HOLISTIC

MHT-CET

ROADMAP TO SUCCESS

2024

- Based on latest paper pattern
- Quick Review
- Important Formulae & Shortcuts

- Subtopic wise segregation
- Classwork/Homework segregation
- Previous Years' Questions

CHEMISTRY (STD. XII)

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HOLISTIC

MHT-CET
CHEMISTRY
MULTIPLE CHOICE QUESTIONS

Based on Std. XII Syllabus of MHT-CET

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CONTENTS

01 Solid State

Subtopics

Valuable defective materials !!!!

Do all defective materials turn up discarded? Well …. think again. They might be present in your necklace studded with precious and semi-precious stones. These stones with eye-catching colour and shine are due to their crystalline structure with presence of trace quantities of mostly transition elements, which are generally called as impurities. One such example is corundum (Al_2O_3) an important mineral of aluminium. The gemstone varieties of this mineral are ruby, sapphire, etc.
Ruby (Red) contains Al_2O_3 and Cr_2O_3
Sapphire (blue) contains Al_2O_3, Fe_2O_3 and TiO_2.

Quick Review

➤ **Classification of solids:**

Solids	
Crystalline solids	**Amorphous solids**
e.g. NaCl, Fe	**e.g.** Glass, Rubber
Regular arrangement of constituent particles	Random arrangement of constituent particles
Shows anisotrophy	Shows isotrophy
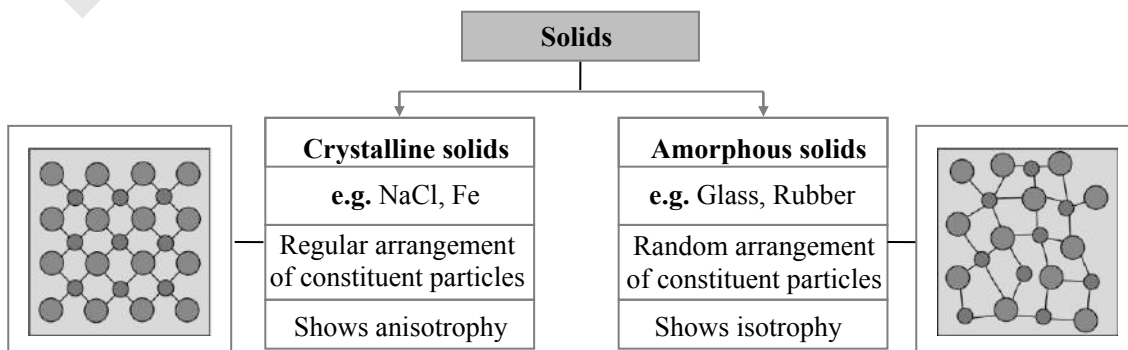
➢ **Isomorphous and polymorphous substances:**

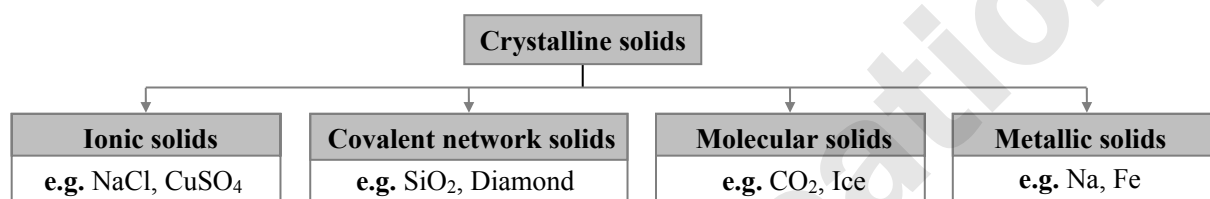| Isomorphous	Two or more substances having the same crystal structure are said to be isomorphous. Isomorphous pairs have same atomic ratio. **e.g.:** NaF and MgO (atomic ratio = 1:1), $NaNO_3$ and $CaCO_3$ (atomic ratio = 1:1:3)
Polymorphous	A single substance that exists in two or more forms or crystalline structures is said to be polymorphous. Polymorphism occurring in elements is called allotropy. **e.g.:** Calcite and aragonite: polymorphic forms of calcium carbonate, α-quartz, β-quartz and cristobalite: polymorphic forms of silica.

➢ **Classification of crystalline solids:**

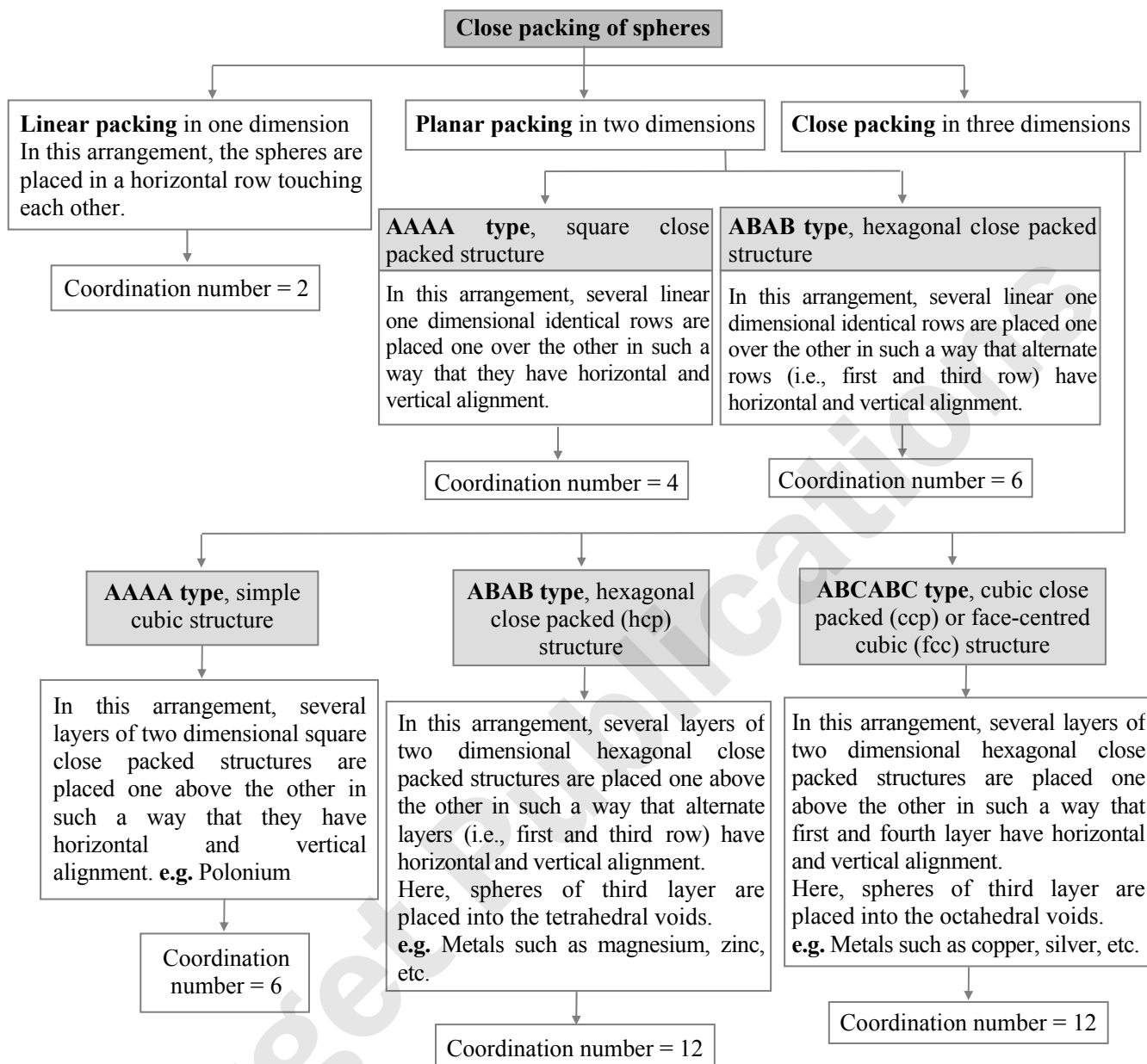| **Crystalline solids**			
Ionic solids **e.g.** NaCl, $CuSO_4$	**Covalent network solids** **e.g.** SiO_2, Diamond	**Molecular solids** **e.g.** CO_2, Ice	**Metallic solids** **e.g.** Na, Fe

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➢ **Types of unit cells:**

Primitive or simple unit cell	Particles are present at its corners only.
Body-centred unit cell	One particle is present at the centre of its body in addition to the corner particles.
Face-centred unit cell	Particles are present at the centre of each of the faces in addition to the corner particles.
Base-centred unit cell	Particles are present at the centre of any two of its opposite faces in addition to the corner particles.

➢ **Seven crystal systems:**
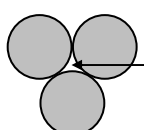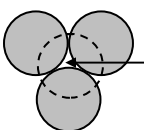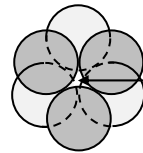
Crystal system	Types of unit cells			
Cubic	i. Simple or primitive	ii. Body-centred	iii. Face-centred	
Orthorhombic	i. Simple or primitive	ii. Body-centred	iii. Face-centred	iv. Base-centred
Tetragonal	i. Simple or primitive	ii. Body-centred		
Monoclinic	i. Simple or primitive	ii. Base-centred		
Rhombohedral	i. Simple or primitive			
Triclinic	i. Simple or primitive			
Hexagonal	i. Simple or primitive			

➤ **Packing in solids:**

Close packing of spheres

Linear packing in one dimension
In this arrangement, the spheres are placed in a horizontal row touching each other.

Coordination number = 2

Planar packing in two dimensions

AAAA type, square close packed structure

In this arrangement, several linear one dimensional identical rows are placed one over the other in such a way that they have horizontal and vertical alignment.

Coordination number = 4

ABAB type, hexagonal close packed structure

In this arrangement, several linear one dimensional identical rows are placed one over the other in such a way that alternate rows (i.e., first and third row) have horizontal and vertical alignment.

Coordination number = 6

Close packing in three dimensions

AAAA type, simple cubic structure

In this arrangement, several layers of two dimensional square close packed structures are placed one above the other in such a way that they have horizontal and vertical alignment. **e.g.** Polonium

Coordination number = 6

ABAB type, hexagonal close packed (hcp) structure

In this arrangement, several layers of two dimensional hexagonal close packed structures are placed one above the other in such a way that alternate layers (i.e., first and third row) have horizontal and vertical alignment.
Here, spheres of third layer are placed into the tetrahedral voids.
e.g. Metals such as magnesium, zinc, etc.

Coordination number = 12

ABCABC type, cubic close packed (ccp) or face-centred cubic (fcc) structure

In this arrangement, several layers of two dimensional hexagonal close packed structures are placed one above the other in such a way that first and fourth layer have horizontal and vertical alignment.
Here, spheres of third layer are placed into the octahedral voids.
e.g. Metals such as copper, silver, etc.
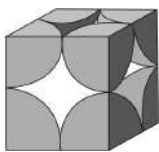
Coordination number = 12

➤ **Types of voids:**
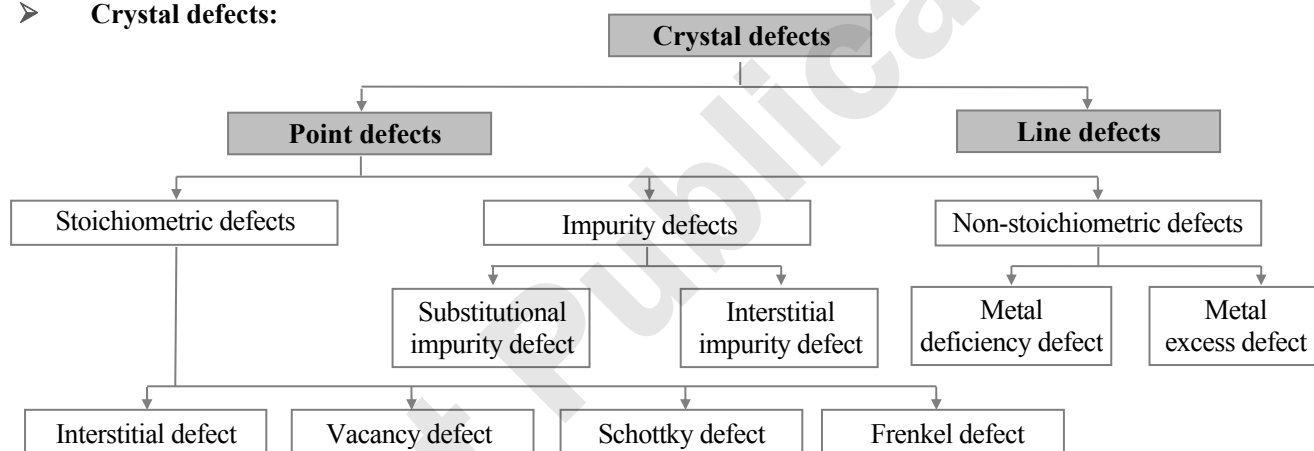
Triangular voids	Tetrahedral voids	Octahedral voids
A triangular void is surrounded by three spheres.	A tetrahedral void is surrounded by four spheres.	An octahedral void is surrounded by six spheres.

➢ **Types of cubic unit cell:**

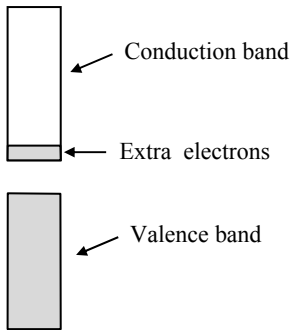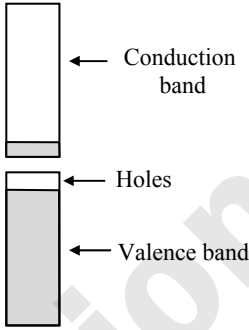| Type of unit cell	Simple cubic	Body-centred cubic	Face-centred cubic
Diagram			
No. of particles per unit cell	**1**	**2**	**4**
Relation between a and r	$r = \dfrac{a}{2} = 0.5000\ a$	$r = \dfrac{\sqrt{3}}{4}a = 0.4330\ a$	$r = \dfrac{\sqrt{2}}{4}a = 0.3535\ a$
Volume of one particle	$\dfrac{\pi a^3}{6} = 0.5237\ a^3$	$\dfrac{\sqrt{3}\pi a^3}{16} = 0.34\ a^3$	$\dfrac{\pi a^3}{12\sqrt{2}} = 0.185\ a^3$
Total volume occupied by particles in unit cell	$\dfrac{\pi a^3}{6} = 0.5237\ a^3$	$\dfrac{\sqrt{3}\pi a^3}{8} = 0.68\ a^3$	$\dfrac{\pi a^3}{3\sqrt{2}} = 0.74\ a^3$
Coordination number of atoms	6 : four in the same layer, one directly above and one directly below	8 : four in the layer below and one in the layer above	12 : six in its own layer, three above and three below
Packing efficiency	**52.4 %**	**68 %**	**74 %**

➢ **Crystal defects:**

```
                        Crystal defects
              ┌──────────────────┴──────────────────┐
         Point defects                          Line defects
    ┌─────────┴─────────────┐              ┌──────────┴──────────┐
Stoichiometric         Impurity defects      Non-stoichiometric defects
  defects           ┌───────┴────────┐        ┌────────┴────────┐
              Substitutional    Interstitial    Metal          Metal
             impurity defect  impurity defect  deficiency     excess
                                               defect         defect

Interstitial defect   Vacancy defect   Schottky defect   Frenkel defect
```

➢ **Classification of solids based on electrical properties:**

```
                            Solids
        ┌────────────────────┼────────────────────┐
Metallic conductors       Insulators           Semiconductors
```

Metallic conductors
e.g. Cu, Al
- Conductivity: 10^4 to 10^7 $Ohm^{-1}\ m^{-1}$
- Band gap = No

p-band
s-band
s-band   Overlapping bands

Insulators
e.g. Diamond
- Conductivity: 10^{-20} to 10^{-10} $Ohm^{-1}m^{-1}$
- Band gap = Large

Empty conduction band
← Forbidden zone (Large energy gap)
Filled valence band

Semiconductors
e.g. Si, Ge
- Conductivity: 10^{-6} to 10^4 $Ohm^{-1}\ m^{-1}$
- Band gap = small

Empty conduction band
← Small energy gap
Filled valence band

➢ **Types of semiconductors:**

n-type semiconductors	p-type semiconductors
It is an extrinsic semiconductor, which is obtained by adding group 15 element to an intrinsic semiconductor which belongs to group 14.	It is an extrinsic semiconductor, which is obtained by adding group 13 element to an intrinsic semiconductor which belongs to group 14.
e.g. Silicon doped with phosphorus	**e.g.** Silicon doped with boron
Bands:	**Bands:**

➢ **Classification of solids based on response to magnetic field:**

Substance	Characteristics	Examples
Diamagnetic materials	• Repelled weakly in magnetic field. • All electrons are paired.	N_2, F_2, NaCl, H_2O, benzene, etc.
Paramagnetic materials	• Weakly attracted in magnetic field. • Unpaired electrons are present. • Permanent magnetisation is not possible.	Oxygen, Cu^{2+}, Fe^{3+}, Cr^{3+}, etc.
Ferromagnetic materials	• Strongly attracted in magnetic field. • Unpaired electrons are present. • Permanent magnetisation is possible.	Fe, Co, Ni, Gd, CrO_2, etc.

Formulae

1. **Density (ρ)** = $\dfrac{M\,n}{a^3\,N_A}$

Where M = molar mass of substance (g/mol),
n = number of particles in a cubic unit cell,
a = edge length (cm),
N_A = Avogadro number $(6.022 \times 10^{23}\ mol^{-1})$

2. **Packing efficiency**

= $\dfrac{\text{Volume occupied by particles in unit cell}}{\text{Total volume of unit cell}} \times 100$

3. **Relationship between radius of atom (r) and edge length (a):**

sc: $r = \dfrac{a}{2} = 0.5000\,a$

bcc: $r = \dfrac{\sqrt{3}}{4}a = 0.4330\,a$

fcc: $r = \dfrac{\sqrt{2}}{4}a = 0.3535\,a$

4. **Relationship between the nearest neighbour distance (D) and edge length (a) of a cubic unit cell:**

sc: D = edge length = a

bcc: $D = \dfrac{1}{2} \times$ body diagonal = $\dfrac{\sqrt{3}}{2}\,a$

fcc: $D = \dfrac{1}{2} \times$ face diagonal = $\dfrac{a}{\sqrt{2}}$

5. **Volume of one particle in unit cell:**
sc: $0.5237\,a^3$
bcc: $0.34\,a^3$
fcc: $0.185\,a^3$

6. **Total volume occupied by particles in unit cell:**
sc: $0.5237\,a^3$
bcc: $0.68\,a^3$
fcc: $0.74\,a^3$

7. **Number of atoms in x g of metal** = $\dfrac{x\,n}{\rho\,a^3}$

8. **Number of unit cells in x g of metal** = $\dfrac{x}{\rho\,a^3}$

9. Number of unit cells in volume (V) of metal

$$= \frac{V}{a^3}$$

10. Conversion factors:

$1\ \text{Å} = 1 \times 10^{-8}\ \text{cm} = 1 \times 10^{-10}\ \text{m} = 100\ \text{pm}$

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

Classwork

1.3 Classification of crystalline solids

1. Which among the following solids is a non-polar solid? **[MHT CET 2016]**
   (A) Hydrogen chloride
   (B) Sulphur dioxide
   (C) Water
   (D) Carbon dioxide

2. Match the following.

	List - I		List - II
i.	Polar molecular solids	a.	Positive ions in a sea of delocalized electrons
ii.	Ionic solids	b.	Covalent bonding
iii.	Metallic solids	c.	London forces
iv.	Network solids	d.	Dipole-dipole interaction
		e.	Coulombic or electrostatic interaction

   (A) i – d, ii – e, iii – a, iv – b
   (B) i – c, ii – e, iii – a, iv – b
   (C) i – c, ii – a, iii – e, iv – d
   (D) i – e, ii – d, iii – c, iv – a

1.5 Cubic system

3. The contribution of particle at the edge centre to a particular unit cell is _____.
   (A) 1/2   (B) 1/4
   (C) 1   (D) 1/8

4. How many total spheres of constituent particles are present in bcc type of unit cell?
   [MHT CET 2019]
   (A) 2   (B) 1
   (C) 4   (D) 3

5. What is the difference between the number of atoms per unit cell in face-centred cube and the number of atoms per unit cell in body-centred cube?
   (A) 2   (B) 1
   (C) 4   (D) 6

6. Suppose the mass of a single Ag atom is 'm'. Ag metal crystallizes in fcc lattice with unit cell of length 'a'. The density of Ag metal in terms of 'a' and 'm' is _____.

   (A) $\dfrac{4m}{a^3}$ (B) $\dfrac{2m}{a^3}$

   (C) $\dfrac{m}{a^3}$ (D) $\dfrac{m}{4a^3}$

7. At T (K), copper (atomic mass = 63.5 u) has fcc unit cell structure with edge length of x Å. What is the approximate density of Cu in g cm^{-3} at that temperature? ($N_A = 6.0 \times 10^{23}\ \text{mol}^{-1}$)

   (A) $\dfrac{42.3}{x^3}$ (B) $\dfrac{4.23}{x^3}$

   (C) $\dfrac{423}{x^3}$ (D) $\dfrac{212}{x^3}$

8. Lithium has a bcc structure. Its density is 530 kg m^{-3} and its atomic mass is 6.94 g mol^{-1}. Calculate the edge length of a unit cell of lithium metal. ($N_0 = 6.02 \times 10^{23}\ \text{mol}^{-1}$)
   (A) 527 pm   (B) 264 pm
   (C) 154 pm   (D) 352 pm

9. A metal has a fcc lattice. The edge length of the unit cell is 404 pm. The density of the metal is 2.72 g cm^{-3}. The molar mass of the metal is _____.
   (N_0, Avogadro's constant = $6.02 \times 10^{23}\ \text{mol}^{-1}$)
   (A) 40 g mol^{-1} (B) 30 g mol^{-1}
   (C) 27 g mol^{-1} (D) 20 g mol^{-1}

10. Iron exhibits bcc structure at room temperature. Above 900 °C, it transforms to fcc structure. The ratio of density of iron at room temperature to that at 900 °C (assuming molar mass and atomic radii of iron remains constant with temperature?

    (A) $\dfrac{\sqrt{3}}{\sqrt{2}}$ (B) $\dfrac{4\sqrt{3}}{3\sqrt{2}}$

    (C) $\dfrac{3\sqrt{3}}{4\sqrt{2}}$ (D) $\dfrac{1}{2}$

1.6 Packing of particles in crystal lattice

11. Which metal crystallizes in a simple cubic structure? **[MHT CET 2016]**
    (A) Polonium   (B) Copper
    (C) Nickel   (D) Iron

12. Which among the following metal crystallise as a simple cube? **[MHT CET 2018]**
    (A) Polonium   (B) Iron
    (C) Copper   (D) Gold

1.7 Packing efficiency

13. The vacant space in bcc lattice unit cell is _____.
    (A) 23% (B) 32%
    (C) 26% (D) 48%

14. What is the packing efficiency of arrangement in a body-centred unit cell?
    (A) 64.00% (B) 68.00%
    (C) 74.00% (D) 53.26%

15. In face-centred cubic unit cell, what is the volume occupied? **[MHT CET 2016]**
    (A) $\frac{4}{3}\pi r^3$ (B) $\frac{8}{3}\pi r^3$
    (C) $\frac{16}{3}\pi r^3$ (D) $\frac{64r^3}{3\sqrt{3}}$

16. Sodium metal crystallizes in a body-centred cubic lattice with a unit cell edge of 4.29 Å. The radius of sodium atom is approximately _____.
    (A) 1.86 Å (B) 3.22 Å
    (C) 5.72 Å (D) 0.93 Å

17. If the edge of a body centred unit cell is 400 pm, what will be the approximate radius of the atom present in it? (in pm)
    (A) 200 (B) 141
    (C) 173 (D) 924

18. A given metal crystallizes out with a cubic structure having edge length of 361 pm. If there are four metal atoms in one unit cell, what is the radius of one atom?
    (A) 40 pm (B) 127 pm
    (C) 80 pm (D) 108 pm

19. AB crystallizes in a body-centred cubic lattice with edge length 'a' equal to 387 pm. The distance between two oppositely charged ions in the lattice is _____.
    (A) 335 pm (B) 250 pm
    (C) 200 pm (D) 300 pm

20. A metal crystallizes in a face-centred cubic structure. If the edge length of its unit cell is 'a', the closest approach between two atoms in metallic crystal will be _____.
    (A) 2a (B) $2\sqrt{2}$ a
    (C) $\sqrt{2}$ a (D) $\frac{a}{\sqrt{2}}$

21. The number of atoms in 2.4 g of body-centred cubic crystal with edge length 200 pm is _____. (density = 10 g cm^{-3}, $N_A = 6 \times 10^{23}$ atoms/mol)
    (A) 6×10^{23} (B) 6×10^{19}
    (C) 6×10^{22} (D) 6×10^{20}

22. An element has body-centred cubic structure with a cell edge length of 300 pm. If the density of the element is 7.2 g cm^{-3}, the number of unit cells in 194.4 g of the element is _____.
    (A) 2.0×10^{24} (B) 6.0×10^{24}
    (C) 3.0×10^{24} (D) 1.0×10^{24}

23. In a face centred cubic lattice, atom A occupies the corner positions and atom B occupies the face centre positions. If one atom of B is missing from one of the face centred points, the formula of the compound is:
    (A) A_2B_3 (B) A_2B_5
    (C) A_2B (D) AB_2

24. The atoms of element 'Y' form hexagonal close packing and the atoms of element X occupies $\frac{2}{3}$ rd portion of the number of tetrahedral voids. Write the formula of the compound formed by X and Y.
    (A) X_2Y_2 (B) X_2Y
    (C) X_3Y_4 (D) X_4Y_3

25. A compound is formed by elements 'X' (cations) and 'Y' (anions). Ions of 'Y' form cubic close packing (ccp) and ions of 'X' occupy all the octahedral voids. What is the molecular formula of the compound?
    (A) XY_2 (B) XY
    (C) X_2Y_3 (D) X_2Y

26. Element 'B' forms ccp structure and 'A' occupies half of the octahedral voids, while oxygen atoms occupy all the tetrahedral voids. The structure of bimetallic oxide is _____.
    (A) AB_2O_4 (B) A_4B_2O
    (C) A_2B_2O (D) A_2BO_4

27. A compound is formed by cation C and anion A. The anions form hexagonal close packed (hcp) lattice and the cations occupy 75% of octahedral voids. The formula of the compound is _____.
    (A) C_3A_2 (B) C_3A_4
    (C) C_4A_3 (D) C_2A_3

28. A crystalline solid XY_3 has ccp arrangement for its element Y. X occupies _____.
    (A) 66% of tetrahedral voids
    (B) 33% of tetrahedral voids
    (C) 66% of octahedral voids
    (D) 33% of octahedral voids

1.8 Crystal defects or imperfections

29. Which type of 'defect' has the presence of cations in the interstitial sites?
    (A) Schottky defect
    (B) Vacancy defect
    (C) Frenkel defect
    (D) Metal deficiency defect

30. Which one of the following compounds show both Schottky and Frenkel defects?
    (A) KCl   (B) AgI
    (C) AgBr   (D) AgCl

31. 1 mole of NaCl is doped with 10^{-5} mole of $SrCl_2$. The number of cationic vacancies in the crystal lattice will be _____.
    (A) 6.022×10^{23}
    (B) 12.044×10^{20}
    (C) 6.022×10^{18}
    (D) 6.022×10^{15}

32. Formula of nickel oxide with metal deficiency defect in its crystal is $Ni_{0.98}O$. The crystal contains Ni^{2+} and Ni^{3+} ions. The fraction of nickel existing as Ni^{2+} ions in the crystal is _____.
    (A) 0.31   (B) 0.96
    (C) 0.04   (D) 0.50

1.10 Magnetic properties of solids

33. Which of these species will have non-zero magnetic moment?
    (A) Na^+ (B) Mg
    (C) F^- (D) Ar^+

34. Select a ferromagnetic material from the following.
    (A) Dioxygen
    (B) Chromium(IV) oxide
    (C) Benzene
    (D) Dihydrogen monoxide

Miscellaneous

35. Volume occupied by single CsCl ion pair in a crystal is 7.014×10^{-23} cm^3. The smallest Cs – Cs internuclear distance is equal to length of the side of the cube corresponding to volume of one CsCl ion pair. The smallest Cs to Cs internuclear distance is nearly _____.
    (A) 4.4 Å   (B) 4.3 Å
    (C) 4 Å   (D) 4.5 Å

Homework

1.2 Types of solids

1. Which of the following statements is TRUE?
   (A) Both crystalline and amorphous solids are isotropic.
   (B) Both crystalline and amorphous solids are anisotropic.
   (C) Crystalline solids except those having cubic structure are isotropic and amorphous solids are anisotropic.
   (D) Crystalline solids except those having cubic structure are anisotropic and amorphous solids are isotropic.

2. Which among the following will show anisotropy?
   (A) Glass   (B) Barium chloride
   (C) Wood   (D) Tar

3. Statement 1: $NaNO_3$ and $CaCO_3$ are isomorphous pairs.
   Statement 2: They have the same atomic ratios of the constituent atoms.
   Statement 3: They have different crystal structures.
   Select the appropriate option.
   (A) All the statements are correct.
   (B) All the statements are incorrect.
   (C) Only statement 3 is incorrect.
   (D) Only statement 2 is incorrect.

1.3 Classification of crystalline solids

4. LiF is a/an _____ crystal.
   (A) ionic   (B) metallic
   (C) covalent   (D) molecular

5. Carborandum and benzoic acid are examples of _____ crystals respectively.
   (A) molecular, metallic
   (B) ionic, covalent network
   (C) covalent network, molecular
   (D) metallic, ionic

6. The interparticle forces in solid hydrogen are _____.
   (A) dipole-dipole interactions
   (B) covalent bonds
   (C) coordinate bonds
   (D) London forces

7. At low temperature and high pressure, SO_2 freezes to form crystalline solid. Which term best describes the solid?
   (A) Ionic crystal   (B) Covalent crystal
   (C) Metallic crystal (D) Molecular crystal

8. In graphite, carbon atoms in the hexagonal rings are joined together due to _____.
   (A) ionic bonding
   (B) coordinate bonding
   (C) metallic bonding
   (D) covalent bonding

9. Match the following:

	Crystalline solids		Types
i.	CaF$_2$	a.	Molecular solids
ii.	CH$_4$	b.	Ionic solid
iii.	Lithium	c.	Covalent network solid
iv.	Diamond	d.	Metallic solid

   (A) i – b, ii – a, iii – c, iv – d
   (B) i – b, ii – a, iii – d, iv – c
   (C) i – c, ii – a, iii – d, iv – b
   (D) i – a, ii – b, iii – d, iv – c

10. Among the following, which crystal will be soft and has low melting point?
    (A) Covalent (B) Ionic
    (C) Metallic (D) Molecular

11. A crystalline solid is hard, brittle and electrically nonconductor. But its melt conducts electricity. What type of solid is it?
    (A) Covalent (B) Ionic
    (C) Metallic (D) Molecular

12. Select the INCORRECT statement.
    (A) Ionic solids become good conductors only at low temperature, below their melting points.
    (B) The conductivity of covalent solids is in general low and increases with temperature.
    (C) In covalent solids, there is no abrupt rise in conductivity when substance is melted.
    (D) Both ionic and covalent solids are hard and have high melting and boiling points.

1.4 Crystal structure

13. There are _____ kinds of unit cells in rhombohedral and orthorhombic crystal systems respectively.
    (A) 2, 4 (B) 1, 1 (C) 1, 2 (D) 1, 4

14. Which of the following is INCORRECT?
    (A) A bcc unit cell has eight corner particles and an additional particle at the centre of the cube.
    (B) A fcc unit cell has total four particles per unit cell.
    (C) The particle at the centre of a unit cell is not shared by any other unit cells.
    (D) A fcc unit cell has particles at the eight corners plus particles at the centre of any two faces.

1.5 Cubic system

15. In a face-centred cubic cell, an atom at the face contributes is _____ to the unit cell.
    (A) 1/4 part (B) 1/8 part
    (C) 1/6 part (D) 1/2 part

16. Na and Mg crystallize in bcc and fcc type crystals respectively, then the number of atoms of Na and Mg present in the unit cell of their respective crystal is _____.
    (A) 4 and 2 (B) 9 and 14
    (C) 14 and 9 (D) 2 and 4

17. A sample of an element occurring in the bcc structure has 12.08×10^{23} unit cells. The total number of atoms of the element in these sample will be _____.
    (A) 24.16×10^{23} (B) 36.18×10^{23}
    (C) 6.04×10^{23} (D) 12.08×10^{23}

18. An element (atomic mass 100 g/mol) having bcc structure has unit cell edge 400 pm. The density of the element is _____.
    [$N_A = 6.0 \times 10^{23}$ atom mol^{-1}]
    (A) 10.3 g / cm^3 (B) 5.2 g / cm^3
    (C) 7.3 g / cm^3 (D) 2.1 g / cm^3

19. Iridium (atomic mass 192.2 g/mol) having fcc structure has density of 22.4 g/cm^3. The volume of a single unit cell is _____.
    (A) 2.7×10^{-23} cm^3 (B) 3.7×10^{-23} cm^3
    (C) 4.7×10^{-23} cm^3 (D) 5.7×10^{-23} cm^3

1.6 Packing of particles in crystal lattice

20. In which of the following, the spheres of the upper layers are exactly above the spheres of the lower layers?
    (A) Two dimensional ABAB type arrangement
    (B) Three dimensional ABAB type arrangement
    (C) Three dimensional AAAA type arrangement
    (D) Three dimensional ABCABC type arrangement

21. The three dimensional ABCABC type arrangement is the same as _____.
    (A) bcc structure
    (B) simple cubic structure
    (C) planar square close packed structure
    (D) face-centred cubic structure

22. Select the CORRECT option.
    (A) Two dimensional hexagonal close packed layer has octahedral voids which is formed by three spheres.
   (B) Square close packing in two dimensions is represented as AAAA type.

(C) Square close packing in two dimensions is more efficient as compared to hexagonal close packing in two dimensions.
(D) In three dimensional hexagonal close packed structure, the spheres of the third layer do not align with the spheres of the first layer.

23. The number of octahedral sites per sphere in a fcc structure is _____.
(A) 8   (B) 4
(C) 2   (D) 1

24. A metal sample has 5×10^4 fcc unit cells. The total number of tetrahedral voids present are _____.
(A) 4×10^4 (B) 4×10^5
(C) 8×10^5 (D) 2×10^6

1.7 Packing efficiency

25. The CORRECT statement is:
(A) Out of the three cubic lattices, body-centred cubic lattice makes the most efficient use of space.
(B) Out of the three cubic lattices, face-centred cubic lattice has the least efficient packing.
(C) Both hcp and ccp lattice have coordination number equal to 8.
(D) Both hcp and ccp lattice have same packing efficiency.

26. In face-centred cubic unit cell, the edge length is _____.
(A) $\dfrac{4}{\sqrt{3}}r$ (B) $\dfrac{4}{\sqrt{2}}r$
(C) $2r$ (D) $\dfrac{\sqrt{3}}{2}r$

27. If 'a' stands for the edge length of the cubic systems: simple cubic, body-centred cubic and face-centred cubic, then the ratio of radii of the spheres in these systems will be _____ respectively.
(A) $\dfrac{1}{2}a : \dfrac{\sqrt{3}}{2}a : \dfrac{\sqrt{3}}{\sqrt{2}}a$
(B) $1a : \sqrt{3}\,a : \sqrt{2}\,a$
(C) $\dfrac{1}{2}a : \dfrac{\sqrt{3}}{4}a : \dfrac{\sqrt{2}}{4}a$
(D) $\dfrac{1}{2}a : \sqrt{3}\,a : \dfrac{1}{\sqrt{2}}a$

28. Potassium crystallizes in a bcc lattice, hence the coordination number of potassium in potassium metal is _____.
(A) 0   (B) 4
(C) 6   (D) 8

29. The number of close neighbour in a face-centred cubic lattice of identical spheres is _____.
(A) 8   (B) 6
(C) 4   (D) 12

30. The edge of unit cell of fcc Xe crystal is 620 pm. The radius of Xe atom is _____.
(A) 219.2 pm   (B) 235.1 pm
(C) 189.3 pm   (D) 209.8 pm

31. An element with atomic radius of 0.14 nm crystallizes in fcc unit cell. The length of the side of the unit cell is approximately _____.
(A) 0.9 nm   (B) 0.4 nm
(C) 0.2 nm   (D) 0.6 nm

32. The number of atoms in 100 g of a fcc crystal with density $d = 10$ g / cm^3 and cell edge equal to 100 pm, is equal to _____.
(A) 4×10^{25} (B) 3×10^{25}
(C) 2×10^{25} (D) 1×10^{25}

33. A metallic element crystallizes in simple cubic lattice. Each edge length of the unit cell is 3 Å. The density of the element is 8 g cm^{-3}. Number of unit cells in 108 g of the metal is _____. (Molar mass of the metal = 108 g/mol.)
(A) 1.33×10^{20} (B) 2.7×10^{22}
(C) 5×10^{23} (D) 2×10^{24}

34. Aluminium crystallizes in cubic close packed structure with unit cell edge length of 353.6 pm. How many unit cells are there in 1.00 cm^3 of Al?
(A) 2.26×10^{22} (B) 4.42×10^{22}
(C) 5.36×10^{22} (D) 7.07×10^{22}

35. An alloy of Cu, Ag and Au is found to have copper constituting the ccp lattice. If silver atoms occupy the edge centre and gold is present at body centre, the alloy has a formula _____.
(A) Cu_4Ag_2Au (B) Cu_4Ag_4Au
(C) Cu_4Ag_3Au (D) $CuAgAu$

36. A compound alloy of gold and copper crystallizes in a cubic lattice in which the gold atoms occupy the lattice points at the corners of cube and copper atoms occupy the centres of each of the cube faces. The formula of this compound is _____.
(A) $AuCu$ (B) $AuCu_2$
(C) $AuCu_3$ (D) Au_2Cu

37. In Corundum, oxide ions are arranged in hcp arrangement and aluminium ions occupy two third of the octahedral holes. Its formula is _____.
(A) Al_2O_3 (B) Al_2O_4
(C) Al_2O_2 (D) AlO_2

38. In a solid, oxide ions are arranged in ccp. Cations A occupy one-sixth of the tetrahedral voids and cations B occupy one-third of the octahedral voids. The formula of the compound is _____.
    (A) ABO_3 (B) AB_2O_3
    (C) A_2BO_3 (D) $A_2B_2O_3$

1.8 Crystal defects or imperfections

39. Which of the following is INCORRECT about Schottky defect?
    (A) Electrical neutrality is not maintained.
    (B) Density decreases due to this defect.
    (C) Some other ions are missing from normal lattice sites.
    (D) It is a type of stoichiometric defects.

40. Frenkel defect is caused due to _____.
    (A) an ion missing from the normal lattice site creating a vacancy
    (B) an extra positive ion occupying an interstitial position in the lattice
    (C) an extra negative ion occupying an interstitial position in the lattice
    (D) the shift of a positive ion from its normal lattice site to an interstitial site

41. Identify the INCORRECT statement.
    (A) Metal deficiency defect is possible only in compounds of metals that show variable oxidation states.
    (B) Metal excess defect due to anion vacancy imparts colour to the colourless crystal.
    (C) Nonstoichiometric defect causes change in the crystal structure.
    (D) $Zn_{1+x}O_{1.0}$ is an example of metal excess defect.

42. Following diagram represents _____.
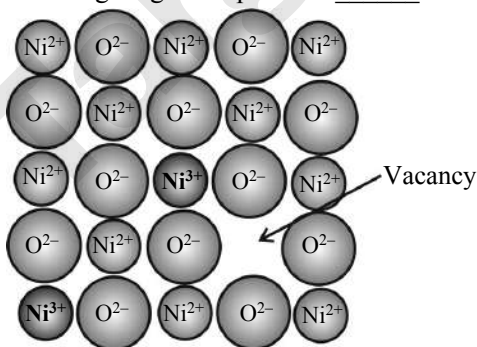
    (A) formation of self-interstitial defect
    (B) formation of vacancy through aliovalent impurity
    (C) substitutional impurity defect
    (D) metal deficiency defect

1.9 Electrical properties of solids

43. Which of the following statements is CORRECT?
    (A) In metals, the band gap is very small and in insulators, the band gap is very large.
    (B) Band gap is very large in metals and insulators.
    (C) Band gap is very small in metals and insulators.
    (D) In metals, the band gap is very large and in insulators, the band gap is very small.

44. Silicon is a _____ as it conducts electricity better than _____ but not as efficient as _____.
    (A) conductor, metals, nonmetals
    (B) semiconductor, nonmetals, metals
    (C) semiconductor, metals, non-metals
    (D) conductor, nonmetals, metals

45. In metallic magnesium, the 3s band is _____ band while the 3p band is _____.
    (A) vacant, partially filled
    (B) partially filled, vacant
    (C) completely filled, partially filled
    (D) completely filled, vacant

46. When suitable impurity is added to pure intrinsic semiconductor, the electrical conductivity _____.
    (A) is enhanced
    (B) remains same
    (C) decreases to a large extent
    (D) decreases slightly

47. To get a n-type semiconductor, the impurity to be added to silicon should have which of the following number of valence electrons?
    (A) 1   (B) 2
    (C) 3   (D) 5

48. Silicon doped with arsenic is an example of _____.
    (A) p - type semiconductor
    (B) n - type semiconductor
    (C) insulator
    (D) intrinsic semiconductor

49. Doping of silicon with boron leads to _____.
    (A) n-type semiconductor
    (B) p-type semiconductor
    (C) metal
    (D) insulator

50. Identify p-type semiconductor.
    (A) Si doped with As   (B) Ge doped with As
    (C) Si doped with P   (D) Ge doped with In

1.10   Magnetic properties of solids

51.   Which of the following statements is CORRECT?
(A)   Paramagnetic substances are attracted by the magnetic field.
(B)   Paramagnetic substances are strongly repelled by the magnetic field.
(C)   Diamagnetic substances are neither attracted nor repelled by the magnetic field.
(D)   Diamagnetic substances are strongly attracted by the magnetic field.

52.   Which of the following is NOT ferromagnetic in nature?
(A)   Ni   (B)   Co   (C) CrO_2 (D) O_2

Miscellaneous

53.   The following statements are CORRECT, EXCEPT:
(A)   Diamond (the hardest known substance) is an example of naturally formed single crystal.
(B)   Calcite and aragonite are two polymorphic forms of silica.
(C)   Single granule of a polycrystalline solid is made of many single crystals or crystallites packed together with different orientations.
(D)   In molecular solids, the constituent particles are monoatomic or polyatomic molecules.

54.   Identify the INCORRECT statement.
(A)   The larger the coordination number, the closer are the spheres to each other.
(B)   The coordination number of any sphere in hcp structure is 12.
(C)   Crystal defects can be minimized by carrying out crystallization at a slower rate.
(D)   Paramagnetic substances can be permanently magnetised.

Previous Years' Questions

1.   Lithium crystallises into body centered cubic structure. What is the radius of lithium if edge length of it's unit cell is 351 pm?
[MHT CET 2020]
(A)   75.50 pm   (B)   151.98 pm
(C)   240.80 pm   (D)   300.50 pm

2.   The edge length of fcc type unit cell of copper having atomic radius 127.6 pm is equal to _____.   **[MHT CET 2020]**
(A)   361 pm   (B)   295 pm
(C)   331 pm   (D)   378 pm

3.   What is the number of atoms present per unit cell of aluminium having edge length 4 Å?
(If density of Al = 2.7 g cm^{-3}, At. Mass of Al = 27)   **[MHT CET 2020]**
(A)   2   (B)   1   (C)   4   (D)   8

4.   What is the contribution of each particle at corner in unit cell of cubic system?
[MHT CET 2021]
(A) $\frac{1}{2}$ (B) $\frac{1}{8}$ (C) $\frac{1}{4}$ (D) $\frac{1}{6}$

5.   If 'a' is edge length of a simple cubic unit cell then atomic radius is given as _____.
[MHT CET 2021]
(A)   0.1 a   (B)   0.5 a   (C)   a   (D)   1.5 a

6.   What is the value of density of an element having bcc structure with edge length 5 A° ?
(Atomic mass = 70 g mol^{-1})   **[MHT CET 2021]**
(A)   4.35 g cm^{-3} (B)   3.72 g cm^{-3}
(C)   5.35 g cm^{-3} (D)   1.86 g cm^{-3}

7.   Calculate the number of atoms in 20 grams metal which crystallises to simple cubic structure having unit cell edge length 340 pm. (density of metal = 9.8 g cm^{-3})
[MHT CET 2022]
(A) 4.95×10^{22} (B) 5.81×10^{22}
(C) 5.19×10^{22} (D) 5.42×10^{22}

8.   What is the co-ordination number of hcp crystal lattice?   **[MHT CET 2022]**
(A)   8   (B)   12   (C)   6   (D)   4

9.   Calculate the molar mass of metal having density 22.4 g cm^{-3}, crystallizes to form unit cell containing 4 particles. ($a^3 = 5.6 \times 10^{-23} cm^3$)
[MHT CET 2022]
(A)   280.2 g mol^{-1} (B)   210.6 g mol^{-1}
(C)   140 g mol^{-1} (D)   188.8 g mol^{-1}

10.   What are the number of octahedral and tetrahedral voids in 0.3 mole substance respectively if it forms hcp structure?
[MHT CET 2023]
(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}

11.   Calculate the molar mass of an element having density 7.8 g cm^{-3} that forms bcc unit cell.
[$a^3.N_A = 16.2 cm^3 mol^{-1}$]   **[MHT CET 2023]**
(A)   63.18 g mol^{-1} (B)   61.23 g mol^{-1}
(C)   59.31 g mol^{-1} (D)   65.61 g mol^{-1}

12. 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]
(A) A   (B) B   (C) C   (D) D

13. Calculate the edge length of bcc unit cell if radius of metal atom is 227 pm.   **[MHT CET 2023]**
(A) 4.54×10^{-8} cm   (B) 5.24×10^{-8} cm
(C) 6.42×10^{-8} cm   (D) 1.135×10^{-8} cm

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

[MHT CET 2023]
(A) Si doped with B   (B) Si doped with P
(C) Si doped with Ga   (D) Si doped with In

15. Calculate the density of metal having molar mass 210 g mol^{-1} that forms simple cubic unit cell. ($a^3 . N_A = 21.5$ cm^3 mol^{-1})   **[MHT CET 2023]**
(A) 9.77 g cm^{-3} (B) 7.15 g cm^{-3}
(C) 8.12 g cm^{-3} (D) 6.94 g cm^{-3}

16. What type of defect is found in brass?

[MHT CET 2024]
(A) Substitutional impurity defect
(B) Vacancy defect

(C) Frenkel defect
(D) Schottky defect

17. Calculate the radius of an atom of metal in fcc unit cell having edge length 500 pm.

[MHT CET 2024]
(A) 250.12 pm   (B) 216.56 pm
(C) 176.75 pm   (D) 275.04 pm

18. Calculate the number of particles per unit cell of an element having molar mass 197 g mol^{-1} and density 19.7 g cm^{-3} forming cubic unit cell.

$\left[a^3 \times N_A = 40 \text{ cm}^3 \text{ mol}^{-1} \right]$ **[MHT CET 2024]**

(A) 1   (B) 2   (C) 4   (D) 6

19. Identify ferromagnetic substance from following.   **[MHT CET 2024]**
(A) NaCl   (B) C_6H_6
(C) CrO_2 (D) H_2O

20. Calculate molar mass of an element having density 8.6 g cm^{-3} if it forms bcc structure $[a^3 \times N_A = 22.0$ cm^3 mol$^{-1}]$ **[MHT CET 2024]**
(A) 106.18 g mol^{-1} (B) 94.6 g mol^{-1}
(C) 88.25 g mol^{-1} (D) 80.16 g mol^{-1}

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

[MHT CET 2024]
(A) 229.5 pm   (B) 187.4 pm
(C) 459.0 pm   (D) 265.2 pm

Answer Key

Classwork

1. (D) 2. (A) 3. (B) 4. (A) 5. (A) 6. (A) 7. (C) 8. (D) 9. (C) 10. (C)
11. (A) 12. (A) 13. (B) 14. (B) 15. (C) 16. (A) 17. (C) 18. (B) 19. (A) 20. (D)
21. (C) 22. (D) 23. (B) 24. (D) 25. (B) 26. (A) 27. (B) 28. (D) 29. (C) 30. (C)
31. (C) 32. (B) 33. (D) 34. (B) 35. (C)

Homework

1. (D) 2. (B) 3. (C) 4. (A) 5. (C) 6. (D) 7. (D) 8. (D) 9. (B) 10. (D)
11. (B) 12. (A) 13. (D) 14. (D) 15. (D) 16. (D) 17. (A) 18. (B) 19. (D) 20. (C)
21. (D) 22. (B) 23. (D) 24. (B) 25. (D) 26. (B) 27. (C) 28. (D) 29. (D) 30. (A)
31. (B) 32. (A) 33. (C) 34. (A) 35. (C) 36. (C) 37. (A) 38. (A) 39. (A) 40. (D)
41. (C) 42. (D) 43. (A) 44. (B) 45. (D) 46. (A) 47. (D) 48. (B) 49. (B) 50. (D)
51. (A) 52. (D) 53. (B) 54. (D)

Previous Years' Questions

1. (B) 2. (A) 3. (C) 4. (B) 5. (B) 6. (D) 7. (C) 8. (B) 9. (D) 10. (A)
11. (A) 12. (B) 13. (B) 14. (B) 15. (A) 16. (A) 17. (C) 18. (C) 19. (C) 20. (B)
21. (A)

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