration is equivalent to placing one sphere on top of a triangle formed by the other three spheres, creating a void or empty space at the center that is tetrahedral in shape. The spherical arrangement can be visualized as the four corners of a regular tetrahedron.

In a close-packed structure, these tetrahedral voids occur naturally and are an important concept in the study of crystal structures and packing.

Question67

Calculate the volume of unit cell if an element having molar mass $92 \mathrm{~g} \mathrm{~mol}^{-1}$ that forms bcc structure $\left[\varrho \times \mathrm{N_A}=5.0 \times 10^{24} \mathrm{~g} \mathrm{~cm}^{-3} \mathrm{~mol}^{-1}\right]$

MHT CET 2024 10th May Morning Shift

Options:

A. $2.44 \times 10^{-23} \mathrm{~cm}^3$

B. $5.86 \times 10^{-23} \mathrm{~cm}^3$

C. $3.68 \times 10^{-23} \mathrm{~cm}^3$

D. $4.76 \times 10^{-23} \mathrm{~cm}^3$

Answer: C

Solution:

For bec unit cell, $\mathrm{n}=2$.

Density of bec unit cell $=\rho=\frac{M \times n}{a^3 \times N_A}$

$$\begin{aligned} \therefore \quad \text{Volume of unit cell } \left(\mathrm{a}^3\right) & =\frac{\mathrm{M} \times \mathrm{n}}{\rho \times \mathrm{N_A}} \\ & =\frac{92 \mathrm{~g} \mathrm{~mol}^{-1} \times 2}{5 \times 10^{24} \mathrm{~g} \mathrm{~cm}^{-3} \mathrm{~mol}^{-1}} \\ & =3.68 \times 10^{-23} \mathrm{~cm}^3 \end{aligned}$$

Question68

In an ionic solid equal number of cations and anions are missing from their regular positions in the crystal lattice creating vacancies is called-

MHT CET 2024 10th May Morning Shift

Options:

A. Vacancy defect

B. Self interstitial defect

C. Schottky defect

D. Frenkel defect

Answer: C

Solution:

Schottky defect is the term used when equal numbers of cations and anions are missing from their regular positions in the crystal lattice of an ionic solid, thereby creating vacancies. This type of defect is common in ionic compounds with high coordination numbers and similar-sized cations and anions. The loss or absence of these ion pairs maintains the electrical neutrality and decreases the density of the crystal.

Question69

Calculate number of atoms per unit cell of an element having molar mass $92.0 \mathrm{~g} \mathrm{~mol}^{-1}$ and density $8.6 \mathrm{~g} \mathrm{~cm}^{-3}$ forming cubic unit cell structure. $\left[\mathrm{a}^3 \times \mathrm{N}_{\mathrm{A}}=21.5 \mathrm{~cm}^3 \mathrm{~mol}^{-1}\right]$

MHT CET 2024 10th May Morning Shift

Options:

A. 1

B. 2

C. 3

D. 4

Answer: B

Solution:

To determine the number of atoms per unit cell, use the formula relating density, molar mass, and volume of the unit cell:

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

where:

Z is the number of atoms per unit cell.

$\rho = 8.6\,\mathrm{g/cm}^3$ is the density of the element.

$N_A = 6.022 \times 10^{23}\,\mathrm{mol}^{-1}$ is Avogadro's number.

$a^3 \times N_A = 21.5\,\mathrm{cm}^3/\mathrm{mol}$.

$M = 92.0\,\mathrm{g/mol}$ is the molar mass of the element.

First, solve for a^3:

Since $a^3 \times N_A = 21.5\,\mathrm{cm}^3/\mathrm{mol}$,

$a^3 = \frac{21.5\ \mathrm{cm}^3/\mathrm{mol}}{N_A} = \frac{21.5}{6.022 \times 10^{23}}\,\mathrm{cm}^3$

Plug a^3 and the other known values into the formula for Z:

$Z = \frac{8.6\ \mathrm{g/cm}^3 \cdot 6.022 \times 10^{23}\ \mathrm{mol}^{-1} \cdot \frac{21.5}{6.022 \times 10^{23}}\ \mathrm{cm}^3}{92.0\ \mathrm{g/mol}}$

Simplifying the equation, all terms involving N_A cancel out:

$Z = \frac{8.6 \cdot 21.5}{92.0}$

Calculate the value:

$Z = \frac{184.9}{92.0} \approx 2.01$

Since Z must be an integer, it is approximately 2. Thus, the element has 2 atoms per unit cell.

Option B: 2

Question70

Calculate the molar mass of an element having density $5.6 \mathrm{~g} \mathrm{~cm}^{-3}$ **that forms bcc structure** $\left[\mathrm{a}^3 \times \mathrm{N}_{\mathrm{A}}=75 \mathrm{~cm}^3 \mathrm{~mol}^{-1}\right]$

MHT CET 2024 9th May Evening Shift

Options:

A. $198 \mathrm{~g} \mathrm{~mol}^{-1}$

B. $210 \mathrm{~g} \mathrm{~mol}^{-1}$

C. $118 \mathrm{~g} \mathrm{~mol}^{-1}$

D. $225 \mathrm{~g} \mathrm{~mol}^{-1}$

Answer: B

Solution:

In a body-centered cubic (bcc) structure, there are 2 atoms per unit cell. The molar volume is given by $a^3 \times N_{\mathrm{A}}=75 \mathrm{~cm}^3 \mathrm{~mol}^{-1}$, where N_{A} is Avogadro's number, approximately $6.022 \times 10^{23} \mathrm{~mol}^{-1}$.

First, calculate the volume of the unit cell a^3:

$a^3=\frac{75}{N_{\mathrm{A}}} \mathrm{~cm}^3$

Number of atoms per unit cell for bcc = 2.

The relationship between density (ρ), molar mass (M), and molar volume is:

$\rho=\frac{Z \cdot M}{a^3 \cdot N_{\mathrm{A}}}$

where Z is the number of atoms in the crystal structure per unit cell, which for bcc is 2.

Using the provided density, let's solve for the molar mass M:

Given:

$\rho=5.6 \mathrm{~g} \mathrm{~cm}^{-3}$

Thus:

$5.6=\frac{2 \cdot M}{75}$

Solving for M:

$M = \frac{5.6 \times 75}{2}$

$M = 210 \text{ g mol}^{-1}$

Thus, the molar mass of the element is 210 g mol^{-1}, which corresponds to Option B.

Question71

What is the coordination number of a particle in fcc structure?

MHT CET 2024 9th May Evening Shift

Options:

A. 12

B. 2

C. 4

D. 6

Answer: A

Solution:

In a face-centered cubic (fcc) structure, each particle (or atom) is surrounded symmetrically by 12 nearest neighbors. This configuration is known as a close-packed structure and results in a coordination number of 12.

Option A: 12

Here is a brief explanation of how this works:

An fcc unit cell is characterized by atoms at each of the corners (8 corners in total) and at the center of each of the 6 faces.

Each corner atom is shared by eight adjacent unit cells, making its contribution 1/8th of an atom per unit cell.

Each face-centered atom is shared by two adjacent unit cells, making its contribution 1/2 of an atom per unit cell.

In terms of coordination, each atom located at a face-center is equidistant from 12 neighboring atoms. These neighbors consist of 4 atoms in the same face, 4 atoms in the above plane, and 4 atoms in the below plane.

The high coordination number is one of the reasons why fcc structures are densely packed and exhibit high packing efficiency.

Question72

Calculate the volume of fcc unit cell if radius of a particle in it is 106.05 pm.

MHT CET 2024 9th May Evening Shift

Options:

A. $7.4 \times 10^{-23}\ \mathrm{cm}^3$

B. $9.9 \times 10^{-23}\ \mathrm{cm}^3$

C. $2.7 \times 10^{-23}\ \mathrm{cm}^3$

D. $6.4 \times 10^{-23}\ \mathrm{cm}^3$

Answer: C

Solution:

For fcc unit cell, $a = \frac{4r}{\sqrt{2}}$

$$\therefore \quad a = \frac{4 \times 106.05}{\sqrt{2}} = \frac{424.2}{1.41}$$
$$= 300\mathrm{pm} = 300 \times 10^{-10}\ \mathrm{cm}$$

$\therefore \quad$ Volume of the unit cell $\left(\mathrm{a}^3\right) = \left(300 \times 10^{-10}\right)^3$

$= 2.7 \times 10^{-23}\ \mathrm{cm}^3$

Question73

Calculate the volume of unit cell when metal having density $1\ \mathrm{g\ cm}^{-3}$ and molar mass $23\ \mathrm{g\ mol}^{-1}$ crystallises to form bec structure.

Options:

A. $6.0 \times 10^{-23}\ \mathrm{cm}^3$

B. $8.6 \times 10^{-23}\ \mathrm{cm}^3$

C. $9.5 \times 10^{-23}\ \mathrm{cm}^3$

D. $7.6 \times 10^{-23}\ \mathrm{cm}^3$

Answer: D

Solution:

The volume of the unit cell for a body-centered cubic (bcc) structure can be calculated using the formula:

$V = \frac{Z \cdot M}{N_A \cdot \rho}$

where:

V is the volume of the unit cell.

Z is the number of atoms per unit cell, which is 2 for a bcc structure.

M is the molar mass (23 g/mol).

N_A is Avogadro's number ($6.022 \times 10^{23}\ \mathrm{mol}^{-1}$).

ρ is the density ($1\ \mathrm{g/cm}^3$).

Substituting the given values:

$V = \frac{2 \cdot 23}{6.022 \times 10^{23} \cdot 1}$

This simplifies to:

$V = \frac{46}{6.022 \times 10^{23}}$

Calculating the above expression:

$V \approx 7.64 \times 10^{-23}\ \mathrm{cm}^3$

Thus, the volume of the unit cell is approximately $7.6 \times 10^{-23}\ \mathrm{cm}^3$, which corresponds to Option D.

Question74

What is the relation between edge length and total volume occupied by atoms in bec unit cell?

MHT CET 2024 9th May Morning Shift

Options:

A. $\mathrm{V}=\frac{\pi \mathrm{a}^3}{6}$

B. $\mathrm{V}=\frac{\sqrt{3} \pi \mathrm{a}^3}{8}$

C. $\mathrm{V}=\frac{\pi \mathrm{a}^3}{3 \sqrt{2}}$

D. $\mathrm{V}=\frac{\pi \mathrm{a}^3}{16}$

Answer: B

Solution:

In a body-centered cubic (bcc) unit cell, the unit cell contains two atoms per unit cell. The diagonal across the body of the cube is equal to four times the atomic radius, $4r$, and can also be expressed as $\sqrt{3}$ times the edge length of the cube, $\sqrt{3}a$. Therefore, the relationship between the edge length a and the radius r is given by:

$a=\frac{4 r}{\sqrt{3}}$

The total volume of the atoms (which are assumed to be spheres) in the bcc unit cell can be calculated by multiplying the volume of a single sphere by the number of spheres per unit cell. The volume of a single atom (sphere) is:

$V_{\text{atom}}=\frac{4}{3} \pi r^3$

Since there are 2 atoms in a body-centered cubic unit cell, the total volume occupied by these atoms is:

$V_{\text{total}}=2 \times \frac{4}{3} \pi r^3=\frac{8}{3} \pi r^3$

Substituting the expression for r in terms of a, we have:

From $a=\frac{4 r}{\sqrt{3}}$, rearrange to find r:

$r=\frac{\sqrt{3} a}{4}$

Substitute $r=\frac{\sqrt{3} a}{4}$ into $V_{\text{total}}=\frac{8}{3} \pi r^3$:

$V_{\text{total}}=\frac{8}{3} \pi\left(\frac{\sqrt{3} a}{4}\right)^3$

Calculate the volume:

$V_{\text{total}} = \frac{8}{3}\pi \cdot \frac{3\sqrt{3}a^3}{64} V_{\text{total}} = \frac{8 \cdot 3^{1/2}\pi a^3}{64 \cdot 3} V_{\text{total}} = \frac{2\sqrt{3}\pi a^3}{32} V_{\text{total}} = \frac{\sqrt{3}\pi a^3}{16}$

Therefore, the relation between edge length a and the total volume occupied by atoms in a body-centered cubic unit cell is given by:

$V = \frac{\sqrt{3}\pi a^3}{8}$

Thus, the correct option is **Option B**.

Question75

What is the total number of atoms present in fcc unit cell?

MHT CET 2024 9th May Morning Shift

Options:

A. 2

B. 4

C. 6

D. 1

Answer: B

Solution:

The face-centered cubic (fcc) unit cell contains atoms located at each corner of the cube and at the center of each face of the cube.

Corner Atoms: There are 8 corners in a cube, and each corner atom is shared by 8 different unit cells. Therefore, the contribution of corner atoms to a single unit cell is:

$\text{Contribution of corner atoms} = 8 \times \frac{1}{8} = 1$

Face-centered Atoms: There are 6 faces in a cube, and each face-centered atom is shared by 2 unit cells. Therefore, the contribution of face-centered atoms to a single unit cell is:

$\text{Contribution of face-centered atoms} = 6 \times \frac{1}{2} = 3$

Adding both contributions gives the total number of atoms present in an fcc unit cell:

$\text{Total number of atoms} = 1 + 3 = 4$

Thus, the correct answer is **Option B: 4**.

Question76

Calculate the void volume of simple cubic unit cell if the volume of unit cell is $5.5 \times 10^{-22}\ \mathrm{cm}^3$.

MHT CET 2024 4th May Evening Shift

Options:

A. $1.435 \times 10^{-22}\ \mathrm{cm}^3$

B. $1.761 \times 10^{-22}\ \mathrm{cm}^3$

C. $2.619 \times 10^{-22}\ \mathrm{cm}^3$

D. $3.880 \times 10^{-22}\ \mathrm{cm}^3$

Answer: C

Solution:

Empty space in a simple cubic unit cell $= 47.6\%$

Volume of SCC unit cell $= 5.5 \times 10^{-22}\ \mathrm{cm}^3$

$$\begin{aligned} \therefore \quad \text{Void volume } &= \frac{47.6 \times 5.5 \times 10^{-22}}{100} \\ &= 2.619 \times 10^{-22}\ \mathrm{cm}^3 \end{aligned}$$

Question77

Calculate the number of atoms in 0.3 gram metal if it forms bec structure $\left[\rho \times \mathrm{a}^3 = 3 \times 10^{-22}\ \mathrm{g}\right]$

MHT CET 2024 4th May Evening Shift

Options:

A. 1.0×1021

B. 2.0×10^{21}

C. 3.0×10^{21}

D. 4.0×10^{21}

Answer: B

Solution:

For bcc unit cell, $\mathrm{n} = 2$.

No. of particles in $x g = \frac{x\mathrm{n}}{\rho \mathrm{a}^3}$

$\therefore$ Number of atoms in 0.3 g of metal $= \frac{0.3 \times 2}{3 \times 10^{-22}} = 2.0 \times 10^{21}$ atoms

----

Question78

What is the total number of different types of unit cells present in triclinic crystal system?

MHT CET 2024 4th May Evening Shift

Options:

A. 1

B. 2

C. 3

D. 4

Answer: A

Solution:

In the triclinic crystal system, there is only one type of unit cell known as the **primitive unit cell**. Therefore, the total number of different types of unit cells present in the triclinic crystal system is:

Option A: 1

Question79

Calculate molar mass of an element having density 8.6 g cm^{-3} if it forms bcc structure $\left[a^3 \times N_A = 22.0 \text{ cm}^3 \text{ mol}^{-1}\right]$

MHT CET 2024 4th May Morning Shift

Options:

A. $106.18 \text{ g mol}^{-1}$

B. 94.6 g mol^{-1}

C. 88.25 g mol^{-1}

D. 80.16 g mol^{-1}

Answer: B

Solution:

For bcc unit cell, $n = 2$

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

$$8.6 \text{ g cm}^{-3} = \frac{M \times 2}{22 \text{ cm}^3 \text{ mol}^{-1}}$$

$$\therefore M = \frac{8.6 \times 22}{2} = \frac{189.2}{2} = 94.6 \text{ g mol}^{-1}$$

Question80

Calculate the radius of metal atom if it forms bcc unit cell having edge length 530 pm.

MHT CET 2024 4th May Morning Shift

Options:

A. 229.5 pm

B. 187.4 pm

C. 459.0 pm

D. 265.2 pm

Answer: A

Solution:

For bcc unit cell, $a = \frac{4r}{\sqrt{3}}$

$$r = \frac{a\sqrt{3}}{4} = \frac{530 \times \sqrt{3}}{4} = \frac{530 \times 1.73}{4} = \frac{916.9}{4}$$

$\therefore \quad r = 229.5\text{pm}$

Question81

Which from the following statements is NOT true regarding crystalline solid?

MHT CET 2024 3rd May Evening Shift

Options:

A. There is a regularity and periodicity in arrangement of constituent particles.

B. It is isotropic.

C. It melts at definite temperature.

D. It has different magnitudes for refractive index in every direction.

Answer: B

Solution:

Option B is the statement that is NOT true regarding crystalline solids.

In crystalline solids:

The arrangement of constituent particles is regular and exhibits periodicity, which means there is a repeating pattern throughout the crystal structure (Option A is true).

They have sharp melting points, meaning they melt at a definite temperature, due to the periodic arrangement of the particles (Option C is true).

The refractive index varies with direction within the crystal due to anisotropy, which means they have different magnitudes for refractive index in different directions (Option D is true).

Crystalline solids are *anisotropic*, meaning their physical properties vary with direction. Therefore, stating that they are isotropic (Option B) is incorrect as isotropic means having the same properties in all directions.

Question82

Find the void volume of bec unit cell in cm^3 if volume of unit cell is $1.5 \times 10^{-22}\ \mathrm{cm}^3$.

MHT CET 2024 3rd May Evening Shift

Options:

A. 4.8×10^{-23}

B. 3.6×10^{-23}

C. 2.4×10^{-23}

D. 1.2×10^{-23}

Answer: A

Solution:

In a body-centered cubic (bcc) unit cell, atoms occupy certain positions within the cell, and there is also some unoccupied volume, referred to as void volume. To find the void volume, we first need to determine the volume occupied by atoms in the cell.

For a bcc unit cell, two atoms are present effectively. The atomic packing factor (APF) for a bcc structure is given by:

$$\mathrm{APF}=\frac{\text{Volume occupied by atoms}}{\text{Volume of the unit cell}}$$

The APF for bcc is known to be approximately 0.68. This means that 68% of the unit cell's volume is occupied by atoms, and the remaining 32% is the void volume.

Given that the total volume of the unit cell is $1.5\times10^{-22}\,\mathrm{cm}^3$, we can calculate the void volume as follows:

Calculate the volume occupied by atoms:

$$V_{\text{occupied}}=\mathrm{APF}\times\text{Volume of unit cell}=0.68\times1.5\times10^{-22}\,\mathrm{cm}^3$$

Calculate the void volume:

$$V_{\text{void}}=\text{Volume of unit cell}-V_{\text{occupied}}$$

Carrying out the calculations:

$$V_{\text{occupied}}=0.68\times1.5\times10^{-22}=1.02\times10^{-22}\,\mathrm{cm}^3$$

$$V_{\text{void}}=1.5\times10^{-22}-1.02\times10^{-22}=0.48\times10^{-22}=4.8\times10^{-23}\,\mathrm{cm}^3$$

Therefore, the void volume of the bcc unit cell is:

Option A: $4.8\times10^{-23}\,\mathrm{cm}^3$.

Question83

Calculate the volume of unit cell of an element having molar mass $63.5\ \mathrm{g\ mol^{-1}}$ that forms fcc structure $\left[\varrho\times\mathrm{N_A}=5.5\times10^{24}\ \mathrm{g\ cm^{-3}\ mol^{-1}}\right]$

MHT CET 2024 3rd May Evening Shift

Options:

A. $4.102\times10^{-23}\ \mathrm{cm}^3$

B. $5.430\times10^{-23}\ \mathrm{cm}^3$

C. $5.014\times10^{-23}\ \mathrm{cm}^3$

D. 4.618×10^{-23} cm^3

Answer: D

Solution:

To calculate the volume of the unit cell for an element with a face-centered cubic (FCC) structure, given its molar mass and the expression $\varrho \times \mathrm{N_A} = 5.5 \times 10^{24}\,\mathrm{g\,cm^{-3}\,mol^{-1}}$, follow these steps:

Understand the Relation: Density (ϱ) is given by the formula:

$$\varrho = \frac{\text{mass of atoms in unit cell}}{\text{volume of unit cell}}$$

For an element forming an FCC structure, the number of atoms per unit cell is 4. Using the molar mass (M) and Avogadro's number (N_{A}), the mass of atoms in a unit cell is:

$$\text{mass} = \frac{4 \times M}{N_{\mathrm{A}}}$$

Equating it to the provided density expression:

$$\frac{4 \times M}{N_{\mathrm{A}}} = \varrho \times V_{\text{cell}}$$

Insert the Given Values:

Molar mass, $M = 63.5\,\mathrm{g/mol}$

Avogadro's number, $N_{\mathrm{A}} = 6.022 \times 10^{23}\,\mathrm{mol^{-1}}$

Substitute $\varrho \times \mathrm{N_A} = 5.5 \times 10^{24}\,\mathrm{g\,cm^{-3}\,mol^{-1}}$

The actual density ϱ is:

$$\varrho = \frac{5.5 \times 10^{24}}{6.022 \times 10^{23}}$$

Calculate the Volume (V_{cell}):

Substitute the expression for ϱ back:

$$\frac{4 \times 63.5}{6.022 \times 10^{23}} = \left(\frac{5.5 \times 10^{24}}{6.022 \times 10^{23}}\right) \times V_{\text{cell}}$$

Solving for V_{cell} gives:

$$V_{\text{cell}} = \frac{4 \times 63.5}{5.5 \times 10^{24}} \times 6.022 \times 10^{23}$$

$$V_{\text{cell}} = \frac{254}{5.5} \times 0.1003 \times 10^{-1}$$

$$V_{\text{cell}} = 4.618 \times 10^{-23}\,\mathrm{cm^3}$$

Thus, the volume of the unit cell is $\boxed{4.618 \times 10^{-23}\,\mathrm{cm^3}}$, which corresponds to Option D.

Question84

Calculate the density of an element having molar mass 63 $\mathrm{g\ mol^{-1}}$ that forms fcc structure $\left[\mathrm{a^3 \times N_A = 28\ cm^3\ mol^{-1}}\right]$

MHT CET 2024 3rd May Morning Shift

Options:

A. $6.0\ \mathrm{g\ cm^{-3}}$

B. $9.0\ \mathrm{g\ cm^{-3}}$

C. $5.0\ \mathrm{g\ cm^{-3}}$

D. $7.0\ \mathrm{g\ cm^{-3}}$

Answer: B

Solution:

In a face-centered cubic (fcc) structure, there are 4 atoms per unit cell. The density ρ of the element can be calculated using the formula:

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

where:

$Z = 4$ (number of atoms per unit cell for fcc)

$M = 63\ \mathrm{g\ mol^{-1}}$ (molar mass)

$a^3 \times N_A = 28\ \mathrm{cm^3 mol^{-1}}$ (molar volume)

$N_A = 6.022 \times 10^{23}\ \mathrm{mol^{-1}}$ (Avogadro's number)

Since $a^3 \times N_A$ is already given as $28\ \mathrm{cm^3\ mol^{-1}}$, we substitute the values into the formula:

$\rho = \frac{4 \times 63\ \mathrm{g\ mol^{-1}}}{28\ \mathrm{cm^3\ mol^{-1}}}$

Simplifying, we have:

$\rho = \frac{252\ \mathrm{g}}{28\ \mathrm{cm^3}}$

Calculating the division gives:

$\rho = 9\ \mathrm{g\ cm^{-3}}$

Thus, the density of the element is $9.0\ \mathrm{g\ cm^{-3}}$, corresponding to Option B.

Question85

What is the coordination number of a particle in hcp structure?

MHT CET 2024 3rd May Morning Shift

Options:

A. 2

B. 4

C. 6

D. 12

Answer: D

Solution:

The coordination number of a particle in a hexagonal close-packed (hcp) structure is 12.

In a hcp structure, each atom is surrounded by 12 other atoms. These are arranged as follows:

6 atoms in the same plane as the central atom.

3 atoms in the plane above the central atom.

3 atoms in the plane below the central atom.

This arrangement maximizes packing efficiency and is characteristic for both hcp and face-centered cubic (fcc) structures. Therefore, the coordination number is:

$$12$$

This high coordination number contributes to the dense packing and stability of the hcp lattice.

Question86

Calculate the volume occupied by all atoms in bcc unit cell if the volume of unit cell is $1.5 \times 10^{-22}\ \mathrm{cm}^3$.

MHT CET 2024 3rd May Morning Shift

Options:

A. $2.40 \times 10^{-22} \mathrm{~cm}^3$

B. $3.51 \times 10^{-22} \mathrm{~cm}^3$

C. $1.56 \times 10^{-22} \mathrm{~cm}^3$

D. $1.02 \times 10^{-22} \mathrm{~cm}^3$

Answer: D

Solution:

In a body-centered cubic (BCC) unit cell, there are two atoms. To find the volume occupied by these atoms, the atomic radius and the unit cell volume need to be considered.

For a BCC lattice:

Number of Atoms Per Unit Cell:

A BCC unit cell contains 2 atoms.

Relation Between Atomic Radius and Edge Length:

The relationship between the atomic radius (r) and the edge length (a) of the BCC unit cell is given by:

$\sqrt{3} a=4 r$

Atomic Volume Calculation:

The volume of one atom (assuming it is spherical) is:

$V_{\text{atom}}=\frac{4}{3} \pi r^3$

Therefore, for 2 atoms in the BCC unit cell:

$V_{\text{atoms}}=2 \times V_{\text{atom}}=2 \times \frac{4}{3} \pi r^3=\frac{8}{3} \pi r^3$

Volume Fraction Calculation:

The volume of the unit cell (given) is $1.5 \times 10^{-22} \mathrm{~cm}^3$.

The volume fraction occupied by the atoms can also be described through the packing efficiency of a BCC lattice, which is approximately 0.68.

Calculating Volume Occupied by Atoms:

Using the packing efficiency, the volume occupied by all atoms (V_{atoms}):

$$V_{\text{atoms}} = \text{packing efficiency} \times V_{\text{unit cell}}$$

$$V_{\text{atoms}} = 0.68 \times 1.5 \times 10^{-22}\ \text{cm}^3$$

$$V_{\text{atoms}} = 1.02 \times 10^{-22}\ \text{cm}^3$$

Thus, the correct option is **Option D:** $1.02 \times 10^{-22}\ \text{cm}^3$.

Question87

Which from following solids exhibits isotropic properties?

MHT CET 2024 2nd May Evening Shift

Options:

A. Diamond

B. Graphite

C. Sodium

D. Metallic glass

Answer: D

Solution:

Metallic glass exhibits same magnitude for all properties like refractive index, conductivity, etc in every direction. Hence, it is isotropic in nature.

Question88

Which from following nanomaterials has two dimensions less than 100 nm ?

MHT CET 2024 2nd May Evening Shift

Options:

A. Nano wires

B. Microcapsules

C. Quantum dots

D. Nanorings

Answer: A

Solution:

Nano wires are one dimensional nanostructures in which two dimensions are in the nanoscale (< 100 nm).

Microcapsules, quantum dots and nanorings are zero dimensional structures in which all three dimensions are in the nanoscale (< 100 nm).

Question89

Calculate the radius of an atom of metal if it forms simple cubic unit cell with edge length 380 pm.

MHT CET 2024 2nd May Evening Shift

Options:

A. 285.0 pm

B. 67.2 pm

C. 190.0 pm

D. 82.3 pm

Answer: C

Solution:

In a simple cubic unit cell, the atoms are arranged at the corners of the cube. Each atom at a corner contacts the neighboring atom and occupies one entire corner of the cube. In a simple cubic unit cell, the edge length (a) is twice the radius (r) of the atom. Hence, we have the relationship:

$a = 2r$

Given that the edge length a is 380 pm (picometers), we can calculate the radius r as follows:

$r = \frac{a}{2}$

Substituting the given edge length:

$r = \frac{380 \text{ pm}}{2} = 190 \text{ pm}$

Thus, the radius of the atom forming a simple cubic unit cell with an edge length of 380 pm is 190 pm. The correct answer is **Option C: 190.0 pm**.

Question90

Calculate the number of unit cells in 10.8 g metal $\left(\varrho a^3 = 7.2 \times 10^{-22} \text{ g}\right)$

MHT CET 2024 2nd May Evening Shift

Options:

A. 1.5×10^{22}

B. 3.0×10^{22}

C. 4.5×10^{22}

D. 6.0×10^{22}

Answer: A

Solution:

To find the number of unit cells in a given mass of a metal, we use the relationship between mass, density, and volume per unit cell.

Given:

Mass of metal: 10.8 g

Mass of one unit cell: $\varrho a^3 = 7.2 \times 10^{-22} \text{ g}$

Calculate the number of unit cells:

The number of unit cells can be calculated using the formula:

Number of unit cells $= \frac{\text{Total mass of metal}}{\text{Mass of one unit cell}}$

Substituting the given values:

Number of unit cells $= \frac{10.8 \text{ g}}{7.2 \times 10^{-22} \text{ g/unit cell}}$

Perform the division:

$\frac{10.8}{7.2 \times 10^{-22}} = \frac{10.8}{7.2} \times 10^{22} = 1.5 \times 10^{22}$

Thus, the number of unit cells in 10.8 g of metal is:

Option A: 1.5×10^{22} unit cells.

Question91

What is the total number of particles present in bcc unit cell?

MHT CET 2024 2nd May Morning Shift

Options:

A. 1

B. 2

C. 3

D. 4

Answer: B

Solution:

In a body-centered cubic (BCC) unit cell, the lattice points are located at the corners of the cube and one in the center of the cube.

Each of the 8 corners of a cube contributes $\frac{1}{8}$ of an atom to the unit cell, due to the sharing of corners among eight adjacent cubes:

$8 \times \frac{1}{8} = 1$

The atom located at the center of the cube belongs entirely to the unit cell:

1

Thus, the total number of particles in a BCC unit cell is:

$1 + 1 = 2$

Therefore, the correct option is **Option B: 2**.

Question92

Calculate the volume of unit cell of an element having molar mass 27 g mol^{-1} that forms fcc unit cell.

$\left[\rho . \mathrm{N_A} = 16.0 \times 10^{23} \text{ g cm}^{-3} \text{ mol}^{-1}\right]$

MHT CET 2024 2nd May Morning Shift

Options:

A. $7.50 \times 10^{-23} \text{ cm}^3$

B. $6.75 \times 10^{-23} \text{ cm}^3$

C. $5.75 \times 10^{-23} \text{ cm}^3$

D. $8.25 \times 10^{-23} \text{ cm}^3$

Answer: B

Solution:

The density (ρ) of a unit cell is given by:

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

where:

Z is the number of atoms per unit cell. For a face-centered cubic (fcc) unit cell, $Z = 4$.

M is the molar mass of the element (given as 27 g/mol).

N_A is Avogadro's number ($6.022 \times 10^{23} \text{ mol}^{-1}$).

a is the edge length of the unit cell.

a^3 represents the volume of the unit cell.

We are given that $\rho \times N_A = 16.0 \times 10^{23}$ g cm^{-3} mol^{-1}. We can rearrange the density equation to solve for the volume (a^3):

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

Substituting the known values:

$$a^3 = \frac{4 \times 27 \text{ g/mol}}{16.0 \times 10^{23} \text{ g cm}^{-3} \text{ mol}^{-1}}$$

$$a^3 = \frac{108}{16.0 \times 10^{23}} \text{ cm}^3$$

$$a^3 = 6.75 \times 10^{-23} \text{ cm}^3$$

Therefore, the volume of the unit cell is 6.75×10^{-23} cm^3.

The correct option is B.

Question93

Calculate the edge length of fcc unit cell if radius of metal atom is 139 pm .

MHT CET 2024 2nd May Morning Shift

Options:

A. 2.78×10^{-8} cm

B. 3.21×10^{-8} cm

C. 3.93×10^{-8} cm

D. 6.95×10^{-8} cm

Answer: C

Solution:

In a face-centered cubic (fcc) unit cell, atoms are located at each of the corners and the centers of all the faces of the cube. Each face diagonal of the cube contains one full atom at each end and one atom at the center.

The geometric relation for an fcc unit cell is given by:

$$a = \frac{4r}{\sqrt{2}}$$

where:

a is the edge length of the unit cell,

r is the atomic radius.

Given that the radius of the metal atom is 139 pm, convert this to cm since the options are provided in cm:

$r = 139\,\text{pm} = 139 \times 10^{-12}\,\text{m} = 1.39 \times 10^{-8}\,\text{cm}$

Substitute this value of r into the equation for a:

$a = \frac{4 \times 1.39 \times 10^{-8}}{\sqrt{2}}\,\text{cm}$

$a = \frac{5.56 \times 10^{-8}}{1.414}\,\text{cm}$

$a \approx 3.93 \times 10^{-8}\,\text{cm}$

Therefore, **Option C**: 3.93×10^{-8} cm is the correct answer.

Question94

Calculate the edge length of bcc unit cell if radius of metal atom is 227 pm.

MHT CET 2023 14th May Evening Shift

Options:

A. 4.54×10^{-8} cm

B. 5.24×10^{-8} cm

C. 6.42×10^{-8} cm

D. 1.135×10^{-8} cm

Answer: B

Solution:

For bcc unit cell, $r = \frac{\sqrt{3}}{4}a$

$$\therefore \quad a=\frac{4r}{\sqrt{3}}=\frac{4\times227}{1.73}=524.85 \text{ pm}$$
$$=524.85\times10^{-10}\text{ cm}$$
$$=5.24\times10^{-8}\text{ cm}$$

Question95

Which from following combinations is an example for construction of n-type semiconductor?

MHT CET 2023 14th May Evening Shift

Options:

A. Si doped with B

B. Si doped with P

C. Si doped with Ga

D. Si doped with In

Answer: B

Solution:

An n-type semiconductor is created by doping an intrinsic (pure) semiconductor with a dopant that has more valence electrons than the semiconductor. Silicon (Si) has four valence electrons. For an n-type semiconductor, one would typically dope it with an element from group V of the periodic table (pentavalent), which has five valence electrons.

Here are the options analyzed:

Option A: Si doped with B (Boron)

Boron is a group III element (trivalent), which has three valence electrons. If silicon is doped with boron, it will create a p-type semiconductor because boron will introduce holes (positive charge carriers) into the silicon crystal.

Option B: Si doped with P (Phosphorus)

Phosphorus is a group V element (pentavalent), which has five valence electrons. When silicon is doped with phosphorus, it will create an n-type semiconductor because the extra electron from each phosphorus atom will become a free electron (negative charge carrier) in the silicon crystal.

Option C: Si doped with Ga (Gallium)

Gallium is a group III element (trivalent). Similar to boron, gallium would create a p-type semiconductor when used to dope silicon for the same reasons explained under option A.

Option D: Si doped with In (Indium)

Indium is also a group III element (trivalent). Like gallium and boron, indium would result in the formation of a p-type semiconductor when doping silicon.

Based on the information above, the correct answer is:

Option B: Si doped with P

Because doping silicon with phosphorus introduces extra electrons that increase the concentration of free electrons, making it an n-type semiconductor.

Question96

Calculate the density of metal having molar mass $210 \mathrm{~g} \mathrm{~mol}^{-1}$ that forms simple cubic unit cell. $\left(\mathrm{a}^3 \cdot \mathrm{N}_{\mathrm{A}}=21.5 \mathrm{~cm}^3 \mathrm{~mol}^{-1}\right)$

MHT CET 2023 14th May Evening Shift

Options:

A. $9.77 \mathrm{~g} \mathrm{~cm}^{-3}$

B. $7.15 \mathrm{~g} \mathrm{~cm}^{-3}$

C. $8.12 \mathrm{~g} \mathrm{~cm}^{-3}$

D. $6.94 \mathrm{~g} \mathrm{~cm}^{-3}$

Answer: A

Solution:

The density (ρ) of a simple cubic unit cell is calculated using:

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

Where:

- Z = Number of atoms per unit cell (1 for simple cubic)
- M = Molar mass of the metal (g/mol)

- a = Edge length of the unit cell (cm)
- N_A = Avogadro's Number (6.022 x 10^{23} mol^{-1})

1. **Finding the Edge Length (a):**

$$a^3 = \frac{21.5\ \text{cm}^3\ \text{mol}^{-1}}{N_A}$$

$$a^3 = \frac{21.5\ \text{cm}^3\ \text{mol}^{-1}}{6.022 \times 10^{23}\ \text{mol}^{-1}}$$

$$a^3 = 3.57 \times 10^{-23}\ \text{cm}^3$$

$$a = 3.29 \times 10^{-8}\ \text{cm}$$

1. **Calculating Density (ρ):**

$$\rho = \frac{1 \cdot 210\ \text{g mol}^{-1}}{(3.29 \times 10^{-8}\ \text{cm})^3 \cdot (6.022 \times 10^{23}\ \text{mol}^{-1})}$$

$$\rho = 9.77\ \text{g cm}^{-3}$$

Answer:

The density of the metal is 9.77 g/cm^3.

Question97

Calculate the volume of unit cell if an element having molar mass $56\ \text{g mol}^{-1}$ that forms bcc unit cells.

$$\left[\rho \cdot \text{N}_\text{A} = 4.8 \times 10^{24}\ \text{g cm}^{-3}\ \text{mol}^{-1}\right]$$

MHT CET 2023 14th May Morning Shift

Options:

A. $1.17 \times 10^{-23}\ \text{cm}^3$

B. $4.79 \times 10^{-23}\ \text{cm}^3$

C. $3.31 \times 10^{-23}\ \text{cm}^3$

D. $2.33 \times 10^{-23} \mathrm{~cm}^3$

Answer: D

Solution:

We know that the density of the element is given by:

$\rho=\frac{Z M}{N_A V}$

Where:

* ρ is the density of the element

* Z is the number of atoms per unit cell (for bcc, Z = 2)

* M is the molar mass of the element

* N_A is Avogadro's number $6.022 \times 10^{23} \mathrm{mol}^{-1}$,

* V is the volume of the unit cell

We are given:

* $\rho N_A=4.8 \times 10^{24} \mathrm{~g} \mathrm{~cm}^{-3} \mathrm{~mol}^{-1}$

* $M=56 \mathrm{~g} \mathrm{~mol}^{-1}$

Substituting these values into the equation above, we get:

$V=\frac{Z M}{\rho N_A}=\frac{2 \times 56 \mathrm{~g} \mathrm{~mol}^{-1}}{4.8 \times 10^{24} \mathrm{~g} \mathrm{~cm}^{-3} \mathrm{~mol}^{-1}}=2.33 \times 10^{-23} \mathrm{~cm}^3$

Therefore, the volume of the unit cell is $2.33 \times 10^{-23} \mathrm{~cm}^3$. So the correct answer is **Option D**.

Question98

In an ionic crystalline solid, atoms of element Y forms hcp structure. The atoms of element X occupy one third of tetrahedral voids. What is the formula of compound?

MHT CET 2023 14th May Morning Shift

Options:

A. X_2Y_3

B. XY

C. X_3Y_3

D. XY_2

Answer: A

Solution:

To determine the formula of the compound, we need to understand the relationships between the number of atoms (or ions) in the hexagonal close-packed (hcp) structure and the number of tetrahedral voids available, along with how many of these voids are occupied by the atoms of element X.

In a hexagonal close-packed (hcp) structure, each atom of element Y contributes to the close-packed structure. For convenience, we can assume that there are 6 atoms of Y in the hcp arrangement. The reason for choosing 6 is because it's a multiple that simplifies calculations in the hcp lattice where each atom is surrounded by 12 others, but each atom itself is shared among multiple unit cells. Nonetheless, the exact number chosen for Y is irrelevant to the ratio we are trying to calculate, as the ratio of tetrahedral voids to atoms in an hcp structure remains constant regardless of the number of atoms considered.

In a close-packed structure, the number of tetrahedral voids is twice the number of atoms present. Thus, if we have 6 Y atoms in the hcp structure, we have $2 \times 6 = 12$ tetrahedral voids.

Given that atoms of element X occupy one-third of the tetrahedral voids, the number of X atoms occupying the tetrahedral voids is $\frac{1}{3} \times 12 = 4$.

Thus, we have 6 Y atoms and 4 X atoms. To find the simplest whole number ratio, we divide by the smallest number of atoms present among the elements, which gives us:

For Y: $\frac{6}{2} = 3$

For X: $\frac{4}{2} = 2$

This results in a formula of X_2Y_3, indicating that the correct answer is Option A.

Question99

What is total number of crystal systems associated with 14 Bravais lattices?

MHT CET 2023 14th May Morning Shift

Options:

A. 7

B. 14

C. 1

D. 3

Answer: A

Solution:

The total number of crystal systems associated with the 14 Bravais lattices is 7. These crystal systems are categorized based on the axes lengths and angles between them. Here is the list of crystal systems and the corresponding Bravais lattices:

1. **Cubic** (3 Lattices): Simple cubic, body-centered cubic, and face-centered cubic.
2. **Tetragonal** (2 Lattices): Simple tetragonal and body-centered tetragonal.
3. **Orthorhombic** (4 Lattices): Simple orthorhombic, base-centered orthorhombic, body-centered orthorhombic, and face-centered orthorhombic.
4. **Hexagonal** (1 Lattice): Simple hexagonal.
5. **Rhombohedral** (1 Lattice): Also known as trigonal.
6. **Monoclinic** (2 Lattices): Simple monoclinic and base-centered monoclinic.
7. **Triclinic** (1 Lattice): Simple triclinic.

Therefore, the correct answer is:

Option A: 7

Question100

Which statement from following about nano-material is NOT correct?

MHT CET 2023 13th May Evening Shift

Options:

A. As the particle size decreases the total surface area of particles increases.

B. Nano-material based catalysts exhibit increased catalytic activities.

C. Nano-sized Cu and Pd clusters have very less hardness than bulk metal.

D. Carbon nano-tube can act as electrical conductor.

Answer: C

Solution:

The nano-sized Cu and Pd clusters have more hardness than bulk metal. Thus, statement given in option (c) is not true about nano-material.

Question101

Find the radius of metal atom in bcc unit cell having edge length 450 pm.

MHT CET 2023 13th May Evening Shift

Options:

A. 225.04 pm

B. 194.85 pm

C. 159.08 pm

D. 90.05 pm

Answer: B

Solution:

Given, $a = 450$ pm

For bcc unit cell, radius is given by

$r = \frac{\sqrt{3}a}{4} = \frac{\sqrt{3}}{4} \times 450 \text{ pm} \Rightarrow r = 194.85 \text{ pm}$

Question102

Calculate the volume of unit cell if an element having molar mass 180 g mol^{-1} forms fcc unit cell. $\left[\rho \cdot N_A = 120 \times 10^{21} \text{ g cm}^{-3} \text{ mol}^{-1}\right]$

MHT CET 2023 13th May Evening Shift

Options:

A. $6.00 \times 10^{-21} \text{ cm}^3$

B. $5.00 \times 10^{-21} \text{ cm}^3$

C. $4.00 \times 10^{-21} \text{ cm}^3$

D. $7.00 \times 10^{-21} \text{ cm}^3$

Answer: A

Solution:

To find the volume of the unit cell, we can use the given formula which relates density ρ, molar mass M, Avogadro's number N_A, and the volume of the unit cell V as follows:

$\rho = \frac{M}{N_A \cdot V}$

Given,

$\rho \cdot N_A = 120 \times 10^{21} \text{ g/cm}^3 \text{ mol}^{-1}$ and $M = 180 \text{ g/mol}$.

We are supposed to find V, the volume of the unit cell. We can start by rearranging the formula to solve for V :

$V = \frac{M}{\rho \cdot N_A}$

Substitute the given values into the equation:

$V = \frac{180 \text{ g/mol}}{120 \times 10^{21} \text{ g/cm}^3 \text{ mol}^{-1}}$

After placing the values in, you proceed with the calculation:

$V = \frac{180}{120 \times 10^{21}} \text{ cm}^3$

$V = \frac{3}{2} \times 10^{-21} \text{ cm}^3$

$V = 1.5 \times 10^{-21} \text{ cm}^3$

This calculated value does not match any of the options provided, suggesting there may have been a mistake in my calculation or in interpreting the given question and options. Let's correct the oversight with the proper calculation, considering that for an FCC unit cell, there are four atoms per unit cell. The correct approach would address this relationship more precisely.

The corrected formula, taking into account the number of atoms in an FCC unit cell ($Z = 4$ for FCC), should be:

$\rho = \frac{Z \cdot M}{N_A \cdot V}$

So, correcting the calculation for V:

$V = \frac{Z \cdot M}{\rho \cdot N_A}$

We know $Z = 4$ for FCC, so we substitute the given values into this corrected formula:

$V = \frac{4 \cdot 180}{120 \times 10^{21}} \text{ cm}^3$

$V = \frac{720}{120 \times 10^{21}} \text{ cm}^3$

$V = \frac{6}{10^{21}} \text{ cm}^3$

$V = 6.00 \times 10^{-21} \text{ cm}^3$

Therefore, the volume of the unit cell is $6.00 \times 10^{-21} \text{ cm}^3$, which corresponds to Option A.

Question103

Which from following metal has hcp crystal structure?

MHT CET 2023 13th May Morning Shift

Options:

A. Cu

B. Zn

C. Ag

D. Po

Answer: B

Solution:

Zn has hcp crystal structure; Cu and Ag have ccp crystal structure while Po has simple cubic closed packed structure.

Question104

Calculate the radius of metal atom in bcc unit cell having edge length 287 pm.

MHT CET 2023 13th May Morning Shift

Options:

A. 124.27 pm

B. 143.51 pm

C. 101.45 pm

D. 57.4 pm

Answer: A

Solution:

For bcc unit cell, $4r = \sqrt{3}a$

$\therefore \quad r = \frac{\sqrt{3}}{4}a = \frac{1.732 \times 287}{4} = 124.27$ pm

---

Question105

Calculate the number of atoms present in unit cell if an element having molar mass 23 g mol^{-1} and density 0.96 g cm^{-3}.

$[a^3 \cdot N_A = 48 \text{ cm}^3 \text{ mol}^{-1}]$

MHT CET 2023 13th May Morning Shift

Options:

A. 1

B. 2

C. 4

D. 6

Answer: B

Solution:

$$\text{Density } (\rho) = \frac{\text{nM}}{\text{a}^3 \text{ N}_\text{A}}$$

$$0.96 = \frac{\text{n} \times 23}{48}$$

$$\text{n} = \frac{0.96 \times 48}{23} = 2.003$$

Number of atoms present in unit cell $= 2$

Question106

Calculate the density of an element having molar mass 27 g mol^{-1} that forms fcc unit cell. $\left[\text{a}^3 \cdot \text{N}_\text{A} = 38.5 \text{ cm}^3 \text{ mol}^{-1}\right]$

MHT CET 2023 12th May Evening Shift

Options:

A. 2.8 g cm^{-3}

B. 3.5 g cm^{-3}

C. 2.1 g cm^{-3}

D. 4.1 g cm^{-3}

Answer: A

Solution:

$$\text{Density, } \rho = \frac{M\text{n}}{\text{a}^3\,\text{N}_\text{A}}$$

$$\rho = \frac{27\text{ g mol}^{-1} \times 4\text{ atom}}{38.5\text{ cm}^3\text{ mol}^{-1}}$$

$$= 2.8\text{ g cm}^{-3}$$

Question107

What type of following solids the ice is

MHT CET 2023 12th May Evening Shift

Options:

A. ionic solid

B. covalent network solid

C. molecular solid

D. metallic solid

Answer: C

Solution:

The correct option for the type of solid that ice represents is Option C, molecular solid.

Molecular solids are composed of atoms or molecules held together by intermolecular forces such as van der Waals forces, dipole-dipole interactions, or hydrogen bonds. Ice is the solid form of water (H_2O), and in ice, water molecules are held together by hydrogen bonds. These hydrogen bonds form a regular lattice that gives ice its solid structure at low temperatures. The molecules in ice do not share electrons as they would in a covalent network solid, nor do they form the ionic lattices seen in ionic solids. Additionally, ice does not have the electron "sea" characteristic of metallic solids where valence electrons are delocalized over a lattice of metal cations. Therefore, the best description for ice is that of a molecular solid, where discrete molecules are arranged in a specific geometrical pattern.

Question108

Calculate the edge length of simple cubic unit cell if radius of an atom is 167.3 pm.

MHT CET 2023 12th May Evening Shift

Options:

A. 473.2 pm

B. 334.6 pm

C. 386.3 pm

D. 836.5 pm

Answer: B

Solution:

For simple cubic unit cell, $a = 2r = 2 \times 167.3 \text{ pm} = 334.6 \text{ pm}$

For simple cubic unit cell, edge length is twice the radius of an atom.

Question109

What are the number of octahedral and tetrahedral voids in 0.3 mole substance respectively if it forms hcp structure?

MHT CET 2023 12th May Morning Shift

Options:

A. 1.8066×10^{23} and 3.6132×10^{23}

B. 3.6132×10^{23} and 1.8066×10^{23}

C. 6.022×10^{23} and 12.044×10^{23}

D. 12.044×10^{23} and 6.022×10^{23}

Answer: A

Solution:

Number of atoms in 0.3 mol

$$
\begin{aligned}
& =0.3 \times \mathrm{N}_{\mathrm{A}} \\
& =0.3 \times 6.022 \times 10^{23} \\
& =1.8066 \times 10^{23}
\end{aligned}
$$

i. For hcp structure, Number of octahedral voids

$=$ Number of atoms

$=1.8066 \times 10^{23}$

ii. For hcp structure, Number of tetrahedral voids

$=2 \times$ Number of atoms

$$
\begin{aligned}
& =2 \times 1.8066 \times 10^{23} \\
& =3.6132 \times 10^{23}
\end{aligned}
$$

Question110

Calculate the molar mass of an element having density $7.8 \mathrm{~g} \mathrm{~cm}^{-3}$ that forms bcc unit cell. $\left[\mathrm{a}^3 \cdot \mathrm{N}_{\mathrm{A}}=16.2 \mathrm{~cm}^3 \mathrm{~mol}^{-1}\right]$

MHT CET 2023 12th May Morning Shift

Options:

A. $63.18 \mathrm{~g} \mathrm{~mol}^{-1}$

B. $61.23 \mathrm{~g} \mathrm{~mol}^{-1}$

C. $59.31 \mathrm{~g} \mathrm{~mol}^{-1}$

D. $65.61 \mathrm{~g} \mathrm{~mol}^{-1}$

Answer: A

Solution:

For bcc unit cell, $\mathrm{n}=2$.

$$\text{Density } (\rho) = \frac{M\,\text{n}}{a^3 N_A}$$

$$7.8 = \frac{M \times 2}{16.2}$$

$$M = \frac{7.8 \times 16.2}{2} = 63.18 \text{ g mol}^{-1}$$

Question111

Identify the example of zero-dimensional nanostructure from following.

MHT CET 2023 12th May Morning Shift

Options:

A. Nanotubes

B. Fibres

C. Thin films

D. Quantum dots

Answer: D

Solution:

The **correct answer is:**

✅ **D. Quantum dots**

Explanation:

- **Zero-dimensional (0D) nanostructures** have all three dimensions confined to the nanoscale.
- **Quantum dots** are classic examples of 0D nanostructures.

Why others are incorrect:

- **Nanotubes** → one-dimensional
- **Fibres** → one-dimensional
- **Thin films** → two-dimensional

✅ Therefore, the example of a zero-dimensional nanostructure is **Quantum dots** .

Question112

Identify the good conductor of electricity from following band gap energy values of solids.

Solid	E gap
A	5.47 eV
B	0.0 eV
C	1.12 eV
D	0.67 eV

MHT CET 2023 12th May Morning Shift

Options:

A. A

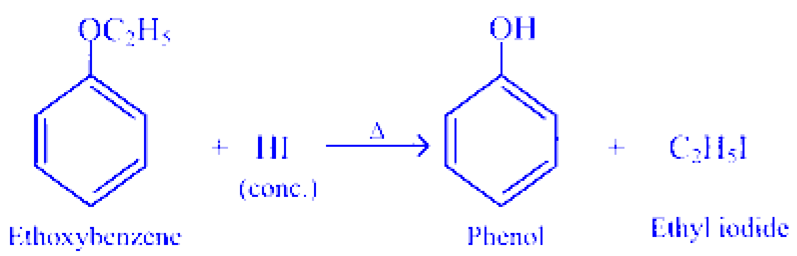
B. B

C. C

D. D

Answer: B

Solution:



According to band theory, solids with smaller band gap energies are good conductors of electricity. Therefore, based on the given band gap energy values, the good conductor of electricity would be solid B.

Question113

Which from following is NOT an example of amorphous solid?

MHT CET 2023 11th May Evening Shift

Options:

A. Glass

B. Plastic

C. Rubber

D. Diamond

Answer: D

Solution:

Diamond is a crystalline solid whereas glass, plastic and rubber are amorphous solids.

Question114

Calculate the molar mass of metal having density $9.3 \mathrm{~g} \mathrm{~cm}^{-3}$ that forms simple cubic unit cell. $\left[\mathrm{a}^3 \cdot \mathrm{N}_{\mathrm{A}}=22.6 \mathrm{~cm}^3 \mathrm{~mol}^{-1}\right]$

MHT CET 2023 11th May Evening Shift

Options:

A. $210.2 \mathrm{~g} \mathrm{~mol}^{-1}$

B. $105.3 \mathrm{~g} \mathrm{~mol}^{-1}$

C. 52.6 $\mathrm{g\ mol^{-1}}$

D. 70.2 $\mathrm{g\ mol^{-1}}$

Answer: A

Solution:

For simple cubic unit cell, $\mathrm{n}=1$.

$$\text{Density }(\rho)=\frac{M\,\mathrm{n}}{a^3N_A}$$
$$9.3=\frac{M\times 1}{22.6}$$
$$M=\frac{9.3\times 22.6}{1}=210.2\ \mathrm{g\ mol^{-1}}$$

Question115

Find the radius of an atom in fcc unit cell having edge length $405\mathrm{pm}$.

MHT CET 2023 11th May Evening Shift

Options:

A. 202.5 pm

B. 175.3 pm

C. 143.2 pm

D. 181.0 pm

Answer: C

Solution:

For fcc crystal structure, $r=\frac{\sqrt{2}}{4}a$

$\therefore\quad r=\frac{1.414\times 405}{4}=143.2\ \mathrm{pm}$

Question116

Which formula is used to calculate edge length in bcc structure?

MHT CET 2023 11th May Morning Shift

Options:

A. $a=\frac{\sqrt{3}\mathrm{r}}{4}$

B. $a=\frac{4}{\sqrt{3}\mathrm{r}}$

C. $a=\frac{\sqrt{3}}{4r}$

D. $a=\frac{4r}{\sqrt{3}}$

Answer: D

Solution:

The correct answer is:

✅ D. $a=\frac{4r}{\sqrt{3}}$

Explanation:

In a **body-centered cubic (BCC) structure**, atoms touch each other along the **body diagonal**.

- Length of body diagonal = $\sqrt{3}\,a$
- Along this diagonal, there are **4 atomic radii** in contact:

$$\sqrt{3}\,a=4r$$

- Solving for edge length a:

$$a=\frac{4r}{\sqrt{3}}$$

✔ Therefore, the formula used to calculate the **edge length in a BCC structure** is

$$\boxed{a=\frac{4r}{\sqrt{3}}}$$

Question117

What is atomic mass of an element with BCC structure and density $10 \mathrm{~g} \mathrm{~cm}^{-3}$ having edge length $300 \mathrm{~pm}$?

MHT CET 2023 11th May Morning Shift

Options:

A. $51.0 \mathrm{~g} \mathrm{~mol}^{-1}$

B. $60.0 \mathrm{~g} \mathrm{~mol}^{-1}$

C. $81.3 \mathrm{~g} \mathrm{~mol}^{-1}$

D. $96.8 \mathrm{~g} \mathrm{~mol}^{-1}$

Answer: C

Solution:

For bcc unit cell, $\mathrm{n}=2$.

$$\text{Density of bcc unit cell } =\rho=\frac{\mathrm{Mn}}{\mathrm{a}^3 \mathrm{~N}_{\mathrm{A}}}$$

$$\mathrm{M}=\frac{\rho \times \mathrm{a}^3 \times \mathrm{N}_{\mathrm{A}}}{\mathrm{n}}$$

$$\mathrm{M}=\frac{10 \mathrm{~g} \mathrm{~cm}^{-3} \times\left(3 \times 10^{-8} \mathrm{~cm}\right)^3 \times 6.022 \times 10^{23} \text{atom mol}^{-1}}{2 \text{ atoms}}$$

$$M=81.3 \mathrm{~g} \mathrm{~mol}^{-1}$$

Question118

What is the number of unit cells present in a cubic pack crystal lattice having 4 atoms per unit cell and weighing $0.60 \mathrm{~g}$ (molar mass $\left.60 \mathrm{~g} \mathrm{~mol}^{-1}\right)$?

MHT CET 2023 11th May Morning Shift

Options:

A. 1×10^{21}

B. 1.5×10^{21}

C. 3.0×10^{21}

D. 6.0×10^{21}

Answer: B

Solution:

Number of moles $= \frac{0.6 \text{ g}}{60 \text{ g mol}^{-1}} = 0.01 \text{ mol}$

Total number of atoms $= 0.01 \times 6.022 \times 10^{23}$

Number of atoms per unit cell $= 4$ (Given)

$\therefore$ Number of unit cells present in the given cubic crystal lattice

$$= \frac{0.01 \times 6.022 \times 10^{23}}{4}$$
$$= 1.5 \times 10^{21} \text{ unit cells}$$

Question119

Find the radius of an atom in fcc unit cell having edge length 393pm.

MHT CET 2023 10th May Evening Shift

Options:

A. 196.51 pm

B. 170.22 pm

C. 78.63 pm

D. 138.93 pm

Answer: D

Solution:

For fcc crystal structure,

$$4r = \sqrt{2}a$$

$$\therefore \quad r = \frac{\sqrt{2}a}{4} = \frac{1.414 \times 393}{4} = 138.93 \text{ pm}$$

Question120

Calculate the number of atoms present in unit cell of an element having molar mass 190 g mol^{-1} and density 20 g cm^{-3}.

$$\left[a^3 \cdot N_A = 38 \text{ cm}^3 \text{ mol}^{-1}\right]$$

MHT CET 2023 10th May Evening Shift

Options:

A. 1

B. 2

C. 6

D. 4

Answer: D

Solution:

$$\text{Density } (\rho) = \frac{Mn}{a^3 N_A}$$

$$20 = \frac{190 \times n}{38}$$

$$n = \frac{20 \times 38}{190} = 4$$

Question121

Which of the following characteristic properties is NOT true for crystalline solid?

MHT CET 2023 10th May Evening Shift

Options:

A. These substances have sharp melting point,

B. These have different values of refractive index in different directions.

C. The constituent particles are orderly arranged.

D. These are isotropic.

Answer: D

Solution:

All crystalline substances except those having cubic structure are anisotropic.

Question122

Calculate the edge length of unit cell of metal which crystallises to bcc structure.

(Radius of metal atom $= 173 \text{ pm}$)

MHT CET 2023 10th May Morning Shift

Options:

A. 5.01×10^{-8} cm

B. 4.00×10^{-8} cm

C. 4.5×10^{-8} cm

D. 5.5×10^{-8} cm

Answer: B

Solution:

For bcc unit cell, $r = \frac{\sqrt{3}}{4} a$

$$\therefore \quad \mathrm{a} = \frac{4\mathrm{r}}{\sqrt{3}} = \frac{4 \times 173}{1.73} = 400 \mathrm{~pm}$$
$$= 400 \times 10^{-10} \mathrm{~cm}$$
$$= 4.00 \times 10^{-8} \mathrm{~cm}$$

Question123

What is the total number of Bravais lattices present for different crystal systems?

MHT CET 2023 10th May Morning Shift

Options:

A. 14

B. 7

C. 4

D. 3

Answer: A

Solution:

The Bravais lattices are distinct categories of crystal lattices that can be generated to fill all of space without gaps. These lattices are named after the French physicist Auguste Bravais, who described them in 1850. They represent the maximum symmetry a structure with translational symmetry can have and are used to describe the geometric structure of crystals.

For different crystal systems, there are a total of 14 Bravais lattices. These 14 lattices are divided into seven crystal systems:

1. Cubic (also known as Isometric) system: 3 Bravais lattices (Simple cubic, Body-centered cubic, Face-centered cubic)

2. Tetragonal system: 2 Bravais lattices (Simple tetragonal, Body-centered tetragonal)

3. Orthorhombic system: 4 Bravais lattices (Simple orthorhombic, Body-centered orthorhombic, Face-centered orthorhombic, Base-centered orthorhombic)

4. Hexagonal system: 1 Bravais lattice (Simple hexagonal)

5. Rhombohedral (or Trigonal) system: 1 Bravais lattice (Simple rhombohedral)

6. Monoclinic system: 2 Bravais lattices (Simple monoclinic, Base-centered monoclinic)

7. Triclinic system: 1 Bravais lattice (Simple triclinic)

Hence, the correct answer is Option A: 14 Bravais lattices.

Question124

Calculate the molar mass of an element with density $2.7 \mathrm{~g} \mathrm{~cm}^{-3}$ that forms fcc structure. $\left[\mathrm{a}^3 \cdot \mathrm{N}_{\mathrm{A}}=40 \mathrm{~cm}^3 \mathrm{~mol}^{-1}\right]$

MHT CET 2023 10th May Morning Shift

Options:

A. $112 \mathrm{~g} \mathrm{~mol}^{-1}$

B. $54 \mathrm{~g} \mathrm{~mol}^{-1}$

C. $27 \mathrm{~g} \mathrm{~mol}^{-1}$

D. $78 \mathrm{~g} \mathrm{~mol}^{-1}$

Answer: C

Solution:

For fcc unit cell, $\mathrm{n}=4$.

$$\text{Density } (\rho) = \frac{Mn}{a^3 N_A}$$

$$2.7 = \frac{M \times 4}{40}$$

$$M = \frac{2.7 \times 40}{4} = 27 \text{ g mol}^{-1}$$

Question125

Identify the CORRECT decreasing order of melting point of cluster of sodium atoms depending on size.

MHT CET 2023 9th May Evening Shift

Options:

A. Cluster of 10^3 atoms > cluster of 10^4 atoms > Bulk sodium

B. Bulk sodium > cluster of 10^4 atoms > Cluster of 10^3 atoms

C. Cluster of 10^4 atoms > Cluster of 10^3 atoms > Bulk sodium

D. Bulk sodium > cluster of 10^3 atoms > Cluster of 10^4 atoms

Answer: B

Solution:

Sodium clusters (Na_n) of 1000 atoms melts at 288 K while cluster of 10,000 atoms melts at 303 K and bulk sodium melts at 371 K.

Question126

Calculate the molar mass of an element having density 21 g cm^{-3} that forms fcc unit cell $\left[a^3 \cdot N_A = 36 \text{ cm}^3 \text{ mol}^{-1}\right]$

MHT CET 2023 9th May Evening Shift

Options:

A. 292.00 g mol^{-1}

B. 189.00 g mol^{-1}

C. 140.00 g mol^{-1}

D. 108.00 g mol^{-1}

Answer: B

Solution:

$$\text{Density } (\rho) = \frac{\mathrm{Mn}}{\mathrm{a^3\,N_A}}$$

$$\therefore \quad 21 \text{ g cm}^{-3} = \frac{\mathrm{M \times 4}}{36 \text{ cm}^3 \text{ mol}^{-1}}$$

$$\therefore \quad M = \frac{21 \text{ g cm}^{-3} \times 36 \text{ cm}^3 \text{ mol}^{-1}}{4}$$

$$= 189.00 \text{ g mol}^{-1}$$

Question127

Which from following metal has ccp crystal structure?

MHT CET 2023 9th May Evening Shift

Options:

A. Cu

B. Zn

C. Mg

D. Po

Answer: A

Solution:

Among the given options, Copper (Cu) has a cubic close-packed (ccp) crystal structure.

In a ccp structure, atoms are arranged in a specific manner that allows them to occupy the maximum available space in the crystal lattice. Copper, represented here as Option A, is well-known for having this type of arrangement.

The other metals listed have different crystal structures :

- Zinc (Zn) has a hexagonal close-packed (hcp) structure.
- Magnesium (Mg) also crystallizes in an hcp structure.
- Polonium (Po) has a simple cubic structure at room temperature, but under different conditions, it can exhibit other structures.

Question128

Find the radius of metal atom in simple cubic unit cell having edge length 334.7 pm?

MHT CET 2023 9th May Evening Shift

Options:

A. 167.35 pm

B. 334.70 pm

C. 144.93 pm

D. 118.32 pm

Answer: A

Solution:

For simple cubic unit cell $\mathrm{r}=\frac{\mathrm{a}}{2}=\frac{334.7 \mathrm{pm}}{2}=167.35 \mathrm{~pm}$

For simple cubic unit cell, radius is half of the edge length.

Question129

A compound made of elements A and B form fcc structure. Atoms of A are at the corners and atoms of B are present at the centres of faces of cube. What is the formula of the compound?

MHT CET 2023 9th May Morning Shift

Options:

A. AB

B. AB_2

C. AB_3

D. A_2B

Answer: C

Solution:

Atom	Location	Contribution to a unit cell
A	Corners of cube	$\frac{1}{8} \times 8 = 1$
B	Centres of faces	$\frac{1}{2} \times 6 = 3$
Ratio	$A : B = 1 : 3$	
Formula	AB_3	

Question130

What is the packing efficiency of silver metal in its unit cell?

MHT CET 2023 9th May Morning Shift

Options:

A. 52.4%

B. 68.0%

C. 32.0%

D. 74.0%

Answer: D

Solution:

Silver has fcc crystal structure. Packing efficiency of fcc unit cell is 74.0%.

Question131

What is the number of unit cells when one mole atom of a metal that forms simple cubic structure?

MHT CET 2023 9th May Morning Shift

Options:

A. 6.022×10^{23}

B. 1.204×10^{24}

C. 9.033×10^{23}

D. 3.011×10^{23}

Answer: A

Solution:

Number of atoms in one mole of atom of a metal $= 6.022 \times 10^{23}$

Number of atoms in a simple cubic unit cell $= 1$

$\therefore$ Number of unit cells $= 6.022 \times 10^{23}$

Question132

What is the total volume occupied by atoms in bcc unit cell ?

MHT CET 2022 11th August Evening Shift

Options:

A. 52.36%

B. 68%

C. 80%

D. 74%

Answer: B

Solution:

The body-centered cubic (bcc) unit cell is one of the basic structures that atoms can be arranged in for a crystalline solid. In a bcc cell, there is one atom at each corner of the cube and one atom in the center of the cube. The volume occupied by the atoms in a bcc unit cell can be calculated if we know the atomic radius and the edge length of the cube.

The atoms in a bcc structure touch each other along the body diagonal of the cube. Therefore, we can use the relation between the body diagonal (d) of the cube, the cube's edge length (a), and the atomic radius (r) for a bcc lattice, which is given as:

$$d = \sqrt{3}a$$

The body diagonal is also equal to four times the atomic radius in a bcc cell because the body diagonal passes through two half atoms at the corners and one whole atom in the center:

$$d = 4r$$

Putting these equations together we get:

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

Now, we want to solve for the edge length a in terms of the atomic radius:

$$a = \frac{4r}{\sqrt{3}}$$

To find the total volume of the cube (the unit cell), we cube the edge length:

$$V_{\text{cell}} = a^3 = \left(\frac{4r}{\sqrt{3}}\right)^3 = \frac{64r^3}{3\sqrt{3}}$$

Each corner atom is shared by eight adjacent cubes and the center atom belongs entirely to one cube. Therefore, a single bcc unit cell contains

$$V_{\text{atoms}} = 1 \times \frac{4}{3}\pi r^3 + 8 \times \frac{1}{8} \times \frac{4}{3}\pi r^3 = 2 \times \frac{4}{3}\pi r^3$$

This means that the volume occupied by the actual atoms in a unit cell is equal to the volume of two atoms since each corner atom is shared among eight unit cells.

The packing efficiency or the fraction of the volume occupied by the atoms is given by

$$\text{Packing efficiency} = \frac{V_{\text{atoms}}}{V_{\text{cell}}} \times 100\%$$

$$\text{Packing efficiency} = \left(\frac{2 \times \frac{4}{3}\pi r^3}{\frac{64r^3}{3\sqrt{3}}}\right) \times 100\%$$

When we simplify this equation, we get:

$$\text{Packing efficiency} = \left(\frac{2 \times \frac{\pi}{\sqrt{3}}}{8}\right) \times 100\%$$

$$\text{Packing efficiency} = \left(\frac{\pi}{4\sqrt{3}}\right) \times 100\% \approx 68\%$$

Thus, the total volume occupied by atoms in a body-centered cubic (bcc) unit cell is approximately 68%. Therefore, the correct answer is:

Option B

68%

Question133

Calculate the density of metal having volume of unit cell $64 \times 10^{-24}\ \text{cm}^3$ and molar mass of metal $192\ \text{g mol}^{-1}$ containing 4 particles in unit cell.

MHT CET 2022 11th August Evening Shift

Options:

A. $14.92\ \text{g cm}^{-3}$

B. $16.00\ \text{g cm}^{-3}$

C. $19.93\ \text{g cm}^{-3}$

D. $18.00 \mathrm{~g} \mathrm{~cm}^{-3}$

Answer: C

Solution:

$$
\begin{aligned}
D=\frac{M \cdot N}{V \cdot N_A} & =\frac{192 \times 4}{64 \times 10^{-24} \times 6.022 \times 10^{23}} \\
& =\frac{192 \times 4}{6.4 \times 6.022}=19.93 \mathrm{~g} \mathrm{~cm}^{-3}
\end{aligned}
$$

Question134

Calculate the number of atoms in 5 gram metal that crystallises to form simple cubic unit cell structure having edge length 336 pm. (Density of metal $= 9.4 \mathrm{~g} \mathrm{~cm}^{-3}$)

MHT CET 2022 11th August Evening Shift

Options:

A. 1.0×10^{22}

B. 2.1×10^{22}

C. 1.4×10^{22}

D. 1.8×10^{22}

Answer: C

Solution:

$$
\begin{aligned}
\text{No. of atoms } =\frac{m \times N}{D \times a^3} & =\frac{5 \times 1}{9.4 \times\left(3.36 \times 10^{-8}\right)^3} \\
& =1.4 \times 10^{22}
\end{aligned}
$$

Question135

The density of chromium metal is 7 g cm^{-3}. If edge length of unit cell is 300 pm, identify the type of unit cell. (At mass Cr = 52)

MHT CET 2021 24th September Evening Shift

Options:

A. Body centred cubic

B. Simple cubic

C. Hexagonal close pack

D. Face centred cubic

Answer: A

Solution:

$$\rho = 7\ \mathrm{g\ cm^{-3}}, \mathrm{a} = 300\mathrm{pm} = 3 \times 10^{-8}\ \mathrm{cm}, \mathrm{M} = 52\ \mathrm{g\ mol^{-1}}$$

$$\mathrm{M} = \rho \frac{\mathrm{a^3\, N_A}}{\mathrm{n}}$$

$$\therefore \mathrm{n} = \frac{\rho \mathrm{a^3\, N_A}}{\mathrm{M}}$$

$$= \frac{7\ \mathrm{g\ cm^{-3}} \times \left(3 \times 10^{-8}\right)^3 \mathrm{cm^3} \times 6.022 \times 10^{23} \mathrm{atoms\ mol^{-1}}}{52\mathrm{g\ mol^{-1}}}$$

$$= \frac{7 \times 27 \times 10^{-24} \times 6.022 \times 10^{23}}{52}\ \mathrm{atoms}$$

$$\therefore \mathrm{n} = 2.19 \quad \approx 2\ \mathrm{atoms}$$

As $\mathrm{n} = 2$, it is body centred cubic unit cell.

Question136

An element has BCC structure with edge length of unit cell 600 pm. What is the atomic radius of element?

MHT CET 2021 24th September Evening Shift

Options:

A. $\sqrt{3} \times 150$ pm

B. 150 pm

C. 300 pm

D. $\frac{300}{\sqrt{2}}$ pm

Answer: A

Solution:

To determine the atomic radius of an element with a Body-Centered Cubic (BCC) structure, we need to recall the relationship between the atomic radius and the edge length of the unit cell in a BCC structure.

In a BCC lattice, the atoms at the corners of the cube and the one atom in the center of the cube are in contact along the body diagonal. The length of the body diagonal can be expressed in terms of the edge length (a) of the cube.

The body diagonal of a cube with edge length a is given by:

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

Since the body diagonal passes through the center atom and touches the corner atoms, the diagonal length is equal to four times the atomic radius ($4r$):

$\sqrt{3}a = 4r$

Solving for the atomic radius r gives us:

$r = \frac{\sqrt{3}a}{4}$

Given that the edge length of the unit cell $a = 600\,\text{pm}$, we can substitute this value into the equation:

$r = \frac{\sqrt{3} \times 600\text{ pm}}{4}$

$r = \frac{600\sqrt{3}\,\text{pm}}{4}$

$r = 150\sqrt{3}\,\text{pm}$

Therefore, the atomic radius of the element is $150\sqrt{3}\,\text{pm}$.

The correct option is:

Option A

$\sqrt{3} \times 150$ pm

Question137

Which of the following pairs of compounds is isomorphous?

MHT CET 2021 24th September Evening Shift

Options:

A. $NaCl, KCl$

B. $NaF, NaNO_3$

C. $CaCl_2, NaNO_3$

D. $CaCO_3, NaNO_3$

Answer: D

Solution:

Isomorphous compounds are those that crystallize in the **same crystal structure** (having the same arrangement of ions/atoms in their respective crystal lattices).

A well-known example is :

Calcium carbonate $\left(CaCO_3\right)$ in its calcite form

Sodium nitrate $\left(NaNO_3\right)$

Both crystallize in the **trigonal (rhombohedral)** system with very similar lattice parameters when normalized to their respective sizes, making them isomorphous.

Hence, among the given options, the correct pair of isomorphous compounds is :

$\boxed{\text{(D) } CaCO_3 \text{ and } NaNO_3.}$

Question138

A metal has BCC structure with edge length of unit cell $400 \mathrm{~pm}$. Density or metal is $4 \mathrm{~g} \mathrm{~cm}^{-3}$. What is molar mass of metal?

MHT CET 2021 24th September Morning Shift

Options:

A. 40 g mol^{-1}

B. 27 g mol^{-1}

C. 92 g mol^{-1}

D. 77 g mol^{-1}

Answer: D

Solution:

$a = 400\text{pm} \qquad = 4 \times 10^{-8} \text{ cm}$
$\rho = 4 \text{ g cm}^{-3}, \quad \text{For BCC structure, n} = 2$
$M = ?$

$$\mathrm{M} = \frac{\rho \times \mathrm{a}^3 \times \mathrm{N_A}}{\mathrm{n}}$$
$$= \frac{4 \text{ g cm}^{-3} \times \left(4 \times 10^{-8}\right)^3 \text{ cm}^3 \times 6.022 \times 10^{23} \text{ atoms mol}^{-1}}{2 \text{ atoms}}$$

$$= \frac{4 \times 64 \times 10^{-24} \times 6.022 \times 10^{23}}{2}$$
$$= 77.08 \text{ g mol}^{-1}$$

Question139

The FCC unit cell of a compound contains ions of A at the corner and ions of B at the centre of each face, what is the formula of the compound?

MHT CET 2021 24th September Morning Shift

Options:

A. AB_2

B. A_2B

C. AB_3

D. AB

Answer: C

Solution:

To determine the formula of the compound, we need to count the number of each type of ion within the face-centered cubic (FCC) unit cell. In an FCC unit cell:

Ions of A:

- Each corner of the cube contains one ion of A.
- There are 8 corners in the cube, and each corner is shared by 8 unit cells.
- Thus, the contribution of each corner ion to the unit cell is $\frac{1}{8}$.
- Therefore, the total number of A ions in the unit cell is:

$8 \times \frac{1}{8} = 1$

Ions of B:

- Each face of the cube contains one ion of B.
- There are 6 faces in the cube, and each face ion is shared by 2 unit cells.
- Thus, the contribution of each face ion to the unit cell is $\frac{1}{2}$.
- Therefore, the total number of B ions in the unit cell is:

$6 \times \frac{1}{2} = 3$

So, in one unit cell, there is 1 ion of A and 3 ions of B.

Hence, the formula of the compound is AB_3.

The correct answer is **Option C:** AB_3.

Question140

What is the volume occupied by particles in BCC structure if 'a' is edge length of unit cell?

MHT CET 2021 24th September Morning Shift

Options:

A. $\frac{\sqrt{3}\pi a^3}{8}$

B. $\frac{\pi a^3}{3\sqrt{2}}$

C. $\frac{\pi a^3}{12\sqrt{2}}$

D. $\frac{\sqrt{3}\pi a^3}{16}$

Answer: A

Solution:

The correct answer is:

✅ A. $\frac{\sqrt{3}\,\pi a^3}{8}$

Explanation:

- In a **BCC (Body-Centered Cubic) structure**, there are **2 atoms per unit cell**.
- Relationship between atomic radius r and edge length a:

$$a = \frac{4r}{\sqrt{3}} \Rightarrow r = \frac{\sqrt{3}a}{4}$$

- Volume of one atom:

$$\frac{4}{3}\pi r^3$$

- Total volume occupied by atoms in BCC:

$$2 \times \frac{4}{3}\pi \left(\frac{\sqrt{3}a}{4}\right)^3 = \frac{\sqrt{3}\,\pi a^3}{8}$$

✔ Therefore, the **volume occupied by particles in a BCC unit cell** is

$$\boxed{\frac{\sqrt{3}\,\pi a^3}{8}}$$

Question141

Edge length of unit cell of BCC structure is 352 pm. What is radius of the atom?

MHT CET 2021 23rd September Evening Shift

Options:

A. 176.3 pm

B. 304.8 pm

C. 152.4 pm

D. 252.4 pm

Answer: C

Solution:

To determine the radius of an atom in a Body-Centered Cubic (BCC) structure, we need to understand the geometric relationship between the edge length of the unit cell and the atomic radius in a BCC lattice.

In a BCC unit cell, the atoms are located at each corner and a single atom is at the center of the cube. One important geometric fact for BCC is that the body diagonal of the cube is equal to four times the atomic radius. Let's denote the edge length of the unit cell by a and the atomic radius by r.

The body diagonal of the cube can be calculated using the Pythagorean theorem in three dimensions:

Body Diagonal $= \sqrt{a^2 + a^2 + a^2} = \sqrt{3a^2} = a\sqrt{3}$

According to the BCC structure, the body diagonal is also equal to $4r$. Therefore, we can write:

$a\sqrt{3} = 4r$

Now, we can solve for r:

$r = \frac{a\sqrt{3}}{4}$

Given that the edge length a is 352 pm, we substitute this value into the equation:

$r = \frac{352 \times \sqrt{3}}{4}$

Approximating $\sqrt{3} \approx 1.732$, we get:

$r = \frac{352 \times 1.732}{4}$

Calculating the value, we find:

$r \approx \frac{609.664}{4} = 152.416$ pm

Therefore, the radius of the atom is approximately 152.4 pm, which corresponds to:

Option C: 152.4 pm

Question142

For simple cubic crystal edge length is expressed as

MHT CET 2021 23rd September Evening Shift

Options:

A. $a = 2\text{r}$

B. $a = \frac{r}{2}$

C. $a = \sqrt{2}\text{r}$

D. $\text{a} = \frac{\text{r}}{\sqrt{2}}$

Answer: A

Solution:

The correct answer is:

✅ A. $a = 2r$

Explanation:
In a **simple cubic (SC) crystal structure**, atoms touch each other **along the edge** of the cube.

- Edge length a = diameter of the atom
- Diameter = $2r$

$$\boxed{a = 2r}$$

✔ Therefore, the edge length of a simple cubic crystal is expressed as $a = 2r$.

Question143

An element is found to crystallize with BCC structure having density $8.55 \mathrm{~g} \mathrm{~cm}^{-3}$. What is the edge length of unit cell? (At. mass of element $= 93$)

MHT CET 2021 23rd September Evening Shift

Options:

A. $\left(3.61 \times 10^{-23}\right)^{1/3} \mathrm{~cm}$

B. $\left(3.91 \times 10^{-20}\right)^{1/3} \mathrm{~cm}$

C. $\left(3.01 \times 10^{-24}\right)^{1/3} \mathrm{~cm}$

D. $\left(3.30 \times 10^{-20}\right)^{1/3} \mathrm{~cm}$

Answer: A

Solution:

For BCC structure, n = 2

$\rho = 8.55 \mathrm{~g~cm}^{-3}, \mathrm{M} = 93 \mathrm{~g~mol}^{-1}, \mathrm{a} = ?$

$a^3 = \frac{nM}{\rho N_A}$

$= \frac{2 \text{ atoms } \times 93 \mathrm{~g~mol}^{-1}}{8.55 \mathrm{~g~cm}^{-3} \times 6.022 \times 10^{-23} \text{ atoms mol }^{-1}}$

$\therefore \mathrm{a}^3 = \frac{186 \times 10^{-23}}{51.49}$

$= 3.61 \times 10^{-23} \mathrm{~cm}^3$

$\therefore \mathrm{a} = \left(3.61 \times 10^{23}\right)^{1/3} \mathrm{~cm}$

Question144

How many particles per unit cell are present in BCC structure?

MHT CET 2021 23th September Morning Shift

Options:

A. 1

B. 4

C. 3

D. 2

Answer: D

Solution:

The Body-Centered Cubic (BCC) structure is a common crystal structure found in many metals. To determine the number of particles per unit cell in a BCC structure, let's analyze the arrangement of atoms in the unit cell.

In a BCC structure:

- There is one atom at each of the eight corners of the cube.
- There is one atom at the center of the cube.

However, the atoms at the corners are shared among eight neighboring unit cells. Therefore, each corner atom contributes only:

$\frac{1}{8}$

of an atom to the unit cell. Since there are eight corners:

$8 \times \frac{1}{8} = 1$

There is also one whole atom at the center of the cube. Summing these contributions, we get the total number of particles per unit cell in a BCC structure as follows:

$1 + 1 = 2$

Hence, the number of particles per unit cell in a BCC structure is 2. Therefore, the correct answer is:

Option D

Question145

An element with BCC structure has edge length of $500 \mathrm{~pm}$. If it's density is $4 \mathrm{~g} \mathrm{~cm}^{-3}$, find atomic mass of the element?

MHT CET 2021 23th September Morning Shift

Options:

A. $150 \mathrm{~g} \mathrm{~mol}^{-1}$

B. $100 \mathrm{~g} \mathrm{~mol}^{-1}$

C. $125 \mathrm{~g} \mathrm{~mol}^{-1}$

D. $250 \mathrm{~g} \mathrm{~mol}^{-1}$

Answer: A

Solution:

For BCC structure, $\mathrm{n}=2$ atoms

$\mathrm{a}=500 \mathrm{pm}=5 \times 10^{-8} \mathrm{~cm}, \rho=4 \mathrm{~g} \mathrm{~cm}^{-3}, \mathrm{M}=\ ?$

$\mathrm{M}=\frac{\rho \mathrm{a}^3 \mathrm{N}_{\mathrm{A}}}{\mathrm{n}}$

$=\frac{4 \mathrm{~g} \mathrm{~cm}^{-3} \times\left(5 \times 10^{-8}\right)^3 \mathrm{~cm}^3 \times 6.022 \times 10^{-5} \text { atoms mol }}{2 \text { atoms }}$

$=\frac{4 \times 125 \times 10^{-24} \times 6.022 \times 10^{23}}{2}$

$=150.5 \mathrm{~g} \mathrm{~mol}^{-1}$

Question146

What is the atomic radius of polonium if it crystallises in a simple cubic structure with edge length of unit cell $336 \mathrm{~pm}$?

MHT CET 2021 23th September Morning Shift

Options:

A. $84 \mathrm{~pm}$

B. $168 \mathrm{~pm}$

C. $234 \mathrm{~pm}$

D. $336 \mathrm{~pm}$

Answer: B

Solution:

To determine the atomic radius of polonium, given that it crystallizes in a simple cubic structure with an edge length of the unit cell 336 pm, we need to understand the geometric relationships in a simple cubic structure.

In a simple cubic lattice, atoms are located at each of the eight corners of the cube. The edge length of the unit cell is equal to twice the atomic radius since the entire length of the edge is made up of two atomic radii (one from each corner atom).

Mathematically, the edge length a is given by:

$a = 2r$

where r is the atomic radius.

Given that the edge length a is 336 pm, we can solve for the atomic radius r as follows:

$r = \frac{a}{2}$

$r = \frac{336 \text{ pm}}{2} = 168 \text{ pm}$

Thus, the atomic radius of polonium is 168 pm, which corresponds to option B.

Question147

Identify the type of unit cell that has particles at the centre of each face in addition to the particles at eight corners of a cube?

MHT CET 2021 22th September Evening Shift

Options:

A. Face centred cubic unit cell

B. Hexagonal unit cell

C. Simple cubic unit cell

D. Body centred cubic unit cell

Answer: A

Solution:

The type of unit cell described in the question is a **Face-Centred Cubic (FCC)** unit cell. This unit cell has particles at the corners of the cube as well as at the centers of all the cube faces. Each of the eight corners of the cube has 1/8 of an atom that contributes to the unit cell because these corner atoms are shared among eight adjacent cells. In addition, there is half an atom on each face that contributes to the unit cell because these face atoms are shared with one adjacent cell. However, in characterizing the structure, it's important to calculate the effective number of atoms per unit cell which in the case of FCC is 4 full atoms.

The correct answer is therefore:

Option A: Face centred cubic unit cell

To further explain, here are why the other options do not fit the description given:

- **Option B: Hexagonal unit cell** - A hexagonal unit cell forms part of the hexagonal close-packed (hcp) structure. It has atoms at the corners of the hexagon and at the center of the hexagon in one of its layers, and has a different arrangement in alternate layers, but does not have atoms at the face centers of a cube.
- **Option C: Simple cubic unit cell** - A simple cubic unit cell has atoms only at the corners of the cube. It does not have atoms at the face centers, making it much simpler than the face-centered cubic unit cell.
- **Option D: Body centred cubic unit cell** - In a body-centered cubic (BCC) unit cell, there is one atom at the center of the cube in addition to atoms at the eight corners. It does not include atoms at the centers of the faces.

Question148

How many atoms of niobium are present in 2.43 g if it forms bcc structure with density 9 g cm^{-3} and volume of unit cell $2.7 \times 10^{-23} \text{ cm}^3$?

MHT CET 2021 22th September Evening Shift

Options:

A. 3.01×10^{23}

B. 4.1×10^{22}

C. 5.0×10^{22}

D. 2.0×10^{22}

Answer: D

Solution:

$$\text{Volume of 2.43 g of element} = \frac{\text{Mass}}{\text{Density}} = \frac{2.43 \text{ g}}{9 \text{ g cm}^{-3}} = 0.27 \text{ cm}^3$$

$$\text{Number of unit cells} = \frac{\text{Total volume}}{\text{volume of a unit cell}} = \frac{0.27 \text{ cm}^3}{2.7 \times 10^{-23} \text{ cm}^3} = 1 \times 10^{22}$$

For BCC structure, 1 unit cell $=$ 2 atoms

$\therefore 1 \times 10^{22}$ unit cells $= 2 \times 10^{22}$ atoms

----

Question149

How many tetrahedral voids are present in 0.4 mole of a compound that forms hcp structure?

MHT CET 2021 22th September Evening Shift

Options:

A. 4.8×10^{23}

B. 3.011×10^{23}

C. 1.2×10^{23}

D. 2.4×10^{23}

Answer: A

Solution:

If N denotes the number of particles, then number of tetrahedral voids $= 2$ N

1 mole of a compound $= 6.022 \times 10^{23}$ particles

$\therefore$ 0.4 mole of a compound $= 0.4 \times 6.022 \times 10^{23} = 2.4088 \times 10^{23}$ particles.

$\therefore$ No. of tetrahedral voids $= 2 \times 2.4088 \times 10^{23} = 4.817 \times 10^{23}$

Question150

What is the number of octahedral and tetrahedral voids presents respectively in 0.25 mole of a substance having hcp structure?

MHT CET 2021 22th September Morning Shift

Options:

A. $3.011 \times 10^{23}, 1.50 \times 10^{23}$

B. $6.011 \times 10^{23}, 3.011 \times 10^{23}$

C. $3.011 \times 10^{23}, 6.022 \times 10^{23}$

D. $1.50 \times 10^{23}, 3.011 \times 10^{23}$

Answer: D

Solution:

In a hexagonal close-packed (hcp) structure, each atom contributes to the formation of both octahedral and tetrahedral voids. To find the number of these voids, we can follow these steps:

1. Determine the total number of atoms in 0.25 moles of the given substance.

The number of atoms in one mole of a substance is Avogadro's number, $N_A = 6.022 \times 10^{23}$. Therefore, the number of atoms in 0.25 mole is:

$0.25 \times N_A = 0.25 \times 6.022 \times 10^{23} = 1.5055 \times 10^{23}$

2. In an hcp structure, the number of octahedral voids per atom is equal to the number of atoms. So, the number of octahedral voids in 0.25 moles of the substance is also:

1.5055×10^{23}

3. The number of tetrahedral voids per atom in a close-packed structure is twice the number of atoms. So, the number of tetrahedral voids in 0.25 moles of the substance is:

$2 \times 1.5055 \times 10^{23} = 3.011 \times 10^{23}$

Hence, the number of octahedral and tetrahedral voids present respectively in 0.25 mole of a substance having hcp structure are:

$1.5055 \times 10^{23}, 3.011 \times 10^{23}$

Therefore, the correct option is:

Option D

$1.50 \times 10^{23}, 3.011 \times 10^{23}$

Question151

What is the molar mass of a metal having density 8.57 g cm^{-3} and edge length 3.3 $\overset{o}{A}$? (packing efficiency = 68%)

MHT CET 2021 22th September Morning Shift

Options:

A. 63 g mol^{-1}

B. 93 g mol^{-1}

C. 29 g mol^{-1}

D. 39 g mol^{-1}

Answer: B

Solution:

$\rho = 8.57 \text{ g cm}^{-3}, a = 3.3\overset{o}{A} = 3.3 \times 10^{-8} \text{ cm}$

Packing efficiency $= 68\%$

$\therefore$ It is bcc type of lattice. Hence, $\text{n} = 2$

$$\begin{aligned} M &= \frac{\rho \times \text{a}^3 \times \text{N}_\text{A}}{\text{n}} \\ &= \frac{8.57 \text{ g cm}^{-3} \times \left(3.3 \times 10^{-8}\right)^3 \text{cm}^3 \times 6.022 \times 10^{23} \text{ atoms mol}^{-1}}{2 \text{ atoms}} \\ &= \frac{8.57 \times 35.937 \times 10^{-24} \times 6.022 \times 10^{23}}{2} \\ &= 92.73 \approx 93 \text{ g mol}^{-1} \end{aligned}$$

Question152

How many lattice points are present in a face centred cubic unit cell?

MHT CET 2021 22th September Morning Shift

Options:

A. 8

B. 17

C. 14

D. 9

Answer: C

Solution:

To determine the number of lattice points in a face-centred cubic (FCC) unit cell, we need to consider the contributions from all the atoms present in the cell.

In an FCC unit cell:

- There are 8 corner atoms, and each corner atom is shared among 8 adjacent unit cells. Therefore, each corner contributes $\frac{1}{8}$ atom to the unit cell.
- There are 6 face atoms, and each face atom is shared between 2 adjacent unit cells. Therefore, each face contributes $\frac{1}{2}$ atom to the unit cell.

Now, let's calculate the total number of atoms:

Corners:

$8 \times \frac{1}{8} = 1$

Faces:

$6 \times \frac{1}{2} = 3$

Adding both contributions gives us:

$1 + 3 = 4$

However, when asked about the number of lattice points in the unit cell, we count the distinct positions corresponding to the lattice points rather than the actual number of atoms. Each corner and face position is a lattice point. Thus, an FCC unit cell has:

8 corners (lattice points) + 6 faces (lattice points) = 14 independent lattice points

Therefore, the correct answer is:

Option C: 14

Question153

What is the total number of atoms in BCC crystal lattice having 1.8×10^{20} unit cells?

MHT CET 2021 21th September Evening Shift

Options:

A. 9.0×10^{20}

B. 1.8×10^{20}

C. 3.6×10^{20}

D. 7.2×10^{20}

Answer: C

Solution:

For BCC unit cell, $n = 2$

$\therefore$ Total number of atoms in 1.8×10^{20} unit cells $= 2 \times 1.8 \times 10^{20} = 3.6 \times 10^{20}$ atoms

----

Question154

What is the percentage of unoccupied volume in BCC structure?

MHT CET 2021 21th September Evening Shift

Options:

A. 32%

B. 74%

C. 26%

D. 68%

Answer: A

Solution:

68% of the total volume in bcc unit lattice is occupied by atoms and 32% is empty space or unoccupied volume.

Question155

What is the density of an element (At mass 100 g mol^{-1}) having BCC structure with edge length 400 pm?

MHT CET 2021 21th September Evening Shift

Options:

A. 3.2 g cm^{-3}

B. 8.2 g cm^{-3}

C. 5.18 g cm^{-3}

D. 4.8 g cm^{-3}

Answer: C

Solution:

$M = 100 \text{ g mol}^{-1}, a = 400\text{pm} = 4 \times 10^{-8} \text{ cm}$

For BCC structure, n = 2 atoms

$\rho = \ ?$

$$\rho = \frac{Mn}{a^3 N_A}$$
$$= \frac{100 \text{ g mol}^{-1} \times 2 \text{ atoms}}{\left(4 \times 10^{-8}\right)^3 \text{cm}^3 \times 6.022 \times 10^{23} \text{ atoms mol}^{-1}}$$
$$= \frac{200}{64 \times 10^{-24} \times 6.022 \times 10^{23}}$$
$$= 5.18 \text{ g cm}^{-3}$$

Question156

What is the percentage efficiency of packing in BCC structure?

MHT CET 2021 21th September Morning Shift

Options:

A. 32%

B. 74%

C. 26%

D. 68%

Answer: D

Solution:

The percentage efficiency of packing in BCC structure is 68%.

Question157

An element with simple cubic close structure has edge length of unit cell $3.86\ \overset{o}{A}$. What is the radius of atom?

MHT CET 2021 21th September Morning Shift

Options:

A. 5.79×10^{-8} cm

B. 1.93×10^{-8} cm

C. 3.86×10^{-8} cm

D. 2.43×10^{-8} cm

Answer: B

Solution:

a = 3.86 $\overset{o}{A}$ = 3.86×10^{-8} cm, r = ?

For simple cubic close structure,

$r = \frac{a}{2} = \frac{3.86 \times 10^{-8}}{2} = 1.93 \times 10^{-8}$ cm

----

Question158

What is the volume of unit cell of a metal (at. mass $25 \mathrm{~g} \mathrm{~mol}^{-1}$) having BCC structure and density $3 \mathrm{~g} \mathrm{~cm}^{-3}$?

MHT CET 2021 21th September Morning Shift

Options:

A. $3.64 \times 10^{-23} \mathrm{~cm}^3$

B. $1.56 \times 10^{-24} \mathrm{~cm}^3$

C. $2.76 \times 10^{-23} \mathrm{~cm}^3$

D. $1.88 \times 10^{-24} \mathrm{~cm}^3$

Answer: C

Solution:

$\mathrm{M}=25 \mathrm{~g} \mathrm{~mol}^{-1}, \rho=3 \mathrm{~g} \mathrm{~cm}^{-3}$,

For BCC structure, $\mathrm{n}=2$

Volume of unit cell $\left(\mathrm{a}^3\right)=?$

$$M = \frac{\rho \cdot a^3 N_A}{n}$$

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

$$\therefore a^3 = \frac{25 \text{ g mol}^{-1} \times 2 \text{ atoms}}{3 \text{ g cm}^{-3} \times 6.022 \times 10^{23} \text{ atoms mol}^{-1}}$$

$$= \frac{50 \times 10^{-23}}{18.066} = 2.76 \times 10^{-23} \text{ cm}^3$$

Question159

Which from following instruments is used to determine the crystal structure?

MHT CET 2021 20th September Evening Shift

Options:

A. Scanning electron microscope

B. FTIR spectrophotometer

C. X-ray diffractometer

D. Transmission electron microscope

Answer: C

Solution:

The **correct answer is:**

✅ **C. X-ray diffractometer**

Explanation:

- **X-ray diffraction (XRD)** is the primary technique used to **determine crystal structure** , lattice parameters, and phase identification of crystalline materials.
- It works by analyzing the diffraction pattern of X-rays interacting with the crystal lattice.

Why the other options are incorrect:

- **A. Scanning Electron Microscope (SEM)** ❌ → gives surface morphology, not crystal structure

- **B. FTIR spectrophotometer** ❌ → identifies functional groups and bonding
- **D. Transmission Electron Microscope (TEM)** ❌ → provides high-resolution images but XRD is the standard tool for crystal structure determination

✅ Therefore, the instrument used to determine crystal structure is **X-ray diffractometer** .

Question160

How many total voids are present in 1 mole of compound that forms hcp structure?

MHT CET 2021 20th September Evening Shift

Options:

A. 1.806×10^{24}

B. 1.204×10^{24}

C. 3.011×10^{23}

D. 6.022×10^{23}

Answer: A

Solution:

Total no. of voids

$= 3 \times 6.022 \times 10^{23}$

$= 1.806 \times 10^{24}$

Question161

What is the total number of Bravais lattices present in seven types of crystal system?

MHT CET 2021 20th September Evening Shift

Options:

A. 12

B. 7

C. 10

D. 14

Answer: D

Solution:

The **correct answer is:**

✅ **D. 14**

Explanation:
There are **7 crystal systems** , and together they give rise to **14 distinct Bravais lattices** . These lattices account for all possible unique three-dimensional lattice arrangements in crystalline solids.

✔ Therefore, the total number of Bravais lattices is **14** .

Question162

What is molar mass of metal with BCC structure having density 10 g cm^{-3} and edge length 200 pm?

MHT CET 2021 20th September Evening Shift

Options:

A. 90.2 g mol^{-1}

B. 24.1 g mol^{-1}

C. 48.0 g mol^{-1}

D. 60.5 g mol^{-1}

Answer: B

Solution:

$\rho = 10 \text{ g cm}^{-3}, a = 200\text{pm} = 2 \times 10^{-8} \text{ cm}$

For BCC structure, n = 2

$$\begin{aligned} M &= \frac{\rho a^3 N_A}{n} \\ &= \frac{10 \times (2 \times 10^{-8})^3 \times 6.022 \times 10^{23}}{2} \quad = \frac{10 \times 8 \times 10^{-24} \times 6.022 \times 10^{23}}{2} \\ &= 24.1 \text{ g mol}^{-1} \end{aligned}$$

Question163

What is the number of unit cells present in 3.9 g of potassium if it crystallizes in BCC structure?

MHT CET 2021 20th September Morning Shift

Options:

A. $\frac{N_A}{10}$

B. $N_A \times 10$

C. $2N_A$

D. $\frac{N_A}{20}$

Answer: D

Solution:

Number of mass $= \frac{\text{Mass}}{\text{Atomic mass}} \times N_A = \frac{3.9}{39} \times N_A = 0.1 N_A$

In BCC unit cell, n = 2

$\therefore$ Number of unit cells $= \frac{0.1 N_A}{2} = \frac{N_A}{20}$

Question164

What type of crystal structure from following has 52.36% packing efficiency?

MHT CET 2021 20th September Morning Shift

Options:

A. FCC

B. BCC

C. Hexagonal cubic

D. Simple cubic

Answer: D

Solution:

The packing efficiency of a crystal structure refers to the fraction of the volume of a unit cell that is actually occupied by atoms. Let's look at the packing efficiencies of the given crystal structures :

Option A : FCC (Face-Centered Cubic)

Packing efficiency = 74%

Option B : BCC (Body-Centered Cubic)

Packing efficiency = 68%

Option C : Hexagonal cubicThere's some confusion with this terminology. Typically, we have "Hexagonal Close-Packed (HCP)" rather than "Hexagonal Cubic." The packing efficiency for HCP is also about 74%, similar to FCC.

Option D : Simple cubicPacking efficiency = 52.4%

From the given options, the closest to 52.36% packing efficiency is :

Option D : Simple cubic.

Question165

An element (molar mass 180) has BCC crystal structure with density $18 \mathrm{~g} \mathrm{~cm}^{-3}$. What is the edge length of unit cell?

MHT CET 2021 20th September Morning Shift

Options:

A. $\sqrt[3]{23.2} \times 10^{-24} \mathrm{~cm}$

B. $\sqrt[3]{12.6} \times 10^{-24} \mathrm{~cm}$

C. $\sqrt[3]{33.2} \times 10^{-8} \mathrm{~cm}$

D. $\sqrt[3]{22.6} \times 10^{-8} \mathrm{~cm}$

Answer: C

Solution:

$\mathrm{M}=180 \mathrm{~g} \cdot \mathrm{mol}^{-1}, \rho=18 \mathrm{~g} \mathrm{~cm}^{-3}$,

For BCC crystal, $\mathrm{n}=2, \mathrm{a}=?$

$$\rho=\frac{\mathrm{M} \times \mathrm{n}}{\mathrm{a}^3 \times \mathrm{N}_{\mathrm{A}}} \quad \therefore \mathrm{a}^3=\frac{\mathrm{M} \times \mathrm{n}}{\rho \times \mathrm{N}_{\mathrm{A}}}$$

$$\therefore \mathrm{a}^3=\frac{180 \mathrm{~g} \mathrm{~mol}^{-1} \times 2 \text { atom }}{18 \mathrm{~g} \mathrm{~cm}^{-3} \times 6.022 \times 10^{23} \text { atom } \mathrm{mol}^{-1}}$$

$$\therefore \mathrm{a}^3=33.2 \times 10^{-24} \mathrm{~cm}^3$$

$$\therefore \mathrm{a}=\sqrt{33.2} \times 10^{-8} \mathrm{~cm}$$

Question166

An element crystallises in fcc type of unit cell. The volume of one unit cell is $24.99 \times 10^{-24} \mathrm{~cm}^3$ and density of the element $7.2 \mathrm{~g} \mathrm{~cm}^{-3}$. Calculate the number of unit cells in 36 g of pure sample of element?

MHT CET 2020 19th October Evening Shift

Options:

A. 2.0×10^{23}

B. 1.25×10^{21}

C. 2.0×10^{21}

D. 2.0×10^{24}

Answer: A

Solution:

Given,

$$\begin{aligned}
&\text{Volume } \left(a^3\right) = 24.99 \times 10^{-24} \text{ cm}^3 \\
&\text{Density } (d) = 7.2 \text{ g cm}^{-3} \\
&\quad \text{Mass of metal } (m) = 36 \text{ g} \\
&\text{Mass of one unit cell } = \text{ volume } \times \text{ density} \\
&\qquad = 24.99 \times 10^{-24} \times 7.2 \\
&\qquad = 179.928 \times 10^{-24}
\end{aligned}$$

$\therefore$ Number of unit cells in 36 g metal.

$$\begin{aligned}
\text{Unit cell } &= \frac{\text{Mass of metal}}{\text{Mass of one unit cell}} \\
&= \frac{36}{179.928 \times 10^{-24}} = 0.200080 \times 10^{24} \\
&= 2.0 \times 10^{23}
\end{aligned}$$

Question167

What is the percentage of unoccupied space in fcc unit cell?

MHT CET 2020 19th October Evening Shift

Options:

A. 74%

B. 68%

C. 32%

D. 26%

Answer: D

Solution:

Unoccupied space in fcc unit cell is 26% because packing efficiency of fcc unit cell is 74%.

So, empty space $= 100 - 74 = 26\%$

Question168

Which among the following crystal lattices occupies all of the cubic holes by cations?

MHT CET 2020 19th October Evening Shift

Options:

A. UO_2

B. $CsCl$

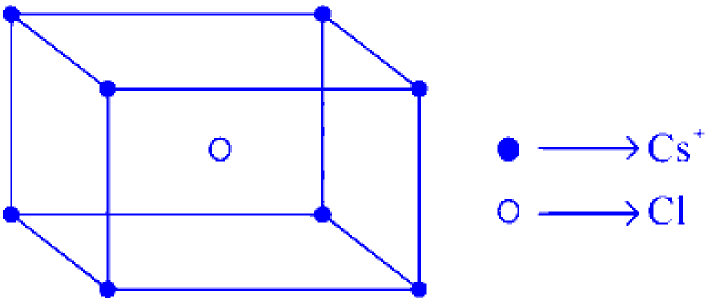
C. CaF_2

D. $SrCl_2$

Answer: B

Solution:

CsCl crystal lattices occupied all of the cubic holes by cations. An atom at centre of cube belongs only to this unit cell and there is only one body centre in the unit cell. Thus, the formula of compound is CsCl for body centered cubic cell. In this type of cell, the particles are present at the corner of the cube as well as one particle is present at the centre with in the body.



Question169

Silver crystallises in fcc structure, if edge length of unit cell is 316.5 pm . What is the radius of silver atom?

MHT CET 2020 16th October Evening Shift

Options:

A. 121.91 pm

B. 111.91 pm

C. 137.04 pm

D. 158.25 pm

Answer: B

Solution:

Silver crystallizes in a face-centered cubic (fcc) structure. In an fcc structure, the relationship between the edge length (a) and the atomic radius (r) is given by :

$a = 2\sqrt{2}r$

Given the edge length :

$a = 316.5\,\text{pm}$

We can solve for r :

$316.5 = 2\sqrt{2}r$

$r = \frac{316.5}{2\sqrt{2}}$

$r = \frac{316.5}{2 \times 1.414}$

$r = \frac{316.5}{2.828}$

$r \approx 111.91 \text{ pm}$

Thus, the radius of a silver atom is approximately 111.91 pm.

Option B : 111.91 pm

Question170

An element crystallises in a bcc lattice with cell edge of 500 pm. The density of the element is 7.5 g cm^{-3}. How many atoms are present in 300 g of metal?

MHT CET 2020 16th October Evening Shift

Options:

A. 6.4×10^{23} atoms

B. 12.8×10^{23} atoms

C. 3.2×10^{23} atoms

D. 1.6×10^{23} atoms

Answer: A

Solution:

Given,

Edge length

$(\mathrm{a}) = 500\mathrm{pm} = 500 \times 10^{-12} \mathrm{~m} = 5 \times 10^{-8} \mathrm{~cm}$

$\text{Density } (d) = 7.5 \text{ g cm}^{-3}$

$\text{Mass}(m) = 300 \text{ g}$

For bec unit, $Z = 2$

The volume of unit cell $\left(a^3\right)$

$= (5 \times 10^{-8}\ \text{cm})^3 = 1.25 \times 10^{-22}\ \text{cm}^3$

Volume occupied by each atom

$= \frac{1.25 \times 10^{-22}\ \text{cm}^{-3}}{2} = 6.25 \times 10^{-23}\ \text{cm}^{-3}$

Volume of sample $= \frac{\text{Mass}}{\text{Density}} = \frac{300\ \text{g}}{7.5\ \text{g cm}^{-3}} = 40\ \text{cm}^3$

The number of atoms present in 300 g of the element

$= \frac{40\ \text{cm}^3}{6.25 \times 10^{-23}\ \text{cm}^{-3}} = 6.4 \times 10^{23}$ atoms

---

Question171

An element has a bcc structure with cell edge of 288 pm . The density of element is $7.2\ \text{g cm}^{-3}$. What is the atomic mass of an element?

MHT CET 2020 16th October Evening Shift

Options:

A. 25.89

B. 51.78

C. 77.68

D. 62.43

Answer: B

Solution:

Given,

Cell is bcc, so $Z = 2$

Edge length $(a) = 288$ pm

$= 2.88 \times 10^{-8}$ cm

Density of metal $(d) = 7.2\ \text{g cm}^{-3}$

$N_A = 6.022 \times 10^{23}$

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

$$\begin{aligned} \therefore M &= \frac{d \cdot a^3 \cdot N_A}{Z} \\ &= \frac{7.2 \times \left(2.88 \times 10^{-8}\right) \times 6.022 \times 10^{23}}{2} \\ &= \frac{7.2 \times 23.8878 \times 10^{-24} \times 6.022 \times 10^{23}}{2} \\ &= 51.78 \text{ g mol}^{-1} \end{aligned}$$

Question172

A metallic element crystallises in simple cubic lattice. If edge length of the unit cell is $3\overset{o}{A}$, with density 8 g/cc, what is the number of unit cells in 100 g of the metal?

(Molar mass of metal $= 108 \text{ g/mol}$)

MHT CET 2020 16th October Morning Shift

Options:

A. 1.33×10^{20}

B. 2.7×10^{22}

C. 2×10^{24}

D. 5×10^{23}

Answer: D

Solution:

Given,

Edge length $(a) = 3\overset{o}{A} = \left(3 \times 10^{-8}\right) \text{cm}$

$\left[1\overset{o}{A} = 1 \times 10^{-8} \text{ cm}\right]$

Density $= 8 \mathrm{~g/cc}$

$$\begin{aligned} \text{Volume of unit cell } &= (\text{ edge length })^3 \\ &= \left(3 \times 10^{-8} \mathrm{~cm}\right)^3 \\ &= 27 \times 10^{-24} \mathrm{~cm}^3 \end{aligned}$$

$$\begin{aligned} \text{Mass of unit cell } &= \text{ volume } \times \text{ density} \\ &= 27 \times 10^{-24} \times 8 \end{aligned}$$

Number of unit cell in 100 g $= \frac{100}{27 \times 10^{-24} \times 8}$

$= 5 \times 10^{23}$

Question173

A compound has fcc structure. If density of unit cell is $3.4 \mathrm{~g~cm}^{-3}$, what is the edge length of unit cell?

(Molar mass $= 98.99$)

MHT CET 2020 16th October Morning Shift

Options:

A. $8.780 \stackrel{o}{A}$

B. $6.083 \stackrel{o}{A}$

C. $5.783 \stackrel{o}{A}$

D. $7.783 \stackrel{o}{A}$

Answer: C

Solution:

Given,

Density $(d) = 3.4 \mathrm{~g~cm}^{-3}$
Molar mass $(M) = 98.99 \mathrm{~g/mol}$
$N_A = 6.023 \times 10^{23}$

For fcc emit cell, $Z = 4$

We know that, edge length $\left(a^3\right) = \frac{M \times Z}{d \times N_A}$

$$= \frac{98.99(\mathrm{~g/mol}) \times 4}{\left(3.4 \mathrm{~g~cm}^{-3}\right) \times \left(6.023 \times 10^{23}\right) \mathrm{mol}^{-1}}$$

$$= 193.3 \times 10^{-24} \mathrm{~cm}^{-3}$$

$$= 5.783 \times 10^{-8} \mathrm{~cm} \left[1 \stackrel{o}{A} = 1 \times 10^{-8} \mathrm{~cm}\right]$$

$$= 5.783 \stackrel{o}{A}$$

Question174

Xenon crystallises in fcc lattice and the edge length of unit cell is 620 pm. What is the radius of Xe atom?

MHT CET 2020 16th October Morning Shift

Options:

A. 438.5 pm

B. 219.2 pm

C. 265.5 pm

D. 536.9 pm

Answer: B

Solution:

In a face-centered cubic (fcc) lattice, the atoms are arranged in a way that each corner atom is shared among eight adjacent cubes, and each face-centered atom is shared between two cubes. The atoms touch each other along the face diagonals. For such a crystal system, we can derive the radius of the atom (r) in terms of the edge length of the unit cell (a) using geometrical analysis.

In an fcc lattice, four atoms make up the diagonal of a face. Since the arrangement is such that there are two half radii at each end of the face diagonal and one whole radius from each atom in the middle (totaling three diameters), the face diagonal can be represented as $4r$. The face diagonal is also a part of a right triangle where the diagonal is the hypotenuse, and the sides are edges of the unit cell, each of length a.

Using Pythagoras' theorem in that triangle gives us the equation:

$\sqrt{a^2 + a^2} = 4r$

Since $a^2 + a^2 = 2a^2$, simplifying the equation gives:

$\sqrt{2}a = 4r$

or

$r = \frac{\sqrt{2}a}{4}$

Given the edge length, $a = 620$ pm, we can substitute it into the above formula to calculate the radius of the Xenon Xe atom:

$r = \frac{\sqrt{2} \times 620 \text{ pm}}{4}$

$r = \frac{1.414 \times 620 \text{ pm}}{4}$

$r \approx \frac{876.68 \text{ pm}}{4}$

$r \approx 219.17$ pm

Therefore, the radius of a Xenon atom, when crystallised in an fcc lattice, is approximately 219.2 pm, which corresponds to Option B.

Question175

If a metal crystallises in bcc structure with edge length of unit cell 4.29×10^{-8} cm the radius of metal atom is

MHT CET 2019 3rd May Morning Shift

Options:

A. 3.2×10^{-7} cm

B. 1.86×10^{-8} cm

C. 1.07×10^{-7} cm

D. 1.07×10^{-8} cm

Answer: B

Solution:

In a body-centered cubic (bcc) structure, the relationship between the edge length (a) of the unit cell and the radius (r) of the metal atom can be derived from the geometry of the structure. The bcc lattice has atoms at each corner of the cube and a single atom at the center.

In a bcc unit cell, the body diagonal of the cube is given by connecting one corner of the cube to the opposite corner through the center atom. The length of the body diagonal in terms of the edge length a is:

$\text{body diagonal} = \sqrt{a^2 + a^2 + a^2} = \sqrt{3}a$

In a bcc structure, this body diagonal is equal to 4 times the radius of the atom (r) because it passes through one corner atom, the center atom, and another corner atom. Therefore, we have:

$\sqrt{3}a = 4r$

Solving for the radius r:

$r = \frac{\sqrt{3}}{4}a$

Substituting the given edge length $a = 4.29 \times 10^{-8}$ cm, we find:

$r = \frac{\sqrt{3}}{4} \times 4.29 \times 10^{-8}$ cm

Calculating this gives:

$r = \frac{1.732}{4} \times 4.29 \times 10^{-8}$ cm

$r \approx 1.86 \times 10^{-8}$ cm

Therefore, the radius of the metal atom is 1.86×10^{-8} cm.

Option B: 1.86×10^{-8} cm is the correct answer.

Question176

Which among the following statements is true about Schottky defect?

MHT CET 2019 3rd May Morning Shift

Options:

A. In this defect cation and anion are lacking in stoichiometric proportion

B. Formation of metal alloy is example of this defect

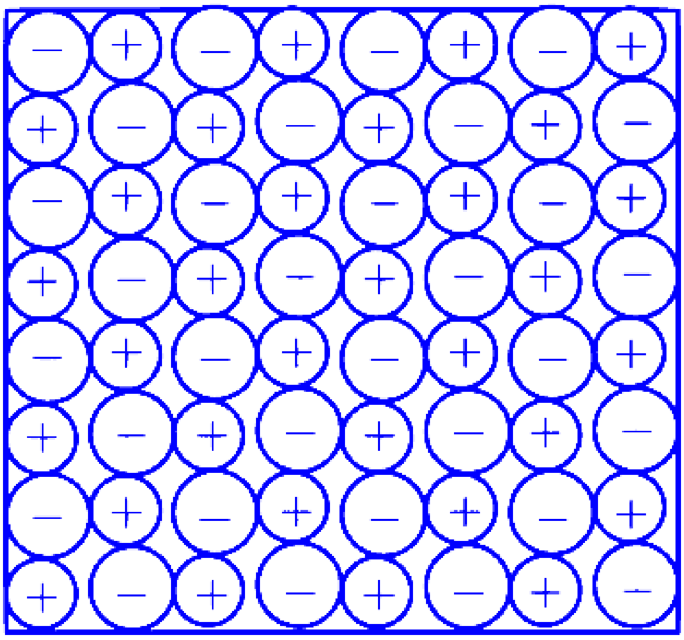
C. In this cation or anion moves from regular site to place between lattice site

D. In this regular cation is replaced by different cation

Answer: A

Solution:

In Schottky defect, cation and anion are lacking in stoichiometric proportion. It is basically a vacancy defect in ionic solids. In order to maintain electrical neutrality, the number of missing cations and anions are equal. This defect can easily be illustrated by the following figure.



Question177

How many total constituent particles are present in simple cubic unit cell?

MHT CET 2019 2nd May Evening Shift

Options:

A. 1

B. 3

C. 4

D. 2

Answer: A

Solution:

A simple cubic unit cell contains a total of 1 constituent particle. In a simple cubic structure, atoms are located at each corner of the cube. Since each corner atom is shared by 8 adjacent unit cells, each can be considered as contributing only $\frac{1}{8}^{th}$ of an atom to one unit cell. Therefore, for a simple cubic unit cell, the total number of atoms is calculated as follows:

$\text{Total Number of Atoms} = 8 \times \frac{1}{8} = 1$

Thus, the correct answer is Option A: 1.

Question178

The percentage of unoccupied volume in simple cubic cell is

MHT CET 2019 2nd May Evening Shift

Options:

A. 52.40%

B. 32.00%

C. 47.60%

D. 68.04%

Answer: C

Solution:

For simple cubic cell,

$\text{Packing effeciency} = \frac{\frac{4}{3}\pi r^3}{8r^3} \times 100 = 52.4\%$

$\therefore$ Percentage of unoccupied volume in Scc $= 100 - 52.4 = 47.6\%$

Question179

Which among the following pairs of compounds is not isomorphous?

MHT CET 2019 2nd May Morning Shift

Options:

A. $NaNO_3$ and $CaCO_3$

B. K_2SO_4 and K_2SeO_4

C. NaCl and KCl

D. NaF and MgO

Answer: C

Solution:

Isomorphous substance have generally similar chemical formulas and the polarisibility and the ratio of anion and cation radii are usually comparable. Crystals of isomorphous substances are almost identical. Among the given pair of compounds, NaCl and KCl are not isomorphous because they have different crystal structures.

Question180

Which among the following solids shows Frenkel defect?

MHT CET 2019 2nd May Morning Shift

Options:

A. NaCl

B. C_sCl

C. KCl

D. AgCl

Answer: D

Solution:

Among the following solids, AgCl shows Frenkel defect as anion is much larger in size than the cation. On the other hand, NaCl, CsCl and KCl shows Schottky defect.

Question181

Which among the following compounds in crystalline form is used for making Nicol's prism?

MHT CET 2019 2nd May Morning Shift

Options:

A. $CaSO_4$

B. Na_2AlF_6

C. $CaCO_3$

D. Al_2O_3

Answer: C

Solution:

Nicol prism used to produce and analyse plane polarised light is made up from calcite crystal (i.e. calcium carbonate in crystalline form) commonly known as calc-spar.
