CLASS 12 CHEMISTRY NCERT SOLUTIONS

NCERT Solutions for Class 12 Chemistry Chapter 1: The Solid State – Free PDF Download

Chapter 1 — The Solid State — covers the classification of solids (amorphous vs crystalline), unit cells, packing efficiency, density calculations, imperfections in solids, and electrical/magnetic properties. Note: this chapter is still Chapter 1 in the printed 2026-27 NCERT Chemistry Part I textbook, but it was...

Contents

Chapter 1 — The Solid State — covers the classification of solids (amorphous vs crystalline), unit cells, packing efficiency, density calculations, imperfections in solids, and electrical/magnetic properties. **Note:** this chapter is still Chapter 1 in the printed 2026-27 NCERT Chemistry Part I textbook, but it was removed from the CBSE board-exam syllabus in the 2023-24 rationalisation (Solutions is now the first board-examinable unit). It remains highly relevant for JEE/NEET aspirants and other boards that still use the full NCERT book. Below are complete, original answers to all 26 end-of-chapter exercise questions. These Class 12 Chemistry Chapter 1 solutions are also useful as quick revision notes before exams.

NCERT Solutions for Class 12 Chemistry Chapter 1: The Solid State

Q1.1. Define the term 'amorphous'. Give a few examples of amorphous solids.
An amorphous solid lacks the long-range, repeating three-dimensional order of a true crystal — its constituent particles show only short-range order (regularity persists across a few particle diameters, then breaks down). Examples: glass, rubber, and plastics.

Q1.2. What makes a glass different from a solid such as quartz? Under what conditions could quartz be converted into glass?
Quartz (crystalline SiO_2) has its SiO_4 tetrahedra linked in a perfectly repeating, long-range pattern; glass has the same tetrahedral building block but joined in a random network with only short-range order — essentially a 'frozen' liquid structure. Melting quartz and then cooling it very rapidly (too fast for the atoms to settle back into an ordered lattice) converts it into glass.

Q1.3. Classify each of the following as amorphous or crystalline: polyurethane, naphthalene, benzoic acid, teflon, potassium nitrate, cellophane, polyvinyl chloride, fibre glass, copper.
Crystalline: naphthalene, benzoic acid, potassium nitrate, copper. **Amorphous:** polyurethane, teflon, cellophane, polyvinyl chloride, fibre glass.

Q1.4. (i) What is meant by the term 'coordination number'? (ii) What is the coordination number of atoms (a) in a cubic close-packed structure, (b) in a body-centred cubic structure?
(i) Coordination number is the number of nearest-neighbour particles directly touching a given particle in a crystal lattice. (ii) (a) In ccp/fcc: **12**. (b) In bcc: **8**.

Q1.5. How can you determine the atomic mass of an unknown metal if you know its density and the dimension of its unit cell?
From the unit-cell mass-density relation, d = ZM/(a^{3}N_A), where a is the edge length, Z the number of atoms per unit cell, d the density, and N_A Avogadro's number. Measuring a (via X-ray diffraction) and d (e.g. via pycnometry), and knowing Z from the lattice type, gives $\mathbf{M = d \cdot a^3 \cdot N\_A / Z}$.

Q1.6. 'Stability of a crystal is reflected in the magnitude of its melting point.' Comment. Collect melting points of solid water, ethyl alcohol, diethyl ether, and methane from a data book. What can you say about the intermolecular forces between these molecules?
A higher melting point generally means stronger interparticle forces holding the lattice together, so more thermal energy is needed to break it down — hence a more thermally stable crystal. Typical values: water ≈273 K, diethyl ether ≈157 K, ethanol ≈156–159 K, methane ≈90 K. Water's strong hydrogen bonding gives it by far the highest melting point among these; methane, held only by weak London dispersion forces, has the lowest.

Q1.7. (a) Distinguish between hexagonal close packing and cubic close packing. (b) Distinguish between a crystal lattice and a unit cell. (c) Distinguish between a tetrahedral void and an octahedral void.
(a) In hcp, the third layer sits directly above the first (ABAB… stacking); in ccp, the third layer is offset, and

only the fourth layer repeats the first (ABCABC… stacking). (b) A crystal lattice is the complete three-dimensional array describing every particle's position in the crystal; a unit cell is the smallest repeating block which, stacked in all directions, regenerates the entire lattice. (c) A tetrahedral void is the small gap enclosed by 4 touching spheres; an octahedral void is the larger gap enclosed by 6 touching spheres.

Q1.8. How many lattice points are there in one unit cell of (i) face-centred cubic, (ii) face-centred tetragonal, (iii) body-centred cubic lattices?
Counting the effective number of lattice points belonging to one cell (applying corner = 1/8, face = 1/2, body-centre = 1 share): (i) fcc: 8×1/8 + 6×1/2 = **4**. (ii) Face-centred tetragonal: same sharing geometry as fcc → **4**. (iii) bcc: 8×1/8 + 1 = **2**.

Q1.9. Explain (i) the basis of similarities and differences between metallic and ionic crystals. (ii) Ionic solids are hard and brittle.
(i) *Similarities:* both are held together by electrostatic attraction and both bonding types are non-directional, so both types often have high melting points. *Differences:* ionic solids conduct electricity only when molten or dissolved (the ions must be free to move), while metals conduct in the solid state via delocalised electrons; ionic bond strength depends mainly on ionic charge and size, metallic bond strength depends on the number of delocalised valence electrons and the metal ion core size. (ii) Ionic solids are hard because of strong, uniform electrostatic attraction throughout the lattice, but brittle because that bonding is non-directional — a shearing force shifts a plane of ions so that like-charged ions line up face to face, and the resulting repulsion shatters the crystal.

Q1.10. Calculate the efficiency of packing in case of a metal crystal for (i) simple cubic, (ii) body-centred cubic, (iii) face-centred cubic (with the assumption that atoms are touching each other).
(i) Simple cubic (atoms touch along the edge, a=2r, 1 atom/cell): **52.4%**. (ii) Body-centred cubic (atoms touch along the body diagonal, $\sqrt{3}\cdot a=4r$, 2 atoms/cell): **68%**. (iii) Face-centred cubic (atoms touch along the face diagonal, $\sqrt{2}\cdot a=4r$, 4 atoms/cell): **74%**.

Q1.11. Silver crystallises in an fcc lattice. If the edge length of the cell is 4.07×10^{-8} cm and the density is 10.5 g cm^{-3}, calculate the atomic mass of silver.
$M = d\cdot a^3\cdot N_A/Z$, with Z=4 for fcc: M ≈ **107 g/mol** — close to silver's actual atomic mass (107.87 g/mol), confirming the fcc assumption.

Q1.12. A cubic solid is made up of two elements P and Q. Atoms of Q are at the corners of the cube, and P at the body-centre. What is the formula of the compound? What are the coordination numbers of P and Q?
Q's contribution: 8 corners × 1/8 = 1. P's contribution: 1 (unshared body-centre). Ratio P:Q = 1:1, so the formula is **PQ**. Each atom touches 8 atoms of the other type, so the coordination number of both P and Q is **8**.

Q1.13. Niobium crystallises in a body-centred cubic structure. If its density is 8.55 g cm^{-3}, calculate the atomic radius given that its atomic mass is 93 u.
For bcc, Z=2: $a^3=2M/(d\cdot N_A)$ gives $a\approx3.31\times10^{-8}$ cm (330.6 pm). Using $r=(\sqrt{3}/4)a$ for bcc: **r ≈ 143 pm**.

Q1.14. If the radius of the octahedral void is r and the radius of the atoms in close packing is R, derive the relation between r and R.
For a sphere of radius r fitting exactly into the octahedral void formed by spheres of radius R, geometry gives **r = 0.414R** (r/R ≈ 0.414).

Q1.15. Copper crystallises into an fcc lattice with edge length 3.61×10^{-8} cm. Show that the calculated density is in agreement with its measured value of 8.92 g cm^{-3}.
$d = ZM/(a^3N_A)$, Z=4, M(Cu)=63.5 g/mol: d ≈ **8.97 g/cm^3**, in close agreement with the measured 8.92 g/cm^3

(the small difference reflects real-world lattice imperfections and rounding).

Q1.16. Analysis shows that nickel oxide has the formula $Ni_{0.110.120}$. What fractions of nickel exist as Ni^{2+} and Ni^{3+} ions?
For 98 Ni against 100 O^{2-} (total negative charge=200): if x atoms are Ni^{2+} and (98−x) are Ni^{3+}, then 2x+3(98−x)=200 ⇒ x=94. So **Ni^{2+} fraction = 94/98 ≈ 95.9% (≈96%)** and **Ni^{3+} fraction = 4/98 ≈ 4.1% (≈4%)**.

Q1.17. What is a semiconductor? Describe the two main types of semiconductors and contrast their conduction mechanisms.
A semiconductor has electrical conductivity between that of a conductor and an insulator. **n-type:** doping Si/Ge (group 14) with a group-15 element (e.g. P, As) adds one extra loosely-bound valence electron per dopant atom, which conducts — conduction is by negative charge carriers. **p-type:** doping with a group-13 element (e.g. B, Al) leaves one bond short of an electron, creating an 'electron hole'; neighbouring electrons hop into the hole, which is equivalent to the hole itself migrating — conduction is effectively by positive charge carriers.

Q1.18. Non-stoichiometric cuprous oxide, Cu_2O, can have copper-to-oxygen ratio slightly less than 2:1. Can you account for the fact that this compound is a p-type semiconductor?
A Cu:O ratio below 2:1 means some Cu^+ sites have been replaced by Cu^{2+} ions. To keep the crystal electrically neutral, every two Cu^+ ions removed are replaced by only one Cu^{2+} ion, leaving one cation vacancy (effectively an electron hole) for every substitution. Conduction proceeds via migration of these positive holes, making the compound p-type.

Q1.19. Ferric oxide crystallises in a hexagonal close-packed array of oxide ions with two out of every three octahedral holes occupied by ferric ions. Derive the formula of the ferric oxide.
In hcp, the number of octahedral voids equals the number of packing spheres. For n oxide ions, there are n octahedral voids, of which (2/3)n are filled by Fe^{3+}. Ratio Fe^{3+}:O^{2-} = (2n/3):n = 2:3, giving the formula **Fe_2O_3** — matching the well-known formula of hematite.

Q1.20. Classify each of the following as being p-type or n-type semiconductors: (i) Ge doped with In, (ii) Si doped with B.
(i) Ge (group 14) doped with In (group 13, one fewer valence electron) creates an electron deficiency — **p-type**. (ii) Si (group 14) doped with B (group 13, one fewer valence electron) also creates an electron deficiency — **p-type**.

Q1.21. Gold (atomic radius = 0.144 nm) crystallises in a face-centred unit cell. What is the length of a side of the cell?
For fcc, $a=2\sqrt{2}\cdot r = 2\times1.4142\times0.144$ nm ≈ **0.407 nm**.

Q1.22. In terms of band theory, what is the difference (i) between a conductor and an insulator, (ii) between a conductor and a semiconductor?
(i) In a conductor, the valence band is partially filled or overlaps the conduction band, so electrons flow freely under an applied field; in an insulator, a large energy gap separates a full valence band from an empty conduction band, so electrons cannot be promoted across it under normal conditions. (ii) A semiconductor resembles an insulator but has a much smaller gap, so a modest number of electrons can be thermally promoted across it — and unlike metals, a semiconductor's conductivity actually rises with temperature.

Q1.23. Explain the following terms with suitable examples: (i) Schottky defect, (ii) Frenkel defect, (iii) Interstitial defect, (iv) F-centres.
(i) **Schottky defect:** equal numbers of cation and anion vacancies appear together, typical of ionic solids

with similarly sized ions and high coordination number (e.g. NaCl, KCl) — lowers density. (ii) **Frenkel defect:** a smaller ion (usually the cation) leaves its regular site and lodges in an interstitial space, leaving a vacancy behind without changing overall density; occurs when cation and anion sizes differ greatly (e.g. AgBr, ZnS). (iii) **Interstitial defect:** extra particles occupy normally-empty interstitial spaces without vacating any lattice sites, which increases density. (iv) **F-centres:** anion vacancies that have trapped an electron in their place; these trapped electrons absorb visible light, giving the crystal a characteristic colour (e.g. NaCl heated in sodium vapour turns yellow).

Q1.24. Aluminium crystallises in a cubic close-packed structure. Its metallic radius is 125 pm. (i) What is the length of the side of the unit cell? (ii) How many unit cells are there in 1.00 cm^3 of aluminium?
(i) For fcc, $a=2\sqrt{2}\cdot r = 2\times1.4142\times125$ pm ≈ **354 pm**. (ii) Volume of one cell ≈$(354\text{ pm})^3 \approx 4.4\times10^7$ pm^3 = 4.4×10^{-23} cm^3; number of cells in 1 cm^3 = $1/(4.4\times10^{-23}) \approx$ **2.27×10^{22}**.

Q1.25. If NaCl is doped with 10^{-3} mol % of $SrCl_2$, what is the concentration of cation vacancies?
Each Sr^{2+} replaces two Na^+ ions but occupies only one lattice site, leaving one cation vacancy per Sr^{2+} introduced. Per 100 mol NaCl there are 10^{-3} mol $SrCl_2$, so per 1 mol NaCl there are 10^{-5} mol of vacancies; multiplying by Avogadro's number: **≈6.022×10^{18} cation vacancies per mole of NaCl**.

Q1.26. Explain the following terms with suitable examples: (i) Ferromagnetism, (ii) Paramagnetism, (iii) Ferrimagnetism, (iv) Antiferromagnetism, (v) 12-16 and 13-15 group compounds.
(i) **Ferromagnetism:** unpaired-electron domains align strongly and stay aligned even after the external field is removed, giving strong, permanent magnetism (Fe, Co, Ni). (ii) **Paramagnetism:** substances with unpaired electrons are weakly attracted into a field but lose their alignment once it is removed (O_2, Cu^{2+}). (iii) **Ferrimagnetism:** domains align in both directions but in unequal numbers, giving a net (weaker) magnetic moment; becomes paramagnetic on heating (Fe_3O_4). (iv) **Antiferromagnetism:** domains align in exactly equal and opposite numbers, so moments cancel completely, giving zero net magnetism (MnO). (v) **12-16 and 13-15 compounds:** combining group 12+16 elements (e.g. ZnS, CdS) or group 13+15 elements (e.g. GaAs, InSb) mimics the average valence-4 behaviour of Si/Ge, producing useful semiconducting compounds with partial ionic character.

Why This Chapter Matters

The Solid State builds the geometric and quantitative foundation (unit cells, packing efficiency, density-formula problems) that recurs throughout physical chemistry, and its band-theory/semiconductor content connects directly to material science and electronics — a staple of JEE/NEET question papers even though it is off the current CBSE board syllabus.

Class 12 Chemistry Chapter 1 – Notes and Extra Questions

Along with these NCERT Solutions, students can also use the Class 12 Chemistry Chapter 1 Extra Questions and Class 12 Chemistry Chapter 1 Revision Notes for quick revision and extra practice.