

# Solid State

## Question1

A metal crystallises in simple cubic lattice. The radius of the metal atom is  $x$  pm. What is the volume of unit cell in  $\text{pm}^3$  ?

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Options:

A.

$$x^3$$

B.

$$4x^3$$

C.

$$8x^3$$

D.

$$16x^3$$

**Answer: C**

**Solution:**

**Step 1. Geometry of the simple cubic lattice**

In a **simple cubic** unit cell:

- Atoms are at the corners only.
- Each corner atom is shared by 8 unit cells.
- The atoms just **touch along the edge** of the cube.

Hence, for a simple cubic structure:

$$\text{Edge length } a = 2r$$



where  $r$  is the radius of the atom.

### Step 2. Volume of the unit cell

$$V = a^3 = (2r)^3 = 8r^3$$

### Step 3. Substitute the given symbol

Given that the radius of the atom  $r = x$  pm,

$$V = 8x^3 \text{ pm}^3$$

✅ **Final Answer:**

Option C:  $8x^3 \text{ pm}^3$

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## Question2

Identify the incorrect statement is regarding the interstitial compounds.

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**Options:**

A.

They have high melting points.

B.

They lose electrical conductivity during the formation from metal.

C.

They are chemically inert.

D.

They are very hard.

**Answer: B**

**Solution:**

Let's analyze each option about **interstitial compounds** — these are formed when small atoms (like H, B, C, or N) occupy the interstitial spaces in metal lattices.

**Option A**



They have high melting points.

True.

Interstitial compounds generally have very high melting points due to strong metallic and covalent character.

### Option B

They lose electrical conductivity during the formation from metal.

False.

The metal lattice is largely retained in interstitial compounds, and they generally **remain good conductors** of electricity (sometimes conductivity decreases slightly but not lost entirely).

### Option C

They are chemically inert.

True.

These compounds are usually chemically inert and stable.

### Option D

They are very hard.

True.

Interstitial compounds are very hard, often harder than the parent metal (e.g., steel from Fe and C).

Correct answer: Option B

The lose electrical conductivity during the formation from metal.

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## Question3

**A metal crystallises in simple cubic lattice. The volume of one unit cell is  $6.4 \times 10^7 \text{pm}^3$ . What is the radius of the metal atom in pm ?**

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Options:

A.

100

B.



200

C.

300

D.

400

**Answer: B**

**Solution:**

The volume of simple cube,  $V = a^3$

$$V = 6.4 \times 10^7 \text{pm}^3$$

$$a = (V)^{1/3} = 400 \text{pm}$$

$$\text{For simple cube } r = \frac{a}{2} = \frac{400}{2} = 200 \text{pm}$$

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## Question4

**An element occurs in the body centred cubic structure with edge length of 288 pm . The density of the element is  $7.2 \text{ g cm}^{-3}$ . The number of atoms present in 208 g of the element is nearly**

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**Options:**

A.

$$24.2 \times 10^{23}$$

B.

$$12.1 \times 10^{23}$$

C.

$$242 \times 10^{24}$$

D.

$$36.3 \times 10^{23}$$



**Answer: A**

## Solution:

### Given Values:

The edge length  $a = 288$  pm. The density ( $\rho$ ) is  $7.2$  g/cm<sup>3</sup>. The mass given is  $208$  g.

### Step 1: Find volume of one unit cell

The edge length must be changed to centimeters:  $1$  pm =  $10^{-10}$  cm. So:  $a = 288 \times 10^{-10}$  cm.

The volume of one unit cell is:  $V = a^3 = (288 \times 10^{-10})^3 \text{ cm}^3 = 2.389 \times 10^{-23} \text{ cm}^3$

### Step 2: Find total volume that 208 g will occupy

$$V_{\text{total}} = \frac{m}{\rho} = \frac{208}{7.2} = 28.89 \text{ cm}^3$$

### Step 3: Find the number of unit cells in 208 g

$$\text{Number of unit cells} = \frac{V_{\text{total}}}{V_{\text{unit cell}}} = \frac{28.89}{2.389 \times 10^{-23}} = 1.209 \times 10^{24}$$

### Step 4: Find the total number of atoms

A body centered cubic (bcc) unit cell has 2 atoms per unit cell.

So, Total atoms = Number of unit cells  $\times$  2 =  $1.209 \times 10^{24} \times 2 = 2.42 \times 10^{24}$  which is the same as  $24.2 \times 10^{23}$ .

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## Question 5

If AgCl is doped with  $1 \times 10^{-4}$  mole percent of CdCl<sub>2</sub> the number of cation vacancies (in mol<sup>-1</sup>) is

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#### Options:

A.

$$6.023 \times 10^{19}$$

B.

$$6.023 \times 10^{21}$$

C.

$$6.023 \times 10^{17}$$



D.

$$6.023 \times 10^{23}$$

**Answer: C**

**Solution:**

$$\text{Mole fraction of CdCl}_2 = \frac{1 \times 10^{-4}}{100}$$

$$\text{Mole fraction of CdCl}_2 = 1 \times 10^{-6}$$

Number of cation vacancies

$$\begin{aligned} &= \text{Mole fraction of CdCl}_2 \times N_A \\ &= 1 \times 10^{-6} \times 6.023 \times 10^{23} \text{ mol}^{-1} \\ &= 6.023 \times 10^{17} \text{ mol}^{-1} \end{aligned}$$

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## Question6

An element (atomic weight = 250u ) crystallises in a simple cubic lattice. If the density of the unit cell is  $7.2 \text{ g cm}^{-3}$ . What is the radius (in Å ) of the atom of the element?

$$\left( N_A = 6.02 \times 10^{23} \text{ mol}^{-1} \right)$$

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**Options:**

A.

$$4.04$$

B.

$$2.93$$

C.

$$1.93$$

D.



3.04

**Answer: C**

**Solution:**

$$\begin{aligned} \text{Mass of one atom} &= \frac{\text{Atomic weight}}{N_A} = \frac{250}{6.02 \times 10^{23}} \text{ g} \\ \text{Volume} &= \frac{\text{Mass}}{\text{Density}} = \frac{250/6.02 \times 10^{23}}{7.2} \\ &\Rightarrow 5.76 \times 10^{-23} \text{ cm}^3 \\ a &= \sqrt[3]{\text{volume}} = 3.86 \times 10^{-8} \text{ cm} \\ a &= 2r, r = \frac{a}{2} = 1.93 \times 10^{-8} \text{ cm or } 1.93 \text{ \AA} \end{aligned}$$

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## Question 7

A compound is formed by two elements *A* and *B*. Atoms of the element *B* (as anion) make ccp lattice and those of element *A* (as cation) occupy all tetrahedral voids. The formula of the compound is

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**Options:**

A.

$A_4B_3$

B.

$AB$

C.

$AB_2$

D.

$A_2B$

**Answer: D**

**Solution:**



$B$  (anion) forms a ccp

ccp has = 4 atom/cell

Voids in ccp

Number of tetrahedral voids =  $2 \times 4 = 8$

All tetrahedral voids are occupied by  $A$  (cation)

$$A = 8, B = 4$$

$$A : B = 2 : 1 \text{ or } A_2B$$

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## Question8

An element crystallises in bcc lattice. The atomic radius of the element is  $2.598\overset{\circ}{\text{Å}}$ . What is the volume (in  $\text{cm}^3$ ) of one unit cell?

### AP EAPCET 2025 - 21st May Evening Shift

Options:

A.

$$6.4 \times 10^{-22}$$

B.

$$2.16 \times 10^{22}$$

C.

$$2.16 \times 10^{-22}$$

D.

$$2.16 \times 10^{-24}$$

**Answer: C**

**Solution:**

The relation between radius and edge length in BCC structure

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

$$a = \frac{4r}{\sqrt{3}} = \frac{4 \times 2.598}{\sqrt{3}} = 6\overset{\circ}{\text{Å}}$$



$$\begin{aligned}
 \text{Volume} &= a^3 = (6)^3 \times (10^{-10})^3 \text{ cm}^3 \\
 &= 216 \times 10^{-24} \text{ cm}^3 \\
 &= 2.16 \times 10^{-22} \text{ cm}^3
 \end{aligned}$$


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## Question9

Gold crystallises in fcc lattice. The edge length of the unit cell is  $4\overset{\circ}{\text{A}}$ . The closest distance between gold atoms is ' $x$ '  $\overset{\circ}{\text{A}}$  and density of gold is ' $y$ '  $\text{gcm}^{-3}$ . What are  $x$  and  $y$  respectively?

(Molar mass of gold =  $197 \text{ g mol}^{-1}$ ;  $N = 6 \times 10^{23} \text{ mol}^{-1}$ )

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Options:

A.

$$\sqrt{2}, 41.04$$

B.

$$2\sqrt{2}, 20.52$$

C.

$$2\sqrt{3}, 10.25$$

D.

$$\sqrt{3}, 5.15$$

**Answer: B**

**Solution:**

The closest distance  $r$  is given by

$$r = \frac{a}{\sqrt{2}} \Rightarrow r = \frac{4}{\sqrt{2}} = 2\sqrt{2}\overset{\circ}{\text{A}} = x\overset{\circ}{\text{A}}$$

The density ( $d$ ) is given by,  $d = \frac{ZM}{a^3 N_A}$



$$Z = 4, M = 197 \text{ g mol}^{-1},$$

$$a = 4 \times 10^{-8} \text{ cm}, N_A = 6 \times 10^{23} \text{ mol}^{-1}$$

$$d = \frac{4 \times 197 \text{ g mol}^{-1}}{(4 \times 10^{-8} \text{ cm})^3 \times 6 \times 10^{23} \text{ mol}^{-1}}$$

$$\approx 20.52 \text{ g cm}^{-3} = y \text{ g cm}^{-3}$$

$$\therefore x = 2\sqrt{2} \text{ and } y = 20.52$$

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## Question 10

The molecular formula of a crystalline solid  $X_3Y_2$ . Atoms of  $Y$  form ccp lattice and atoms of  $X$  occupy 50% octahedral voids and  $X\%$  of tetrahedral voids. What is the percentage of unoccupied tetrahedral voids?

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Options:

A. 66.6

B. 25

C. 50

D. 33.3

**Answer: C**

**Solution:**

In a cubic close-packed (ccp) lattice, there are 4 atoms per unit cell. Therefore, the number of octahedral voids is equal to the number of atoms, which is 4. The number of tetrahedral voids is twice the number of atoms, calculated as:

$$2n = 2 \times 4 = 8$$

For element  $Y$ :

$$n = 2$$

Thus, the number of octahedral voids is:

$$2 \text{ (since } n = 2)$$

The number of tetrahedral voids is:

$$2 \times 2 = 4$$

Atoms of  $X$  occupy 50% of the octahedral voids:

$$0.5 \times 2 = 1$$

Given that  $X$  must account for one additional atom (since  $X_3$  implies three atoms per formula unit), these additional  $X$  atoms occupy tetrahedral voids:

$$3 - 1 = 2 \text{ atoms of } X$$

The percentage of the tetrahedral voids occupied by  $X$  is:

$$\frac{2}{4} \times 100 = 50\%$$

Thus, the percentage of unoccupied tetrahedral voids is:

$$100\% - 50\% = 50\%$$

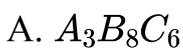
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## Question 11

**A compound is formed by atoms of  $A$ ,  $B$  and  $C$ . Atoms of  $C$  form hcp lattice. Atoms of  $A$  occupy 50% of octahedral voids and atoms of  $B$  occupy  $2/3$  rd of tetrahedral voids. What is the molecular formula of the solid?**

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**Options:**



**Answer: A**

**Solution:**

Given the problem:

A compound is formed by atoms of  $A$ ,  $B$ , and  $C$ . Atoms of  $C$  form an hcp (hexagonal close-packed) lattice. Atoms of  $A$  occupy 50% of the octahedral voids, and atoms of  $B$  occupy  $\frac{2}{3}$  of the tetrahedral voids. We need to determine the molecular formula of the solid.

To solve this:

Atoms of  $C$  form an hcp lattice. The effective number of atoms per unit cell for an hcp lattice is calculated by:

$$= \frac{1}{2} \times 12 + \frac{1}{2} \times 2 + 1 \times 3 = 6$$

Here:

12 atoms from corners contribute  $\frac{1}{2}$  each.



2 atoms from faces contribute  $\frac{1}{2}$  each.

3 atoms from the middle contribute 1 each.

Thus, the total is 6.

The number of octahedral voids in a lattice is equal to the number of atoms, so there are 6 octahedral voids. Atoms A occupy 50% of these octahedral voids:

$$\Rightarrow \frac{50}{100} \times 6 = 3 \text{ atoms of } A$$

The number of tetrahedral voids is twice the number of atoms in the hcp lattice, which equals  $2 \times 6 = 12$ . Atoms B occupy  $\frac{2}{3}$  of these tetrahedral voids:

$$\Rightarrow \frac{2}{3} \times 12 = 8 \text{ atoms of } B$$

Thus, the molecular formula of the solid is  $A_3B_8C_6$ .

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## Question 12

**Zinc oxide (white) is heated to high temperature for some time. Observe the following statements regarding above process. I. Zinc oxide colour changes to pale yellow II. The type of defect formed is 'metal deficiency' III. Some  $Zn^{2-}$  and  $e^-$  are present in interstitial place** The correct statements are

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**Options:**

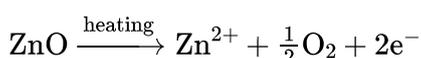
- A. I, II only
- B. I, III, only
- C. II, III only
- D. I, II and III

**Answer: B**

**Solution:**

*Explanation of the Process*

When zinc oxide is heated, it loses oxygen and forms excess zinc ions ( $Zn^{2+}$ ) and electrons ( $e^-$ ) which get trapped in the interstitial sites. This process can be represented as:



This leads to a non-stoichiometric compound where there's a slight excess of zinc. The released electrons are responsible for the change in color.

### Analyzing the Statements

#### Statement I: Zinc oxide colour changes to pale yellow

This is correct. When ZnO is heated, it typically turns pale yellow due to the creation of F-centers (electrons trapped in oxygen vacancies).

#### Statement II: The type of defect formed is 'metal deficiency'

This is incorrect. The defect formed is a 'metal excess' defect because there are more zinc ions than the stoichiometric ratio.

#### Statement III: Some $\text{Zn}^{2+}$ and $e^-$ are present in interstitial place

This is correct. As explained above, the excess zinc ions and electrons occupy interstitial sites in the crystal lattice.

### Conclusion

Based on the analysis, statements I and III are correct, while statement II is incorrect.

Therefore, the correct answer is:

**Option B: I, III, only**

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## Question 13

Identify the incorrect set from the following.

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#### Options:

- A.  $\text{SiO}_2$ , covalent solid, insulator, high melting point
- B.  $\text{MgO}$ , covalent solid, insulator, high melting point
- C.  $\text{H}_2\text{O}_{(\text{ice})}$ , molecular solid, insulator, low melting point.
- D.  $\text{Ag}(\text{s})$ , metallic solid, conductor, high melting point.

**Answer: B**

#### Solution:

Option A:  $\text{SiO}_2$  is a covalent (network) solid with a very high melting point and acts as an insulator. This description is correct.

Option B: While  $\text{MgO}$  does have a high melting point and is an insulator, it is an ionic solid—not a covalent solid. The bonding in  $\text{MgO}$  is due to the electrostatic attraction between  $\text{Mg}^{2+}$  and  $\text{O}^{2-}$  ions. Therefore, this set is incorrect.



Option C:  $\text{H}_2\text{O}$  (ice) is a molecular solid. It is an insulator and has a relatively low melting point compared to network or ionic solids. This description is correct.

Option D:  $\text{Ag}(s)$  is a metallic solid, which is a conductor and has a high melting point. This description is correct.

Thus, the incorrect set is Option B.

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## Question14

**What are the variables in the graph of powder diffraction pattern of a crystalline solid?**

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**Options:**

A.  $X$ -axis =  $2\theta$  :  $Y$ -axis = intensity

B.  $X$ -axis = intensity :  $Y$ -axis =  $2\theta$

C.  $X$ -axis =  $\theta$  :  $Y$ -axis = intensity

D.  $X$ -axis = intensity :  $Y$ -axis =  $\theta$

**Answer: A**

**Solution:**

Powder diffraction is a scientific technique using X-ray, neutron or electron diffraction on powder for structural characterisation of material.

The graph is drawn between intensity (on  $Y$ -axis) and degree of diffraction ( $2\theta$ ) on  $X$ -axis.

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## Question15

**The density of  $\beta$  - Fe is  $7.6 \text{ g cm}^{-3}$ . It crystallises in cubic lattice with  $a = 290\text{pm}$ . What is the value of  $Z$  ?**

**(Fe =  $56 \text{ g mol}^{-1}$  :  $N_A = 6.022 \times 10^{23} \text{ mol}^{-1}$ )**

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**Options:**

A. 2

B. 1

C. 4

D. 6

**Answer: A**

### **Solution:**

The density of  $\beta$ -Fe is given as  $7.6 \text{ g/cm}^3$ . It crystallizes in a cubic lattice with a lattice parameter  $a = 290 \text{ pm}$ . The molar mass of Fe is  $56 \text{ g/mol}$ , and Avogadro's number is  $N_A = 6.022 \times 10^{23} \text{ mol}^{-1}$ .

To find the value of  $Z$ , the formula for the density of a crystalline solid is used:

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

Rearranging for  $Z$ , we have:

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

Substituting the given values:

Convert  $a$  from picometers to centimeters:  $a = 290 \text{ pm} = 290 \times 10^{-10} \text{ cm}$ .

$$Z = \frac{7.6 \times (290 \times 10^{-10})^3 \times 6.022 \times 10^{23}}{56}$$

This calculation yields:

$$Z = 2$$

Thus, the rank of the unit cell,  $Z$ , is 2.

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## **Question 16**

**A solid compound is formed by atoms of A (cations), B (cations) and O (anions). Atoms of O form hcp lattice. Atoms of A occupy 25% of tetrahedral holes and atoms of B occupy 50% octahedral holes. What is the molecular formula of solid?**

### **AP EAPCET 2024 - 20th May Morning Shift**

**Options:**

A.  $\text{AB}_2\text{O}_4$

B.  $\text{ABO}_3$

C.  $\text{ABO}_2$

D.  $\text{A}_2\text{BO}_4$

**Answer: C**

### Solution:

In this problem, we are asked to determine the molecular formula of a compound that consists of atoms A (cations), B (cations), and O (anions) where the oxygen atoms form an hcp (hexagonal close-packed) lattice.

**Oxygen Lattice:** Given that the lattice is an hcp structure, each unit cell contains 6 oxygen atoms (anions).

**Tetrahedral Holes:** In an hcp lattice, there are 12 tetrahedral holes per unit cell. Atoms of A occupy 25% of these tetrahedral holes, which can be calculated as follows:

$$\frac{25}{100} \times 12 = 3 \text{ atoms of A per unit cell.}$$

**Octahedral Holes:** There are 6 octahedral holes per unit cell. Atoms of B occupy 50% of the octahedral holes:

$$\frac{50}{100} \times 6 = 3 \text{ atoms of B per unit cell.}$$

**Molecular Formula Calculation:** With the aforementioned counts of atoms per unit cell (3 A atoms, 3 B atoms, and 6 O atoms), the ratio of A : B : O becomes:

$$3 : 3 : 6 = 1 : 1 : 2$$

Therefore, the molecular formula of the compound is  $\text{ABO}_2$ .

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## Question 17

**Which one of the following is used as piezoelectric material?**

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**Options:**

A. Tridymite

B. Quartz

C. Zeolite

D. Mica

**Answer: B**

### Solution:

The correct answer is Option B: Quartz.



Here's why:

Quartz is famous for its piezoelectric properties. This means when mechanical stress is applied to quartz, it produces an electric charge.

These properties make quartz widely used in electronic devices such as oscillators, sensors, and frequency control applications.

The other materials listed (Tridymite, Zeolite, and Mica) are not primarily known for piezoelectric applications.

Thus, quartz is the most common and useful piezoelectric material among the options given.

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## Question 18

Some substances are given below

Ag,  $\text{CO}_2(s)$ ,  $\text{SiO}_2$ , ZnS

$\text{SO}_2(s)$ , AlN, HCl(s),  $\text{H}_2\text{O}(s)$

The number of molecular solids and network solids in the above list is respectively.

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Options:

A. 3,3

B. 2,4

C. 1,4

D. 4,2

**Answer: D**

**Solution:**

Molecular solids are compounds of discrete molecules held together by intermolecular forces.

A network solid is a compound in which the atoms are bounded by covalent bonds in continuous network extending throughout the material. Molecular solids :  $\text{CO}_2$ ,  $\text{H}_2\text{O}$ ,  $\text{SO}_2$ , HCl. Network solids :  $\text{SiO}_2$ , AlN Thus, the number of molecular and network solids are 4 and 2 respectively.

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## Question19

The diffraction pattern of crystalline solid gave a peak at  $2\theta = 60^\circ$ . What is the distance ( in cm ) between the layers which gave this peak?

(  $\lambda$  of X-rays is  $1.54 \text{ \AA}$  ) (  $\sin 30^\circ = 0.5$ ,  $\sin 60^\circ = 0.866$ ;  $n = 1$  )

(a)  $8.89 \times 10^{-8}$

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Options:

A.  $8.89 \times 10^{-9}$

B.  $8.89 \times 10^{-1}$

C.  $1.54 \times 10^{-8}$

D. 1.54

Answer: C

### Solution:

To find the distance between the layers in a crystalline solid that produces a diffraction peak at  $2\theta = 60^\circ$ , we first need to determine  $\theta$ . Given that  $2\theta = 60^\circ$ , it follows that  $\theta = 30^\circ$ .

Then, we use Bragg's law for diffraction, which is:

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

Given:

$$\text{Wavelength of X-rays, } \lambda = 1.54 \text{ \AA} = 1.54 \times 10^{-10} \text{ m}$$

$$\text{Order of reflection, } n = 1$$

$$\sin 30^\circ = 0.5$$

Rearranging Bragg's law to solve for  $d$ , we have:

$$d = \frac{n\lambda}{2 \sin \theta}$$

Substituting the given values into the equation:

$$d = \frac{1 \times 1.54 \times 10^{-10}}{2 \times 0.5} = \frac{1.54 \times 10^{-10}}{1} = 1.54 \times 10^{-10} \text{ m} = 1.54 \times 10^{-8} \text{ cm}$$

Thus, the distance between the layers is  $1.54 \times 10^{-8} \text{ cm}$ .

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## Question20

An element crystallising in fcc lattice has a density of  $8.92 \text{ g cm}^{-3}$  and edge length of  $3.61 \times 10^{-8} \text{ cm}$ . What is the atomic weight of element?  
( $N = 6.022 \times 10^{23} \text{ mol}^{-1}$ )

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Options:

- A. 126.356 u
- B. 63.178 u
- C. 31.589 u
- D. 47.383 u

**Answer: B**

**Solution:**

Given,  $d = 8.92 \text{ g cm}^{-3}$

(Edge length)  $a = 3.61 \times 10^{-8} \text{ cm}$

$M = ?$

For fcc,  $Z = 4$

$$d = \frac{Z \times M}{a^3 \times N}$$
$$8.92 = \frac{4 \times M}{(3.61 \times 10^{-8})^3 \times 6.022 \times 10^{23}}$$
$$\Rightarrow M = \frac{8.92 \times 47.045 \times 10^{-24} \times 6.022 \times 10^{23}}{4}$$
$$= 63.178 \text{ u}$$

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## Question21

Which of the following statement is correct for fcc lattice?

### AP EAPCET 2022 - 5th July Morning Shift

Options:

- A. There are equal number of octahedral and tetrahedral voids in a unit cell.
- B. The tetrahedral voids are present at the edge centers.
- C. Octahedral voids are present at the body center and edge centers.
- D. Its packing efficiency (PE) is higher than hcp lattice PE.

**Answer: C**

**Solution:**

- (a) There are equal number of octahedral and tetrahedral voids in a unit cell for fcc lattice is incorrect statement. The number of octahedral and tetrahedral void in unit cell for fcc lattice is 4 and 8 respectively.
- (b) The tetrahedral voids are present at the edge centers is incorrect as they are present on each body diagonal, i.e. diagonal of cubic unit cell.
- (c) Octahedral voids are present at the body center and edge centers. Statement (c) is correct.
- (d) Its packing efficiency ( PE ) is higher than hcp lattice PE is incorrect.

The packing efficiency of hcp is 74% and that of fcc is also 74%. It is higher in comparison to packing efficiency of simple cube and bcc which have values 52.4 and 68% respectively.

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## Question22

Match List I with List II.

	List - I (Defects)		List - II (Examples)
(A)	Frenkel defects	(I)	FeO
(B)	Schottkey defects	(II)	NaCl
(C)	Vacancy defects	(III)	AgCl
(D)	Metal deficiency defects	(IV)	Crystals with vacant lattice sites.

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### Options:

A. A - IV, B - III, C - II, D - I

B. A - III, B - II, C - IV, D - I

C. A - I, B - II, C - III, D - IV

D. A - II, B - III, C - IV, D - I

**Answer: B**

### Solution:

A. Frenkel defects is a defect in which an atom/ion occupies a normally vacant site other than its own. This defect is possible if the cations are smaller in size as compared to the anions. Size of  $\text{Ag}^+$  is smaller than  $\text{Cl}^-$  so, it shows Frenkel defect.

B. Schottky defects is a type of defect in which both cations and anions remain missing from their lattice sites in equal numbers. This is possible if size of both ions is nearly same. Size of  $\text{Na}^+$  is equal to size of  $\text{Cl}^-$  so, it shows Schottky defect.

C. Vacancy defects is a defect in which crystals have vacant sites.

D. Metal deficiency defects, in this solids have less number of metals, FeO shows metal deficiency defect due to variable oxidation state of Fe.

Hence, the correct match is

	List - I (Defects)		List - II (Examples)
A.	Frenkel defects	(III)	AgCl
B.	Schottky defects	(II)	NaCl
C.	Vacancy defects	(IV)	Crystals with vacant lattice sites.
(D)	Metal deficiency defects	(I)	FeO

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## Question23

**Which of the following solids is not a molecular solid?**

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Options:



- A. HCl
- B. H<sub>2</sub>O
- C. CCl<sub>4</sub>
- D. SiO<sub>2</sub>

**Answer: D**

### **Solution:**

Molecular solids are the solids in which atoms or molecules are held together by London dispersion forces, dipole-dipole interactions or hydrogen bonds. They have low melting points and flexibility and are poor conductors. HCl has dipole-dipole forces.

H<sub>2</sub>O has hydrogen bonding.

CCl<sub>4</sub> has London dispersion forces.

Thus, these are molecular solids.

SiO<sub>2</sub> is a covalent or network solid.

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## **Question24**

**The number of network solids and ionic solids in the list given below is respectively. H<sub>2</sub>O (ice), AlN, Cu, CaF<sub>2</sub>, diamond, MgO, CCl<sub>4</sub>, ZnS, Ag, NaCl, SiO<sub>2</sub>**

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**Options:**

- A. 3, 3
- B. 3, 4
- C. 4, 4
- D. 4, 3

**Answer: B**

### **Solution:**



Network solid or covalent solid is a compound in which the atoms are bonded together by covalent bonds in a continuous network. Out of given solids, network solids are; AlN, diamond and SiO<sub>2</sub>.

Ionic solid are composed of ions (cations and anions) held together by electrostatic forces. Out of given solids, ionic solids are; NaCl, MgO, CaF<sub>2</sub>, ZnS.

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## Question25

**If molten NaCl contains SrCl<sub>2</sub> as impurity, crystallisation can generate**

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**Options:**

- A. anionic vacancies
- B. cationic vacancies
- C. metal excess defects
- D. metal deficiency defects

**Answer: B**

**Solution:**

If molten NaCl contains an impurity of SrCl<sub>2</sub> then, on crystallisation, some of the sites of Na<sup>+</sup> ions are occupied by Sr<sup>2+</sup>. Each Sr<sup>2+</sup> will replace two Na<sup>+</sup> ions. One site is occupied by one Sr<sup>2+</sup> but other remains vacant. Thus, a cationic vacancy is produced.

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## Question26

**Photographic plates are prepared by coating emulsion of which of the following in gelatin?**

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**Options:**

- A. AgBr



B. CuBr

C. ZnB<sub>2</sub>

D. FeBr<sub>2</sub>

**Answer: A**

**Solution:**

Photographic plate of film consists of a glass plate or thin strip of celluloid which is coated with the thin layer of an emulsion of silver bromide (AgBr) dispersed in gelatin.

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## Question27

**A metal crystallises with a fcc lattice, the edge of whose unit cell is  $x$  pm. The diameter of this metal atom would be ..... pm.**

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**Options:**

A.  $2x$

B.  $\frac{x}{\sqrt{2}}$

C.  $x\sqrt{2}$

D.  $\frac{\sqrt{2}}{x}$

**Answer: B**

**Solution:**

**Given:**

A metal crystallizes with a **face-centered cubic (fcc)** lattice.

The **edge length** (unit cell edge) =  $x$  pm

We need to find: **diameter of the metal atom** in pm.

**Step 1: Relationship between atomic radius and edge length in fcc**

In an **fcc lattice**, atoms touch each other **along the face diagonal**.



- Along the face diagonal, there are **4 radii** across it.

That means:

$$\text{Face diagonal} = 4r$$

But from geometry:

$$\text{Face diagonal} = \sqrt{2} \times a$$

where  $a$  = edge length of the cube (given as  $x$ ).

### Step 2: Equate the two expressions

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

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

### Step 3: Diameter = $2r$

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

### Step 4: Substitute $a = x$

$\text{Diameter} = \frac{x}{\sqrt{2}} \text{ pm}$
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**Correct Option:**

Option B —  $\frac{x}{\sqrt{2}}$

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## Question28

**In the face centered unit cell, the lattice points are present at**

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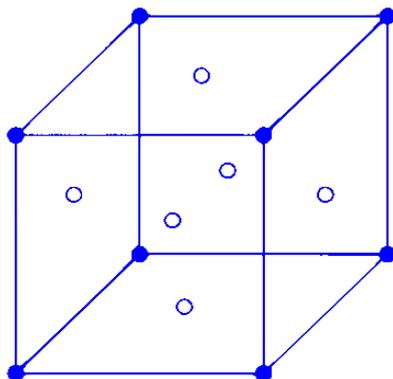
**Options:**

- A. only the corners of the unit cell
- B. the corners and the center of the unit cell
- C. the corners and the face centres of the unit cell
- D. only the face centres of the unit cell

**Answer: C**

## Solution:

In the face centred unit cell, the lattice points are present at the corners and face centres of unit cell.



Face centred unit cell

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## Question 29

The fcc crystal contains how many atoms in each unit cell?

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Options:

- A. 4
- B. 8
- C. 10
- D. 12

**Answer: A**

## Solution:

In face centered cubic unit cell (fcc), each particle is at the corner and at face centers. Corner atoms contribute  $\frac{1}{8}$  per unit cell. Face center atoms contribute =  $\frac{1}{2}$

Now, number of atoms,  $Z = 8 \times \frac{1}{8} + 6 \times \frac{1}{2} = 4$

Hence, fcc crystal contains 4 atoms in each unit cell.

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