The Solid State Class 12 Formula Sheet

CBSE Class 12 Chemistry · NCERT · for boards, NEET and JEE revision

ChapterNotes

Crystalline vs Amorphous

Crystalline → long-range order, sharp m.p., anisotropic

Amorphous (glass, rubber) = short-range order, isotropic, called pseudo-solids / supercooled liquids.

- Crystalline: definite shape, sharp melting point, true solids
- Amorphous: melt over a range, no overall pattern, isotropic
- Anisotropy + sharp m.p. are the signatures of a crystal

The Four Crystalline Solids

Molecular · Ionic · Metallic · Covalent (network)

Exception: graphite is covalent but soft and a good conductor (layered, delocalised electrons).

- Molecular: van der Waals / H-bonds → soft, low m.p., insulators
- Ionic: electrostatic → hard, brittle, conduct only molten/aqueous
- Metallic: electron sea → malleable conductors; Covalent: very hard, very high m.p.

Lattice, Unit Cell & Crystal Systems

7 crystal systems · 14 Bravais lattices

Cell defined by edges a, b, c and angles α, β, γ. Cubic = most symmetric, triclinic = least.

- Cubic: a = b = c, α = β = γ = 90° (P, BCC, FCC → 3 lattices)
- Hexagonal: a = b ≠ c, α = β = 90°, γ = 120°
- Centring types: Primitive (P), Body (I), Face (F), End (C)

Atoms per Unit Cell (Z)

corner = ⅛ · edge = ¼ · face = ½ · body = 1

Z: simple cubic = 1, BCC = 2, FCC = 4, HCP = 6.

- Simple cubic: 8 × ⅛ = 1
- BCC: 8 × ⅛ + 1 = 2
- FCC: 8 × ⅛ + 6 × ½ = 4

Packing Efficiency & Coordination

SC 52.4% (CN 6) · BCC 68% (CN 8) · FCC/HCP 74% (CN 12)

FCC and HCP are the densest possible sphere packings.

- Edge–radius: SC a = 2r, BCC √3·a = 4r, FCC √2·a = 4r
- CN = number of nearest neighbours touching an atom
- √2 → FCC (face diagonal), √3 → BCC (body diagonal)

Density of a Unit Cell

$\rho = (Z \cdot M) / (a^3 \cdot N_A)$

a must be in cm (1 pm = 10^{-10} cm, 1 Å = 10^{-8} cm); ρ comes out in g cm^{-3}.

- Z = atoms per cell, M = molar mass (g mol^{-1}), N_A = 6.022 × 10^{23}
- Rearrange: Z = (ρ · a^3 · N_A) / M to find the cell type
- Cube the whole edge length, including its power of ten

Voids & Radius Ratio

tetrahedral voids = 2N · octahedral voids = N

Radius ratio r_+/r_- decides the void: 0.225-0.414 tetrahedral (CN 4), 0.414-0.732 octahedral (CN 6), 0.732-1.0 cubic (CN 8).

- For N close-packed atoms: N octahedral, 2N tetrahedral voids
- Tetrahedral void → CN 4; octahedral void → CN 6
- Always compute the ratio as cation over anion (r_+/r_-)

Key Ionic Structures

NaCl 6:6 · ZnS 4:4 · CaF_2 8:4

Antifluorite (Na_2O) is the reverse of fluorite → CN 4:8.

- Rock salt NaCl: Cl^- FCC, Na^+ in ALL octahedral voids, Z = 4
- Zinc blende ZnS: S^{2-} FCC, Zn^{2+} in HALF the tetrahedral voids
- Fluorite CaF_2: Ca^{2+} FCC, F^- in ALL tetrahedral voids

Point Defects

Schottky → density ↓ · Frenkel → density unchanged

Schottky: NaCl, KCl, CsCl (similar sizes). Frenkel: ZnS, AgCl, AgBr (large size difference). F-centre → colour.

- Schottky: a cation + anion pair both missing → density falls
- Frenkel: a small cation shifts to an interstitial site → density same
- Metal-excess F-centre: anion vacancy holds an electron → NaCl turns yellow

Semiconductors & Magnetism

n-type → group 15 doping · p-type → group 13 doping

Conductivity of a semiconductor rises with temperature (unlike metals).

- n-type: P/As add extra electrons; p-type: B/Al create holes
- Paramagnetic = unpaired e^- (O_2, Cu^{2+}); Diamagnetic = all paired
- Ferro (Fe, Co, Ni) · Ferrimagnetic Fe_3O_4 · Antiferromagnetic MnO

Quick revision

- Crystalline = long-range order, sharp m.p., anisotropic; amorphous = short-range order, isotropic, pseudo solid.
- Four crystalline types: ionic, molecular, covalent/network, metallic. Graphite is the soft, conducting covalent exception.
- 7 crystal systems give 14 Bravais lattices; cubic has 3 (P, I, F).
- Atoms per cell: SCC = 1, BCC = 2, FCC = 4. Contributions: corner 1/8, face 1/2, edge 1/4, body 1.
- Packing efficiency: SCC 52.4%, BCC 68%, FCC & HCP 74%. Coordination: 6, 8, 12, 12.
- Edge-radius: SCC a = 2r; BCC √3 a = 4r; FCC √2 a = 4r.
- Density d = ZM/(a^3N_0) - the top scoring numerical.
- N spheres → 2N tetrahedral + N octahedral voids. Radius ratio decides the void: 0.225 (tetra), 0.414 (octa), 0.732 (cubic).
- NaCl 6:6 (Z=4), CsCl 8:8 (Z=1), ZnS 4:4 (Z=4).
- Schottky lowers density (NaCl); Frenkel keeps density (ZnS, AgCl); F-centre gives colour.
- n-type = group-15 doping (extra electron); p-type = group-13 doping (hole).
- Magnetism: dia (paired), para (random unpaired), ferro (parallel), antiferro (cancel), ferri (unequal opposite, e.g. Fe_3O_4).

Full chapter notes with solved examples and practice questions: https://chapternotes.in/cbse/class-12-chemistry/the-solid-state-class-12-notes/